DOE/CF-026
Volume 3

Department of Energy

FY 2009 Congressional Budget Request

Energy Supply and Conservation
Energy Efficiency and Renewable Energy
Electricity Delivery and Energy Reliability
Nuclear Energy
Legacy Management

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February 2008 Office of Chief Financial Officer Volume 3

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The Department of Energy's Congressional Budget justification is available on the Office of Chief Financial Officer, Office of Budget homepage at http://www.cfo.doe.gov/crorg/cf30.htm.

Department of Energy
Appropriation Account Summary
(dollars in thousands - OMB Scoring)

	FY 2007 Current Op. Plan	FY 2008 Current Approp.	FY 2009 Congressional Request	FY 2009 vs. FY 2008	
				$	%
Discretionary Summary By Appropriation					
Energy And Water Development, And Related Agencies					
Appropriation Summary:					
Energy Programs					
Energy efficiency and renewable energy..........................	——	1,722,407	1,255,393	-467,014	-27.1%
Electricity delivery and energy reliability..........................	——	138,556	134,000	-4,556	-3.3%
Nuclear energy..	——	961,665	853,644	-108,021	-11.2%
Legacy management...	——	33,872	——	-33,872	-100.0%
Energy supply and Conservation.....................................	2,145,149	——	——	——	——
Fossil energy programs					
Clean coal technology..	——	-58,000	——	+58,000	+100.0%
Fossil energy research and development.....................	580,946	742,838	754,030	+11,192	+1.5%
Naval petroleum and oil shale reserves.......................	21,316	20,272	19,099	-1,173	-5.8%
Strategic petroleum reserve...	164,441	186,757	344,000	+157,243	+84.2%
Northeast home heating oil reserve..............................	7,966	12,335	9,800	-2,535	-20.6%
Total, Fossil energy programs..	774,669	904,202	1,126,929	+222,727	+24.6%
Uranium enrichment D&D fund..	556,606	622,162	480,333	-141,829	-22.8%
Energy information administration..................................	90,653	95,460	110,595	+15,135	+15.9%
Non-Defense environmental cleanup..............................	349,687	182,263	213,411	+31,148	+17.1%
Science...	3,836,613	3,973,142	4,721,969	+748,827	+18.8%
Nuclear waste disposal..	99,206	187,269	247,371	+60,102	+32.1%
Departmental administration..	147,943	148,415	154,827	+6,412	+4.3%
Inspector general..	41,819	46,057	51,927	+5,870	+12.7%
Innovative technology loan guarantee program..............	——	4,459	——	-4,459	-100.0%
Total, Energy Programs..	8,042,345	9,019,929	9,350,399	+330,470	+3.7%
Atomic Energy Defense Activities					
National nuclear security administration:					
Weapons activities..	6,258,583	6,297,466	6,618,079	+320,613	+5.1%
Defense nuclear nonproliferation..................................	1,824,202	1,335,996	1,247,048	-88,948	-6.7%
Naval reactors...	781,800	774,686	828,054	+53,368	+6.9%
Office of the administrator..	358,291	402,137	404,081	+1,944	+0.5%
Total, National nuclear security administration................	9,222,876	8,810,285	9,097,262	+286,977	+3.3%
Environmental and other defense activities:					
Defense environmental cleanup..................................	5,731,240	5,349,325	5,297,256	-52,069	-1.0%
Other defense activities..	636,271	754,359	1,313,461	+559,102	+74.1%
Defense nuclear waste disposal...................................	346,500	199,171	247,371	+48,200	+24.2%
Total, Environmental & other defense activities..............	6,714,011	6,302,855	6,858,088	+555,233	+8.8%
Total, Atomic Energy Defense Activities............................	15,936,887	15,113,140	15,955,350	+842,210	+5.6%
Power marketing administrations:					
Southeastern power administration.................................	5,602	6,404	7,420	+1,016	+15.9%
Southwestern power administration................................	29,998	30,165	28,414	-1,751	-5.8%
Western area power administration.................................	232,326	228,907	193,346	-35,561	-15.5%
Falcon & Amistad operating & maintenance fund...........	2,665	2,477	2,959	+482	+19.5%
Colorado River Basins...	——	-23,000	-23,000	——	——
Total, Power marketing administrations.............................	270,591	244,953	209,139	-35,814	-14.6%
Federal energy regulatory commission..............................	——	——	——	——	——
Subtotal, Energy And Water Development and Related Agencies..	24,249,823	24,378,022	25,514,888	+1,136,866	+4.7%
Uranium enrichment D&D fund discretionary payments.....	-452,000	-458,787	-463,000	-4,213	-0.9%
Excess fees and recoveries, FERC....................................	-43,595	-34,411	-36,932	-2,521	-7.3%
Total, Discretionary Funding...	**23,754,228**	**23,884,824**	**25,014,956**	**+1,130,132**	**+4.7%**

Energy Supply

Energy Supply

Energy Supply and Conservation

Overview

Appropriation Summary by Program

In FY 2008, Congress created four separate accounts to replace Energy Supply and Conservation: Energy Efficiency and Renewable Energy, Electricity Delivery and Energy Reliability, Nuclear Energy, and Legacy Management. In FY 2009, all Legacy Management activities are funded under Other Defense Activities. Prior to 2008, Environment, Safety and Health programs were funded in two separate accounts (Energy Supply and Conservation and Other Defense Activities). Beginning in 2008, those activities have been restructured and are now funded by the Health, Safety and Security Program within the Other Defense Activities appropriation.

	FY 2007 Current Op. Plan	FY 2008 Current Approp.	FY 2009 Congressional Request
Energy Supply And Conservation			
Energy Efficiency and Renewable Energy			
Hydrogen technology	189,511	——	——
Biomass and biorefinery systems R&D	196,277	——	——
Solar energy	157,028	——	——
Wind energy	48,659	——	——
Geothermal technology	5,000	——	——
Vehicle technologies	183,580	——	——
Building technologies	102,983	——	——
Industrial technologies	55,763	——	——
Federal energy management program	19,480	——	——
Facilities and infrastructure	107,035	——	——
Weatherization and intergovernmental activities	281,731	——	——
Program direction	99,264	——	——
Program support	10,930	——	——
Total, Energy Efficiency and Renewable Energy	1,457,241	——	——
Electricity Delivery & Energy Reliability			
Research and development	96,506	——	——
Operations and analysis	20,500	——	——
Program direction	17,357	——	——
Total, Electricity Delivery & Energy Reliability	134,363	——	——
Nuclear Energy			
University reactor infrastructure and education assistance	16,547	——	——
Research and development	300,452	——	——
Infrastructure	236,417	——	——
Program direction	62,600	——	——
Transfer from state department	12,500	——	——
Total, Nuclear Energy	628,516	——	——
Environment, Safety and Health			
Office of environment, safety andhealth (non-defense)	7,848	——	——
Program direction	19,993	——	——
Total, Environment, Safety and Health	27,841	——	——
Office of Legacy Management	33,187	——	——
Subtotal, Energy Supply and Conservation	2,281,148	——	——
Funding from other defense activities	-122,634	——	——
Funding from Naval Reactors	-13,365	——	——
Total, Energy Supply And Conservation	**2,145,149**	——	——

Energy Efficiency and Renewable Energy

Energy Efficiency and Renewable Energy

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Energy Efficiency and Renewable Energy

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for energy efficiency and renewable energy activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, *and the purchase of not to exceed two passenger vehicles for replacement* [$1,739,541,000] *$1,255,393,000* to remain available until expended[: *Provided*, That the Secretary is directed to make fiscal year 2008 weatherization funding available from October 1, 2007, through March 31, 2009, for States that submit plans requesting allocations for all or part of this period: *Provided further*, That the funds provided for Federal technical assistance and training are intended to be used exclusively to support the effective delivery of weatherization services as set forth in statute and applicable regulations: *Provided further,* That any change in program implementation should be proposed to Congress in the Department's budget submission and not implemented before congressional approval is obtained].

Explanation of Change

The two provisos are deleted because no funds are requested for the Weatherization Assistance Program in FY 2009.

Energy Efficiency and Renewable Energy

Office of Energy Efficiency and Renewable Energy

Overview

Appropriation Summary by Program[a]

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Energy Supply and Conservation					
Hydrogen Technology	189,511	---	---	---	---
Biomass and Biorefinery Systems R&D	196,277	---	---	---	---
Solar Energy	157,028	---	---	---	---
Wind Energy	48,659	---	---	---	---
Geothermal Technology	5,000	---	---	---	---
Water Power	0	---	---	---	---
Vehicle Technologies	183,580	---	---	---	---
Building Technologies	102,983	---	---	---	---
Industrial Technologies	55,763	---	---	---	---
Federal Energy Management Program	19,480	---	---	---	---
Facilities and Infrastructure	107,035	---	---	---	---
Weatherization and Intergovernmental Activities	281,731	---	---	---	---
Program Direction	99,264	---	---	---	---
Program Support	10,930	---	---	---	---
Congressionally Directed	0	---	---	---	---
Subtotal, Energy Efficiency and Renewable Energy	1,457,241	---	---	---	---
Use Of Prior Year Balances	0	---	---	---	---
Total, Energy Efficiency and Renewable Energy	1,457,241	---	---	---	---

[a] The FY 2008 and FY 2009 columns are blank because the appropriation account structure was changed in the FY 2008 Omnibus Appropriations Act.

Energy Efficiency and Renewable Energy

Office of Energy Efficiency and Renewable Energy

Overview

Appropriation Summary by Program[a]

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Energy Efficiency and Renewable Energy					
Hydrogen Technology	---	213,000	-1,938	211,062	146,213[b]
Biomass and Biorefinery Systems R&D	---	200,000	-1,820	198,180	225,000
Solar Energy	---	170,000	-1,547	168,453	156,120
Wind Energy	---	50,000	-455	49,545	52,500
Geothermal Technology	---	20,000	-182	19,818	30,000
Water Power	---	10,000	-91	9,909	3,000
Vehicle Technologies	---	215,000	-1,957	213,043	221,086[b]
Building Technologies	---	110,000	-1,001	108,999	123,765
Industrial Technologies	---	65,000	-592	64,408	62,119
Federal Energy Management Program	---	20,000	-182	19,818	22,000
Facilities and Infrastructure	---	76,876	-700	76,176	13,982
Weatherization and Intergovernmental Activities	---	284,808	-2,591	282,217	58,500
Program Direction	---	105,013	-956	104,057	121,846
Program Support	---	10,900	-99	10,801	20,000
Congressionally Directed	---	189,687	-3,023	186,664	0
Subtotal, Energy Efficiency and Renewable Energy	---	1,740,284	-17,134	1,723,150	1,256,131
Use Of Prior Year Balances	---	-743	0	-743	-738
Total, Energy Efficiency and Renewable Energy	---	1,739,541	-17,134	1,722,407	1,255,393

[a] The FY 2007 column is blank because the appropriation account structure was changed in the FY 2008 Omnibus Appropriation Act.

[b] Some activities previously in the Hydrogen Technology (Technology Validation, Safety and Codes and Standards, and Education) now appear in Vehicle Technologies.

Preface

The Office of Energy Efficiency and Renewable Energy (EERE) is requesting $1.255 billion for Fiscal Year (FY) 2009, approximately $19 Million higher than the FY 2008 request, to manage America's investment in the research, development, and deployment (RD&D) of DOE's diverse energy efficiency and renewable energy applied science portfolio. These funds support a necessary, diverse and critical path of energy efficiency and renewable energy research that, partnered with public and private actions, can help the United States meet the energy challenges of the 21st century. This RD&D portfolio will generate the advances necessary to meet the needs of the American public. It will also significantly contribute to achieving the President's "Twenty in Ten" and the Advanced Energy Initiative (AEI) goals,meet our commitments to managing climate change, and catalyze investment and partnerships necessary to achieve rapid and large-scale change in energy systems.

The EERE portfolio leads Administration efforts to break dependence on foreign energy resources and to transform how we power our economy. The Department's FY 2009 energy program portfolio funding decisions were made by an informed strategic and corporate assessment of all the energy programs in a common context focusing on climate challenges. All of EERE's programs contribute to that challenge. EERE's implementation of the Presidential Initiatives will reduce our dependency on gasoline 20% by 2017 and accelerate breakthroughs in the way we power our cars, homes, and businesses. EERE's budget portfolio is key to addressing those challenges by growing critical elements of Wind, Biomass, Geothermal, Vehicles, Buildings, Industry and support programs; by maintaining key programs such as Solar and the Federal Energy Management Program (FEMP); and by reallocating resources requested for Weatherization programs to support critical growth in R&D. Major reallocations are discussed in the Significant Changes section of the Overview and in detail in the individual program chapters. These funding levels will provide the foundation for a safer, cleaner, and sustainable energy future and expand efforts to get more new technologies into the marketplace more quickly. This request builds upon work in progress in EERE and supports provisions of the Energy Policy Act of 2005 and the recently enacted Energy Independence and Security Act of 2007. In partnership with organizations that leverage EERE program technologies, the EERE portfolio supports the Department's mission to power and secure America's future by developing cost-effective options for reliable, clean, and affordable energy, by addressing barriers to their adoption, and enabling durable policy. This will increase the energy supply and productivity of all sectors of the economy.

The FY 2009 EERE budget maintains focus on key components of the AEI and Twenty in Ten including: the Biofuels Initiative to develop affordable, bio-based transportation fuels from a wider variety of feedstocks and agricultural waste products; advanced automobile efficiency technologies including plug-in hybrid vehicles; the Solar America Initiative to accelerate the development of materials that convert sunlight directly to carbon-free electricity; strategic elements of Hydrogen technology efforts to develop options for hydrogen storage and for hydrogen-powered fuel cells to power vehicles without greenhouse gases; wind energy research to reduce costs and address barriers to wide-scale domestic use of large turbine technology wind power in the U.S.; and expanded emphasis on efficiency in Buildings and Industry which directly address the President's charge to change the way we power our homes and businesses. Consistent with the AEI, we are funding two renewed programs: Water Power to assess and explore new ocean and river technology potentials and a refocused Geothermal Program that concentrates on Enhanced Geothermal Systems (EGS). EGS technologies have significant baseload power and industrial, commercial, and residential heat energy potentials. This budget also continues to address the key EPACT sections and Departmental initiatives to create a stronger link among the basic sciences, applied energy programs, policy tools, and enabling market mechanisms. These linkages will more successfully leverage, focus, and accelerate the specific technology advances needed to overcome barriers and expand the value and use of new and emerging technologies.

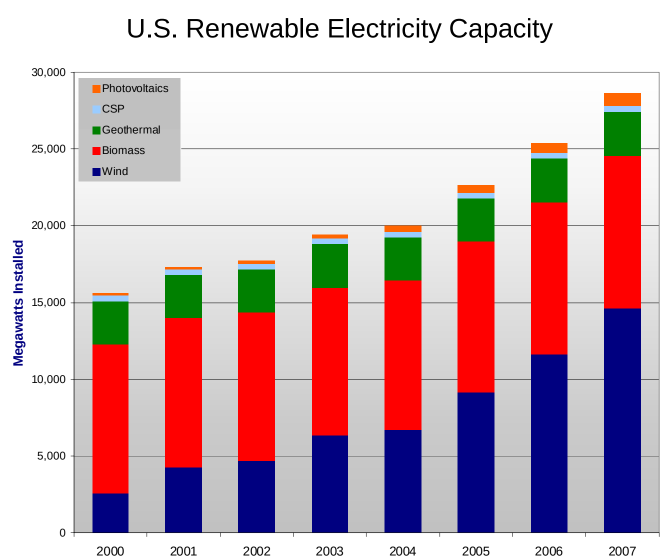
Within the Energy Supply and Conservation Appropriation EERE has 14 programs in FY 2009: Hydrogen Technology (5 subprograms), Biomass and Biorefinery Systems R&D (3 subprograms), Solar Energy (2 subprograms), Geothermal Energy (1 subprogram), Wind Energy (2 subprograms), Water Power (1 subprogram), Vehicle Technologies (5 subprograms), Building Technologies (5 subprograms), Industrial Technologies (2 subprograms), Federal Energy Management Program (3 subprograms), Facilities and Infrastructure (3 subprograms), Weatherization and Intergovernmental Activities (3 subprograms), Program Support (2 subprograms), and Program Direction (4 subprograms).

Mission

Our mission is to develop renewable energy sources and conversion technologies, as well as efficiency best practices, regulations and technologies that collectively strengthen our economy, environment and national security.

Benefits

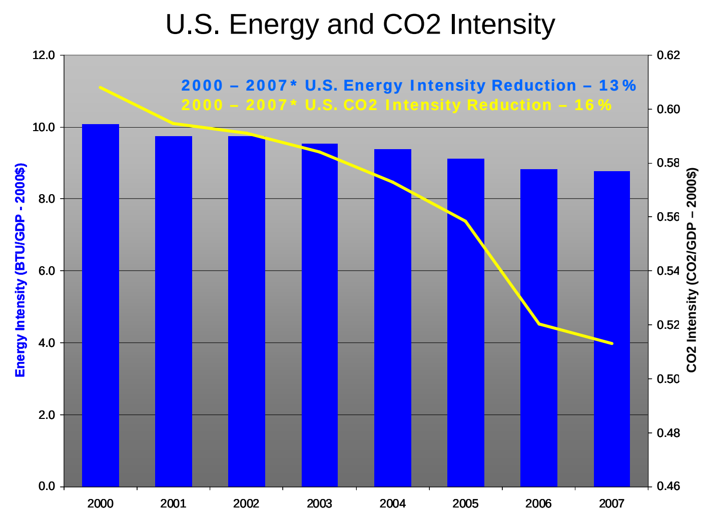
Accomplishing the mission will benefit both the supply and demand sides of the Department's energy security equation, enabling more productive use of the energy we have and accelerating the arrival and use of the new fuels and technologies that we need. Energy efficiency efforts benefit all sectors of the economy that use energy. Some key examples include: lighting that could transform conventional illumination and reduce electricity use by 50 percent or more; appliance standards that save energy for consumers and provide net benefits to the economy; cost-shared partnerships that target America's most energy-intensive industries to help make them more productive and globally competitive; and strategies that reduce the energy use of one of the Nation's largest consumers, the Federal Government itself. Vehicle efficiency continues to be transformed by ongoing research to increase the productivity of key vehicle systems regardless of fuel. Vehicle R&D will continue to reduce the cost of high-power lightweight lithium ion batteries and usher in plug-in hybrid vehicles as viable near- and



mid-term options for the oil-dependent transportation sector. As we achieve our R&D objectives on the biofuels and hydrogen components of the fuels of tomorrow, and effectively partner with industry, we fundamentally change our domestic energy economy's import dependence. EERE continues to advance the critical next system components improvements in wind power technologies and the conversion efficiencies of photovoltaic components. Aggressive development of these key technologies is a precondition to large scale adoption. When this progress in renewables and efficiency technologies is combined with our efforts to address market barriers, our investment in R&D will enable accelerated and large-scale contributions to meet the growth in energy demand across the Nation, while diversifying energy supply, reducing greenhouse gas emissions and, improving our domestic economy and competitiveness.

These integrated programs directly contribute to the Departmental goal by: (1) reducing demand-side pressure on our energy markets (mitigates costs); (2) reducing oil imports; (3) diversifying the mix of domestic energy production; (4) providing smaller and decentralized alternative and non-fuel based sources of electricity generation that are inherently less susceptible to interruption or attack; and (5) resolving the technology and market components of barriers to widespread use of these solutions. These provide the principal energy technologies and pathways that break barriers, accelerate markets and underpin durable policies that enable the Nation to achieve its energy and Climate Change Technology Program goals.

As depicted in the bar chart in the benefits section below, the diverse EERE clean energy programs have catalyzed unprecedented growth rates of renewable energy and efficiency gains through adoption of technology cultivated by the Office growing by half this decade. Biofuels production has also reached record levels, with the U.S. now leading the world -- producing over 6 billion gallons annually (as a result of the 25% growth in the industry). In addition to energy supply gains, U.S. deployment of energy efficiency technologies has contributed to a reduction in energy intensity (energy consumption per dollar of gross domestic product) of 13% for the U.S. economy since 2000 shown in the energy intensity line graph.



The EERE portfolio will deliver significant security, economic, and environmental benefits. Drawing upon (1) the Energy Information Administration's (EIA) expectations of energy supply, demand, and cost; and (2) recent EERE scenario modeled estimates of our programs' goals in integrated energy-economy models, we expect that achievement of EERE program goals would provide significant consumer savings; electric power sector cost savings; and imported oil offsets; and significantly diversify our transportation energy portfolio

The Department and the Office of Management and Budget have been working with the Congress to create a budget in which results, expected benefits and costs are expressed across the department in a way that both the informed and casual reader can understand and reasonably compare the benefits that the budget is expected to deliver. This year's portfolio analysis includes EERE program assessment of what benefits are possible to achieve, e.g., if barriers were successfully addressed, technology goals were achieved, and resources were made available as necessary. The achievement of EERE program goals could save consumers over $600 billion by the year 2030[a] and as much as $4 trillion by 2050 (cumulatively); and reduce annual costs to the electric power sector by $200 billion and $700 billion in by those years, respectively. Similarly, we expect that our portfolio will avoid 6 gigatons of carbon (GTC) by 2030 and nearly 50 GTC by 2050. Finally, we expect that our portfolio will offset 5 billion barrels of imported oil by 2030 and more than 60 billion barrels by 2050, respectively, considerably diversifying our portfolio with substitutions for oil. More detailed expected benefits estimates are provided in the Expected Program Outcomes section at the end of this Overview, and in the individual program sections.

The Department plans to follow up and continue the progress made this year in presenting a common context for considering the energy portfolio. In the next budget cycle the Department plans to weave together the processes and the benefits estimation methodologies of the energy programs (evolved from the OMB PART recommendations to the applied energy R&D programs and the Department's need to assess market potential and benefits in the economic and energy context).

Next year's analysis is planned to expand the comparability of benefits to produce a more robust framework for R&D investment and portfolio decisions. In the future, more robust risk analyses is planned across Department technologies, and we will continue to build new energy-economy modeling capabilities that will allow explicit consideration of risk and uncertainty with common baselines.

Strategic Themes and Goals and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Energy Efficiency and Renewable Energy appropriation supports the following goals:

Strategic Theme 1, Energy Security: Promoting America's energy security through reliable, clean, and affordable energy.

Strategic Goal 1.1, Energy Diversity: Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs.

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Goal 1.3, Energy Infrastructure: Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

Strategic Goal 1.4, Energy Productivity: Cost-effectively improve the energy efficiency of the U.S. economy.

Strategic Theme 3, Scientific Discovery and Innovation: Strengthening U.S. scientific discovery, economic competitiveness, and improving quality of life through innovations in science and technology.

Strategic Goal 3.3, Research Integration: Integrate basic and applied research to accelerate innovation and to create transformational solutions for energy and other U.S. needs.

The programs funded within the Energy Supply and Conservation appropriation have twelve GPRA Unit Program Goals that contribute to the Strategic Goals in the "goal cascade." These goals are:

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[a] References in these justification documents to future years represent calendar years unless otherwise noted.

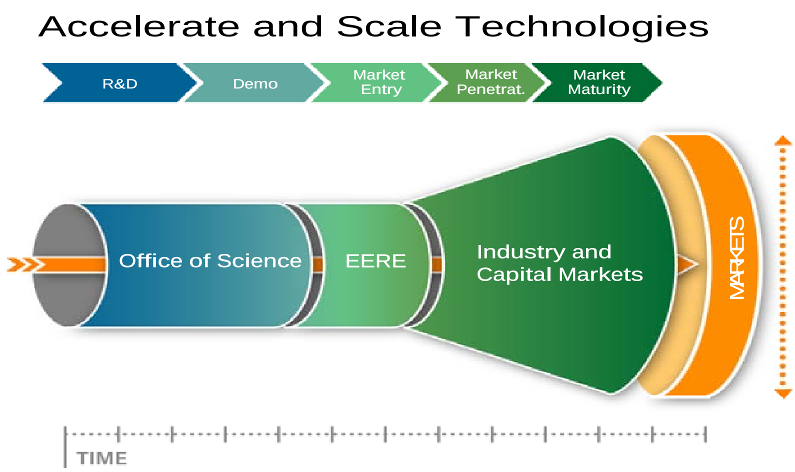
- GPRA Unit Program Goal 1.1.01.00: Hydrogen/ Fuel Cell Technology - Develop fuel cell and vehicle storage technologies to the point that they are cost and performance competitive and are being used by the Nation's transportation, energy, and power industries. Development of these technologies will also make our clean domestic energy supplies more flexible, dramatically reducing or even ending dependence on foreign oil.
- GPRA Unit Program Goal 1.1.06.00: Biomass and Biorefinery Systems R&D - Develop biorefinery-related technologies associated with the different biomass resource pathways to the point that they can compete in terms of cost and performance and are used by the Nation's transportation, chemical, agriculture, forestry, and power industries to meet their respective market objectives. This helps the Nation expand its clean, sustainable energy supplies, improve its energy infrastructure, and reduce its greenhouse gases emissions, fossil energy consumption and dependence on foreign oil.
- GPRA Unit Program Goal 1.1.03.00: Solar Energy - The Solar Program goal is to improve the performance and reduce the cost of solar energy systems to make solar power cost-competitive with conventional electricity sources by 2015, thereby accelerating large-scale usage across the Nation and making a significant contribution to a clean, reliable and flexible U.S. energy supply.
- GPRA Unit Program Goal 1.1.04.00: Wind Energy - The goal of the Wind Program is to enable wind to compete with conventional fuel throughout the Nation, creating a clean renewable energy option. The Department accomplishes this through technology research and development, collaborative efforts, technical support and outreach to overcome barriers in energy cost, energy market and infrastructure rules and energy sector acceptance.
- GPRA Unit Program Goal 1.1.05.00: Geothermal Technology - the Geothermal Technology Program goal is to improve technology that will enable the private sector to create commercial EGS.
- GPRA Unit Program Goal 1.1.08.00: Water Power - The Water Power Program's goal is to identify the potential of water power energy systems becoming cost-competitive with conventional electricity sources, making a significant contribution to a clean, reliable and flexible U.S. energy supply.
- GPRA Unit Program Goal 1.1.02.00: Vehicle Technologies - The Vehicle Technologies Program goal is developing technologies that enable cars and trucks to become highly efficient, through improved power technologies and cleaner domestic fuels, while remaining cost- and performance-competitive. Manufacturers and consumers can then use these technologies to help the Nation reduce both petroleum use and greenhouse gas emissions.
- GPRA Unit Program Goal 1.4.20.00: Building Technologies - The Building Technologies Program goal is to develop cost effective tools, techniques and integrated technologies, systems and designs for buildings that generate and use energy so efficiently that buildings are capable of generating as much energy as they consume.
- GPRA Unit Program Goal 1.3.19.00: Industrial Technologies - The Industrial Technology Program goal is to partner with our most energy-intensive industries in strategic planning and specific RD&D to develop the technologies needed to use energy efficiently in their industrial processes and cost-effectively generate much of the energy they consume. The result of these activities will save feedstock and process energy, improve the environmental performance of industry, and help America's economic competitiveness.
- GPRA Unit Program Goal 1.1.07.00: DEMP/FEMP - The Federal Energy Management Program goal is to provide assistance with project financing and technical assistance to Federal agencies to

further the use of cost-effective energy efficiency and renewable energy. FEMP's activities enhance energy security, environmental stewardship and cost reduction within the Federal Government.

- GPRA Unit Program Goal 1.4.22.000: State Energy Programs - The State Energy Program contributes to Strategic Goal 1.4 by influencing state promotion and adoption of affordable energy efficiency and renewable energy technologies.

Contribution to Strategic Goal

The EERE Programs – Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Water Power, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, and Weatherization and Intergovernmental Activities – as well as our administrative activities – Facilities and Infrastructure, Program Direction, and Program Support – all combine to contribute to Strategic Theme 1. EERE works with science, supply, productivity, and process management programs to reduce both the probability and potential magnitude of energy-based disruptions, and to improve the Nation's mix of clean affordable energy options and to accelerate and expand adoption of those solutions to large scale growth through industry and capital investment.



Individual program activities planned for, and funded by this appropriation, would contribute to these improvements in the following ways under business-as-usual conditions.[a]

- Hydrogen Technology contributes to this goal by developing cost-competitive storage technologies and by improving the durability of fuel cells while reducing their cost. Specific goals include reducing the cost of automotive fuel cell systems to $30/kW, and developing storage technologies that enable greater than 300-mile vehicle driving range. The key intermediate technology target for fuel cells is reducing the production cost of the fuel cell power system to $45/kW by 2010. Collectively, and with enabling technologies from the Vehicle Technologies program, our modeling suggests that these technologies could displace 0.3 million barrels per day (mbpd) of oil in 2030 and as these hydrogen technologies enter the market in significant numbers, oil displacement could increase to over 2 mbpd in 2050. Additionally, they provide the option for substantially faster growth in hydrogen use if energy markets demand more rapid change.

- Biomass and Biorefinery Systems R&D contributes to this goal by developing cost and performance competitive biorefinery related technologies associated with the different biomass resource pathways which are used by the Nation's transportation, chemical, agriculture, forestry, and power industries to meet their respective market objectives. This helps the Nation expand its clean, sustainable energy supplies, improve its energy infrastructure, reduce its greenhouse gas emissions, and reduce fossil

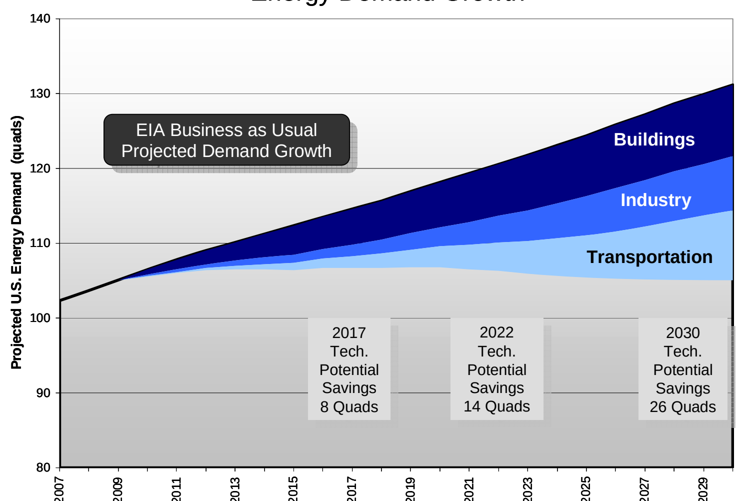
[a] Important information regarding benefits estimation assumptions and methods are discussed in the Expected Integrated Program Outcomes section in the Overview.

fuel consumption. As outlined by the President's Advanced Energy Initiative (AEI), the program's goal is to develop and demonstrate cost-competitive technology for the conversion of cellulosic biomass to ethanol by 2012. The program's R&D will contribute key technologies that help in the displacement of significant gasoline demand.

- Solar Energy contributes to this goal by accelerating breakthroughs in advanced solar energy technologies to help address the critical national goal of energy security by changing the way we power our homes and businesses. The Solar America Initiative under the AEI aims to reduce the cost of solar photovoltaic technologies so that they become cost-competitive by 2015, which accelerates the technology development by five years compared to the prior program. Solar energy also improves the environment by reducing greenhouse gases, creates more reliable infrastructure through on-site distributed systems, and is important to achieving the possibility of "zero energy buildings" that produce as much energy as they use (net, on an annual basis), when coupled with energy efficient technologies and building designs.

- Wind Energy contributes to this goal by developing wind technologies that will provide large scale wind production in Class-4 wind conditions at $0.036/kWh for land-based applications by 2012, in Class-6 wind conditions at $0.07/kWh for offshore shallow water by 2014. The program also addresses the barriers to large-scale use of wind energy in the United States which could significantly accelerate and expand wind generation of electricity.

Energy Efficiency Has the Technical Potential to Level Energy Demand Growth



- Water Power contributes to this goal by facilitating development and deployment of hydrokinetic technologies as a key regional renewable energy resource through national laboratories and U.S. industry resource experts. Rapid development of the vast ocean and river energy resources [10,000 MW from ocean wave energy technologies and 3,000 MW from current (ocean and tidal) technologies] will serve to increase and diversify the domestic energy supply, thus offering the United States another clean, domestic energy source that will help mitigate utility sector greenhouse gas emissions, and support our Nation's energy independence and national security.

- Vehicle Technologies contribute to this goal by developing technologies for highly efficient cars and trucks including: more efficient combustion engines and corresponding clean fuels; power electronics, batteries, and hybrid systems for both conventional and plug-in hybrid vehicles (and ultimately for fuel cell vehicles); and lightweight vehicle materials. Technology goals include reducing the cost of a 25 kW hybrid vehicle battery pack from $3,000 in 1998 to $500 in 2010; improving advanced light-duty engine combustion efficiency from 30 percent in 2002 to 45 percent in 2010; and developing lightweight materials that could reduce the weight of a passenger car or light truck by 50 percent by 2010. Our modeling suggests that the Vehicle Technologies Program technologies could displace oil imports of nearly 2 million barrels per day (mbpd) by 2030 and nearly 6 mbpd in 2050, based on projected market conditions.

- Building Technologies contribute to this goal by developing advanced lighting and appliances, which, when coupled with improved building system integration and design, could provide marketable technologies that can reduce energy use by up to 70 percent in homes by 2020. Interim goals by 2010 include: five Building America technology packages that can achieve an average of 40 percent reduction in whole house end use energy will be developed and evaluated; up to fourteen technology packages that can achieve 30 percent reduction in the purchased energy use in new, small commercial buildings relative to ASHRAE 90.1-2004 will be developed; and issuing 13 formal proposals for product standards and test procedures.. Improvements in equipment standards, building codes, and consumer access to these technologies could also facilitate marketable improvements in the efficiency of existing buildings, when these contributions are taken all together they could improve building efficiency by up to 20 percent. If successful, our modeling suggests that these activities could reduce building energy use by nearly 1.3 Quads per year in 2030 and nearly 2.1 Quads by 2050.
- Industrial Technologies contribute to the goal of cost-effectively improving the energy efficiency of the U.S. economy by helping to improve the energy efficiency of the Nation's industrial sector through a coordinated program of research and development, validation, and dissemination of energy-efficiency technologies and operating practices. Energy efficiency improvements in the industrial sector directly reduce the demand for oil, natural gas, and electricity, building economic strength for a more secure future that does not depend so heavily on imported fossil fuels and produces fewer carbon emissions. Our modeling suggests that the Industrial Technologies program could contribute to a 14.9 percent reduction in energy intensity in energy-intensive industries between 2003 and 2015.
- FEMP contributes to this goal through project financing, technical assistance, and project evaluation which will facilitate Federal facility energy efficiency and renewable energy investments. Our analysis suggests that FEMP activities could result in lifecycle energy savings of approximately 20 trillion Btus each year from 2008 to 2011. FEMP is helping agencies reach the goal of Executive Order 13423 (all Federal agencies reduce energy intensity in Federal buildings by 35 percent by 2010 from 1985 levels), and to reach the goal of the Energy Policy Act of 2005 to reduce energy consumption per square foot by 20 percent by 2015, at a rate of 2 percent per year.
- Weatherization and Intergovernmental Activities contributes to this goal by accelerating adoption of cost-effective efficient technologies state energy grants, and intergovernmental activities which will help reduce energy intensity in all sectors of the economy. If the targets are met and sustained, the activities could contribute to improved quality of life for millions of people. Additionally, our analysis suggests that Intergovernmental Activities will contribute to the building of as much as 80 MW of new renewable energy generating capacity on American Indian lands by 2012.
- Program Direction contributes to EERE through direct staffing and support of the programs addressing the energy security goals and continued work to implement the President's Management Agenda.
- Program Support provides two types of corporately focused contributions. The Planning, Analysis, and Evaluation subprogram establishes and maintains the methods, information base, and standards for planning and analysis, budget formulation, performance management and evaluation. The Technology Advancement and Outreach subprogram manages and creates regular, consistent current

content through targeted multi-media outreach and information products that inform new audiences of important energy choices and keep EERE stakeholders advised of corporate management issues affecting EERE operations.

These technology and market improvements also help prepare the Nation for future economic, environmental, and energy security needs by providing options for additional fuel savings, air emission reductions and electricity reliability and energy diversity improvements beyond those expected under business-as-usual scenarios.

Funding by Strategic and GPRA Unit Program Goal

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Strategic Goals 1.1, Energy Diversity; 1.3, Energy Infrastructure; 1.4, Energy Productivity; and 3.3, Research Integration			
GPRA Unit Program Goal 1.1.01.00, Hydrogen Technology	189,511	211,062	146,213
GPRA Unit Program Goal 1.1.06.00, Biomass and Biorefinery Systems R&D[a]	196,277	198,180	225,000
GPRA Unit Program Goal 1.1.03.00, Solar Energy	157,028	168,453	156,120
GPRA Unit Program Goal 1.1.04.00, Wind Energy	48,659	49,545	52,500
GPRA Unit Program Goal 1.1.05.00, Geothermal Technology[a]	5,000	19,818	30,000
GPRA Unit Program Goal 1.1.08.00, Water Power	0	9,909	3,000
GPRA Unit Program Goal 1.1.02.00, Vehicle Technologies	183,580	213,043	221,086
Total, Strategic Goal 1.1, Energy Diversity	780,055	870,010	833,919
Strategic Goal 1.4, Energy Productivity			
GPRA Unit Program Goal 1.4.20.00, Building Technologies[a]	102,983	108,999	123,765
GPRA Unit Program Goal 1.3.19.00, Industrial Technologies	55,763	64,408	62,119
GPRA Unit Program Goal 1.4.07.00, Departmental Energy Management Program/Federal Energy Management Program	19,480	19,818	22,000
GPRA Unit Program Goal 1.4.21.00, Weatherization	204,550	227,222	0
GPRA Unit Program Goal 1.4.22.00, State Energy Programs	58,805	44,095	50,000
Total, Strategic Goal 1.4, Energy Productivity	441,581	464,542	257,884
Subtotal, Strategic Goals 1.1, 1.3, 1.4, and 3.3 (Energy Supply and Conservation)	1,221,636	1,334,552	1,091,803

[a] Also supports Strategic Goal 3.3, Research Integration.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
All Other			
Facilities and Infrastructure	107,035	76,176	13,982
Weatherization and Intergovernmental Activities/Intergovernmental Activities	18,376	10,900	8,500
Program Support	10,930	10,801	20,000
Program Direction	99,264	104,057	121,846
Congressionally-Directed Activities	0	186,664	0
Total, All Other	235,605	388,598	164,328
Less Use of Prior Year Balances	0	-743	-738
Total, Strategic Goals 1.1, 1.3, 1.4, and 3.3 (Energy Supply and Conservation)	1,457,241	1,722,407	1,255,393

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by the Office of Management and Budget (OMB) to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The current focus is to establish outcome- and output-oriented goals, the successful completion of which will lead to benefits to the public, such as increased energy security, and improved environmental conditions. DOE has incorporated feedback from OMB into the FY 2009 Budget Request, and the Department will take the necessary steps to continue to improve performance.

All EERE programs (except for the new Water Power Program) have been assessed using the PART as of 2005, and one program was re-assessed in 2006 (Hydrogen Technology). Program performance information and improvement plans were updated in the fall of 2007. The most recent information is available on www.ExpectMore.gov. Individual programs have taken action to address PART findings and recommendations within their direct control and many recommendations have been completely addressed. Many of EERE's FY 2009 performance targets are consistent with and support PART measures; the Department is striving to further improve consistency.

The Department has responded to the PART recommendation of "Develop guidance that specifies a consistent framework for analyzing the costs and benefits of research and development investments, and use this information to guide budget decisions." The Department continues to work on the development and implementation of common assumptions, a consistent approach to incorporation of risk, and other issues. EERE continues to refine the methods it uses in support of this framework and Departmental processes.

Basic and Applied R&D Coordination

EERE coordinates and collaborates significantly with the Office of Science. We collaborate to (1) ensure the products of their basic research and science skill sets are productively designed and developed to help address the technology based barriers and opportunities the programs face where appropriate; and (2) to ensure that the DOE R&D is strategically and cost effectively planned for both organizations. Cooperative areas between the Biomass, Solar, Wind, Geothermal and FEMP programs and Science extend beyond direct budgetary cooperation indicated below:

The Vehicle Technologies Program (VT) pursues a broad technology portfolio aimed at reducing petroleum consumption. The VT Energy Storage activity coordinates with other DOE programs doing relevant work in advanced battery technologies in order to maximize the return on DOE's technology investments in this area. In coordination with the Office of Basic Energy Sciences and the Office of Electricity Delivery and Energy Reliability, the VT energy storage activity will participate in integrated activities to support development of nanoscale materials and architectures for electrical energy storage. Nanomaterials can exhibit superior performance over conventional battery materials in terms of high pulse discharge and recharge power and improved performance at low temperatures. However, the behavior of these materials is not well understood and is thought to be more than just a length-scale effect. New diagnostic tools and techniques could be required to investigate these materials.

The VT Advanced Combustion R&D activity collaborates with the Office of Science through its combustion research and modeling activities which are conducted at Office of Science facilities at Sandia National Laboratory /Combustion Research Facility and the Argonne Laboratory/Advanced Photon Source. Although Vehicle Technologies pays for the salaries of the researchers, the bulk of the equipment and the facilities are owned and operated by the Office of Science. Work conducted at these facilities is fully integrated into the Office of Science activities and cost sharing is obtained through the free use of the equipment and facilities.

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Applied mathematics for optimization of complex systems, control theory, and risk assessment			
Vehicle Technologies	Active Collaboration		500
Electrical Energy Storage			
Vehicle Technologies	Active Collaboration		2,000

Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by this budget are displayed below.

Indirect-Funded Maintenance and Repair

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
National Renewable Energy Laboratory	2,543	2,512	2,043
Total, Indirect-Funded Maintenance and Repair	2,543	2,512	2,043

Direct-Funded Maintenance and Repair

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
National Renewable Energy Laboratory	3,362	4,935	3,576
Total, Direct-Funded Maintenance and Repair	3,362	4,935	3,576

Significant Changes

Hydrogen Technology

Within a constrained budget, the EERE Hydrogen Program will devote resources to its highest priority critical path work in fuel cell research, hydrogen storage, and supporting activities. Approximately $40 million in Hydrogen Production and Delivery R&D is being deferred and three activities in the Hydrogen Technology Program (Technology Validation, Safety & Codes & Standards, and Education) are being transferred to the Vehicle Technologies Program (VT). The Technology Validation activity is focused on demonstrating fuel-cell vehicles and their refueling infrastructure, and the shift places this activity in the same VT subprogram (Hybrid Electric Systems) as other vehicle test activities. The intent is to optimize coordination and integration among related efforts, and to better ensure a "fuel-neutral" approach not only for Technology Validation efforts but for Education and Safety, Codes, and Standards as well.

The $16 million increase in Hydrogen Storage R&D supports R&D on materials-based hydrogen storage technologies focusing on metal hydrides and sorbent materials, and on chemical hydrogen storage, as well as continuation of engineering science of sub-systems and storage materials safety for the overall storage systems. It includes investment in the new Engineering Science Center of Excellence for systems engineering capabilities needed to meet total storage system targets and new awards for high-throughput synthesis and testing of novel hydrogen storage materials. The planned additional funding supports critical R&D that is required to meet the 2010 performance targets (2.0 kWh/kg and 1.5 kWh/L) and for meeting the longer term 2015 targets of 3.0 kWh/kg and 2.7 kWh/L.

The $19.1 million increase in Fuel Cell Stack Component R&D will allow examination of innovative concepts to improve fuel cell performance through simplified, integrated or eliminated components or functions in fuel cell systems. Ionomer and membrane materials that conduct protons at low relative humidity (25-50% RH) and at temperatures from below freezing up to 120°C will be synthesized. Catalyst degradation mechanisms will be determined and strategies will be developed to meet the targets for electrochemical area loss as well as increase catalyst activity and utilization.

Biomass and Biorefinery Systems R&D

In Feedstock Infrastructure, a $3.0 million increase is added for Regional Biomass Feedstock Development Partnerships and Infrastructure Core R&D to address barriers to accessing biomass resources and feedstock supply. The activities include: resource assessment, education, sustainable agronomic systems development, and biomass crop development. Regional Biomass Feedstock Development Partnerships R&D will also establish a regional Geographic Information System-based feedstock atlas.

Biochemical Platform R&D will be reduced by $7.0 million, for this year only, to support high priority requirements among the EPACT Section 932 integrated biorefinery demonstration projects and the 10% of commercial scale demonstration projects within the Utilization of Platform Outputs R&D subprogram. Projects and agreements in the Biochemical Platform linked to the AEI cost goal and the "Twenty in Ten" goal are still fully supported at this funding level.

Biorefinery technology integration is increased by $35.4 million to support multi-year contractual agreements for EPACT Section 932 integrated biorefinery demonstration projects and the 10% of commercial scale demonstration projects initiated in Fiscal Year 2007. These activities will address challenges from fuels distribution to vehicle end use in order to achieve large scale market adaptation of biofuels from biorefineries.

Products Development will increase by $5.8 million to support the five public-private partnership projects for fermentation organism (aka ethanologen) development selected for award in Fiscal Year 2007. Additionally, the funding level allows the program to assess, prioritize, and initiate addressing R&D barriers for other biofuels options beyond cellulosic ethanol.

Solar Energy

The $0.7 million decrease in concentrating solar power (CSP) reflects the anticipated down-selection of CSP industry Contracts. The $2 million decrease in solar heating reflects the transfer of the program to buildings to improve integration.

Wind Energy

The Low Wind Speed Technology reduction of $3.1 million is due to the shift to the CRADA process for development of utility scale turbines and a reduction in funding for offshore wind technology assessment. The $7.4 million increase provides additional CRADAs for promoting wind energy technology advancements and improved collaboration in testing at the NWTC.

Geothermal Technology

The $10.2 million increase, continues the refocused Enhanced Geothermal Systems R&D initiated by Congress in the FY 2008 appropriations. The program will utilize cost-shared field sites and a dedicated field test site through solicitations to find and develop a site and partners for EGS field work at existing well sites. This work encompasses possible drilling/recompletion of wells, reservoir fracturing, establishment of a fluid circulation loop, and long term (two year minimum) reservoir testing.

Water Power

Initiated by Congress in FY 2008, the Water Power Program is requesting $3.0 million to complete initial program activities focused on assessing the U.S. wave and current resources, identifying prime domestic potential; technology characterizations of the various ocean energy conversion technologies, with the goal of determining cost, and performance and reliability characteristics. The program will also begin developing industry partnerships to best position U.S. industry to take advantage of our findings and prepare an RD&D roadmap to accelerate development of promising technologies.

Vehicle Technologies

The Vehicles Technology budget includes $15 million for technology validation of hydrogen infrastructure and fuel-cell vehicles, previously funded in the Hydrogen Technology Program. This activity is located in the same subprogram as existing vehicle test and validation efforts in order to gain synergies. On a "comparable" basis, this is a $15 million reduction for former Hydrogen Program Technology Validation activities, specifically deferring testing of vehicles with advanced "generation 2" fuel cells to fund R&D priorities with higher potential for oil savings and greenhouse gas emissions reduction.

The VT budget also includes an increase of $4 million for Hydrogen Education and $12 million for, Safety & Codes & Standards (S&C&S), reflecting the transfer integration of these activities previously funded in the Hydrogen program. On a comparable basis, this is a $4 million decrease in S&C&S delaying hydrogen based quantitative risk assessment, component and system level testing, leak detection technologies, and fuel quality R&D until earlier critical path technologies have made key advances.

Building Technologies

Overall the Building Technologies Program is increased by nearly $15 million. Building Energy Codes will increase $4 million to provide analyses and code changes to ASHRAE 90.1 and the IECC for residential buildings. Over $3 million is for The Solar Decathlon which was transferred from the Solar Program is a high-profile university-based energy efficiency solar building competition. Within Emerging Technologies, the Solar Heating and Cooling activity transferred from the Solar Program to allow better program integration of the R,D&D, is increased by nearly $4 million.

Facilities

The request for Facilities and Infrastructure represents a $62 million decrease. In FY 2008, Congress provided substantial additional funds to begin two new construction projects: 1) $54.5 million for Phase I (design/construction) of the Energy Systems Integration Facility (ESIF); and 2) $6.8 million for the South Table Mountain Infrastructure (STM) project. Congress also provided $7.9 million continue outfitting the Science & Technology Facility (STF) with new capital equipment and to replace outdated equipment at the Solar Energy Research Facility (SERF). The FY 2009 request of nearly $14 million includes a $3 million increase for General Plant Projects and General Capital Equipment on the NREL research campus, as well as the remaining $4 million needed for ESIF Phase I. ESIF Phase II funds (which include specialized equipment and advanced computational capabilities) will be requested in subsequent budgets. In FY 2009, funds for STF and SERF equipment are included within the Solar Energy Program budget, where program-specific capital equipment needs are traditionally requested.

Weatherization and Intergovernmental Assistance

Weatherization Assistance Funds are reduced by $227.2 million and redirected to R&D programs which deliver greater benefits.

State energy programs were increased a net of $5.9 million. State grants also reduced by $9.2 million which was shifted to State Energy Program Special Projects which was increased by $5.9 million for higher yield competitive grants to States pursuing state and local innovations that can be replicated, including removing market barriers at the state level, crosscutting solutions, improving liquidity of renewable power, reducing barriers to utility investment in energy efficiency to meet future electricity demand, scaling up the use of energy saving performance contracting, and expanding state/pilot models for green mortgages.

The Renewable Energy Production Incentive is eliminated ($5.0 million) as its incentive value is negligible given improved renewable energy technology cost competitiveness and the limited amount of funds being dispersed to even larger numbers of eligible recipients; and state initiatives and policies like Renewable Portfolio Standards providing effective alternatives.

Program Direction

The $17.8 million increase in program direction reflects cost of living increases, provides for hires of 30 new employees with critical skills, and supports additional mission-related work to improve project management, support and oversight.

Key Accomplishments

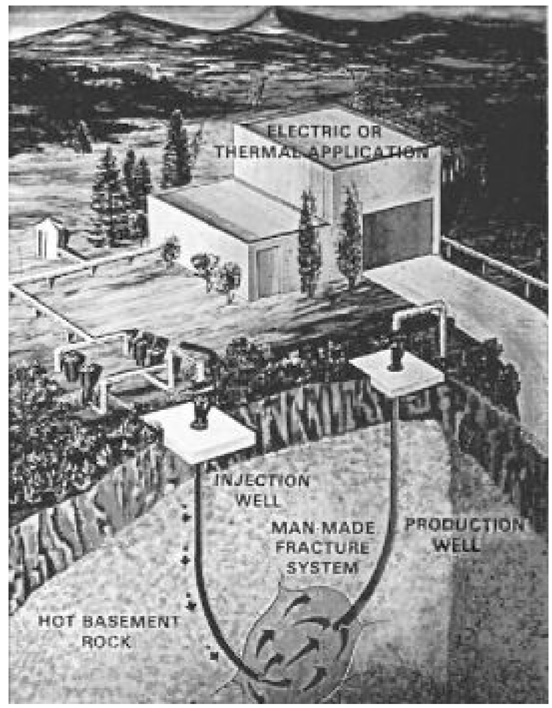
In addition to the scheduled individual targets completed by the programs in FY 2007, several noteworthy system delivery accomplishments took place this year that put the individual R&D elements to work moving the Nation toward its energy security goals. Some noteworthy examples include:

Hydrogen Technology (HT) made significant progress with its partners in several critical areas: HT and DuPont developed a fuel cell membrane with nearly 5,000 hour durability; HT and Lawrence Livermore National Lab demonstrated a novel "cryo-compressed" hydrogen storage technology on-board a vehicle, meeting the 2007 target of 4.5 percent by weight; HT and NREL established an integrated wind turbine-electrolyzer research and test facility to develop cost-effective integrated renewable electrolysis technology. To accelerate early market acceptance, HT executed an interagency agreement with the Department of Defense (DOD) to deploy 80 fuel cell-powered fork lifts at three DOD installations.

The Biomass Program accelerated cellulosic ethanol production cost reduction by investing a total of $650 million in competitively awarded private sector and university RD&D directed at a 10% scale-up, and alternative approaches, for next generation cellusoic production. The Program established Regional Feedstock Partnerships in five regions throughout the U.S. to address the availability of sustainable biomass feedstocks for future biorefineries, and hosted the interagency National Biofuels Action Planning forum to coordinate Federal activities in support of the President's AEI and "Twenty in Ten" initiatives.

Solar Technologies' R&D partner Spectrolab, Inc., achieved a new world record in terrestrial concentrator solar cell efficiency. Using concentrated sunlight, Spectrolab demonstrated the ability of a photovoltaic cell to convert 40.7 percent of the sun's energy into electricity. NREL verified this technology milestone which will dramatically reduce the cost of generating electricity from solar energy.

The Wind Program made significant advances in several areas: formation of a Wind Industry Reliability Collaborative to focus on improving operations and maintenance (O&M) practices, which made substantial progress in reducing the failure rates of gearboxes, a large source of O&M problems; selection of two partners to build significantly larger testing facilities, essential to reducing the technical and financial risk of deploying mass-produced wind turbine blades; and the launch of the Skystream 1.7 kW wind turbine, the first residential turbine designed for suburban environments, meeting the Wind Program's cost of energy goal (under 15 cents/kWh).



Geothermal Technology cosponsored UTC Power 400kW binary system won a 2007 R&D 100 Award for generating electricity from the lowest temperature resource to date (74ºC) at Chena Hot Springs Resort, the first site in Alaska to generate electricity from a geothermal resource. Other advances included the development of a well monitoring tool with the capability of operating at 300ºC, twice the temperature reliability of those commercially available. This technology will be increasingly important for future EGS technology development.

Vehicle Technologies significantly shifted its focus to plug-in hybrid electric vehicles and initiated new research into motors, batteries, and power electronics as well as vehicle demonstration activities. The program verified achievement of the FreedomCAR Partnership goal of 42 percent peak brake efficiency on a GM 1.9 liter passenger car diesel engine, a 23.5 percent improvement over an equivalent conventional gasoline engine, and awarded seven projects to develop production-intent engines optimized to use ethanol for the next generation of flexible-fuel vehicles.

The Buildings Program addressed prior year constraints and returned to its schedule for addressing efficiency standards and test procedures for existing covered products as well as new EPACT 2005 inclusions, issuing a final rule addressing the efficiency of commercial heating, air-conditioning and water heating equipment and an "en masse" test procedure final rule covering EPACT 2005 products. The program also upgraded three Energy Star criteria (clothes washers, dishwashers, and refrigerators and freezers) and supported solid-state lighting research which demonstrated record power efficacy and improved color rendering.

The Industrial Technology Program (ITP) has completed 253 Save Energy Now assessments, resulting in over $60 million per year in energy cost savings activities implemented in those plants -- with plans for additional activities valued at more than $250 million in annual savings. New ITP and industry co-funded technologies, ranging from innovations in aluminum and glass melting to nanocrystalline diamond coatings, had major commercial sales activities and are expected to produce energy savings of nearly 140 trillion Btus in 2020, with carbon emissions reductions of over 2.5 MMTCE. R&D activities in this program won three R&D 100 awards in 2007.

The Federal Energy Management Program helped Federal agencies save 23 trillion Btu in facilities compared to 2003 and Energy Savings Performance Contracts grew over $140 million in total private investment in energy savings. More than fifty technical and design assistance projects will save more than half a trillion Btus annually. The program helped DOE obtain nearly 7 percent of its energy use from renewable energy sources, surpassing the Federal 2.5 percent goal, and established 30 percent better building codes for Federal buildings.

Expected Integrated Program Outcomes

The program pursues its mission through an integrated portfolio of research, development, demonstration and deployment activities that improve the Nation's energy security, energy efficiency and productivity of our economy while minimizing environmental impacts. We expect the energy efficiency and renewable energy components of these energy savings to result in lower energy bills and reduced susceptibility to energy price fluctuations; reduced GHG and cost of controlling regulated pollutants; enhanced energy security as petroleum and natural gas dependence is reduced and domestic fuel supplies increase; and greater energy security and reliability from improvements in energy infrastructure. The longer-term benefits are estimates based on modeling of some of the possible program production technologies. The estimates generated by the model have been rounded to reduce implied precision.

The assumptions and methods underlying the EERE modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices, differ from the baseline case assumed for this analysis (essentially the EIA business as usual outlook for components of the economy affecting energy use). EERE modeling includes competing technologies. Possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors such as unexpected changes in competing technology costs, identified in the Means and Strategies sections in each of the individual contributing programs, could also affect EERE's ability to achieve its strategic goals as could persistent directed funding. Projections of future benefits depend on assumptions relating to how the economy will evolve over time and how rapidly energy efficient technologies will be developed and adopted among other variables. The estimated benefits developed for use in the climate benefits analysis are predicated on the assumptions included in EIA's Annual Energy Outlook 2007 Reference Case projections.

EIA also provides projections under alternative economic assumptions ranging from 2.4 to 3.5 percent annual growth between 2004 and 2030. Across this range, total energy consumption may grow by anywhere from 22 to 47 percent between 2004 and 2030. EIA also offers a range of technology and price assumptions. Across these cases total energy consumption may grow by anywhere from 45 percent between 2004 and 2030 if technology does not improve at all to 26 percent if technology improves rapidly. Changing assumptions on important variables such as these would affect the estimated benefits in this budget.

Benefits estimates provided in the Benefits climate section are based on modeling of some of the possible program production technologies. While uncertainties are larger for longer term estimates, they provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Estimated benefits assume that individual technology plans and market assumptions occur. A summary of the methods, assumptions, and models used in developing these benefit estimates are provided at www1.eere.energy.gov/ba/pba.

EERE's portfolio includes a mix of efforts intended to produce short-, mid-, and long-term benefits. The size of these benefits depends not only on the success of the EERE program efforts funded in this budget request, but on how future energy markets and policies evolve. EERE estimates a subset of these benefits assuming a continuation of current policies and business-as-usual development of energy markets. These estimates do not include the underlying, base case improvements in energy efficiency and renewable energy use that could be expected in the absence of continued funding of EERE's programs.

The EERE portfolio focuses on the three benefits that align with DOE's strategic goals:

- Environmental benefits
- Economic benefits, and
- Benefits associated with security and reliability.

EERE benefits result from the mix of interrelated investments supported by EERE's budget request. More efficient buildings and factories, for instance, provide the basis for distributed energy resources, such as building integrated solar photovoltaic systems and combined heat and power cogeneration. In addition to these "business-as-usual" benefits, EERE's portfolio would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs. The development of widespread sources of wind, solar, and biomass energy sources; new ways of using energy through hydrogen and distributed power; and technologies that would fundamentally improve the basic efficiency of our homes, businesses, factories, and vehicles could facilitate substantial reductions in our oil use and convert a larger portion of our electricity system to decentralized capacity and renewable energy sources to improve security and reliability.

A summary of the modeled benefits for EERE's portfolio is shown below. The table shows, that if successful and the assumptions play out as expected, EERE's programs could provide cumulative benefits as follows:

- Consumer savings of over $600 billion by 2030 and over $4 trillion by 2050;
- Reductions of about 6 gigatons of carbon emissions (GTCE) by 2030 and nearly 50 GTCE by 2050; and
- Reductions in oil imports of 5 billion barrels by 2030 and nearly 7 billion barrels in 2050.

While a range of expected benefits are presented based upon the two economic systems models EERE uses to try and characterize the range of likely outcomes, the mid-term and long-term modeling are particularly dependent upon the methodology and assumptions used and could vary substantially around these estimates. Many of the key variables affecting the benefits estimates are listed as the external factors that could affect expected results in the means and strategy sections of the individual programs, and include variables such as system commodity prices, market and policy interactions and the future price of oil, natural gas and electricity generation. Long-term estimates should be considered preliminary as EERE refines its analytical approaches for the 2030-2050 timeframe.

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	0.2	0.9	5.3	N/A
		MARKAL	0.2	1.4	10.0	66.1
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	1.7	4.0	15.0	N/A
		MARKAL	ns	0.3	5.5	41.7
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	4%	30%
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	324	1234	6469	N/A
		MARKAL	591	2084	9926	47099
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	1167	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	8	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	63	156	623	N/A
		MARKAL	142	317	1318	4130
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	27	63	195	N/A
		MARKAL	30	73	265	720
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	60	140	450	N/A
		MARKAL	71	166	700	1739

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Office of Energy Efficiency and Renewable Energy

Funding by Site by Program

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Ames Laboratory			
Vehicle Technologies	340	300	340
Industrial Technologies	500	540	1,985
Total, Ames Laboratory	840	840	2,325
Argonne National Laboratory (East)			
Hydrogen Technology	8,554	10,760	9,550
Biomass and Biorefinery Systems R&D	1,260	500	2,000
Vehicle Technologies	18,111	24,992	16,011
Industrial Technologies	1,512	1,740	73
Weatherization and Intergovernmental Activities	300	0	0
Program Support	900	251	900
Total, Argonne National Laboratory	30,637	38,243	28,534
Brookhaven National Laboratory			
Hydrogen Technology	2,095	1,607	3,000
Solar Energy	470	0	0
Vehicle Technologies	680	600	680
Industrial Technologies	80	60	60
Weatherization and Intergovernmental Activities	200	0	0
Program Support	410	400	410
Total, Brookhaven National Laboratory	3,935	2,667	4,150

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Golden Field Office/Project Management Center			
Solar Energy	550	0	0
Congressionally Directed Projects	0	186,664	0
Weatherization and Intergovernmental Activities	2,307	4,645	0
Program Direction	23,483	24,308	26,544
Sub Total, Less Use of Prior Year Balances	0	-743	
Total, Golden Field Office	26,340	214,874	26,544
Idaho National Laboratory			
Biomass and Biorefinery Systems R&D	6,315	5,000	7,000
Wind Energy Systems	900	600	800
Water Power	0	500	300
Geothermal Technology	125	0	0
Vehicle Technologies	3,324	3,935	3,324
Industrial Technologies	925	400	203
Federal Energy Management Program	205	201	0
Total, Idaho National Laboratory	11,794	10,636	11,627
Lawrence Berkeley National Laboratory			
Hydrogen Technology	1,161	1,147	2,500
Wind Energy Systems	475	335	400
Geothermal Technology	100	1,000	1,000
Vehicle Technologies	6,229	9,500	6,229
Building Technologies	8,656	9,162	10,403
Industrial Technologies	2,142	1,250	1,500
Federal Energy Management Program	2,276	2,200	2,200
Weatherization and Intergovernmental Activities	4,050	0	0
Program Support	520	90	520
Total, Lawrence Berkeley National Laboratory	25,609	24,684	24,752

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		
Lawrence Livermore National Laboratory			
Hydrogen Technology	1,161	857	1,400
Geothermal Technology	50	0	0
Vehicle Technologies	3,354	3,275	4,354
Industrial Technologies	25	0	75
Total, Lawrence Livermore National Laboratory	4,590	4,132	5,829
Los Alamos National Laboratory			
Hydrogen Technology	9,047	11,526	13,000
Biomass and Biorefinery Systems R&D	0	50	0
Vehicle Technologies	376	367	1,876
Industrial Technologies	0	60	60
Total, Los Alamos National Laboratory	9,423	12,003	14,936
National Energy Technology Laboratory			
Hydrogen Technology	145	57	0
Geothermal Technology	3,441	8,000	12,000
Industrial Technologies	0	645	650
Federal Energy Management Program	3,614	2,787	3,740
Weatherization and Intergovernmental Activities	7,113	0	0
Program Direction	12,210	12,933	14,231
Program Support	100	100	100
Total, National Energy Technology Laboratory	26,623	24,522	30,721
National Renewable Energy Laboratory			
Hydrogen Technology	14,275	19,578	5,800
Biomass and Biorefinery Systems R&D	44,905	32,330	35,000
Solar Energy	76,798	69,417	68,914
Wind Energy Systems	36,939	33,742	36,050
Water Power	0	3,359	2,100
Geothermal Technology	551	5,000	10,000
Vehicle Technologies	12,609	17,634	17,634

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		
Building Technologies	7,868	8,328	9,456
Industrial Technologies	2,160	1,295	795
Federal Energy Management Program	3,500	3,762	3,300
Facilities and Infrastructure	107,035	76,176	13,982
Weatherization and Intergovernmental Activities	5,375	250	500
Program Support	2,010	7,013	6,822
Total, National Renewable Energy Laboratory	314,025	277,884	210,353
Oak Ridge National Laboratory			
Hydrogen Technology	6,210	6,416	5,700
Biomass and Biorefinery Systems R&D	3,670	6,200	4,000
Wind Energy Systems	383	576	350
Water Power	0	3,500	300
Vehicle Technologies	41,655	42,653	45,405
Building Technologies	7,249	7,672	8,712
Industrial Technologies	13,469	7,221	7,510
Federal Energy Management Program	2,333	2,708	2,860
Weatherization and Intergovernmental Activities	1,362	0	0
Program Support	2,004	115	2,004
Total, Oak Ridge National Laboratory	78,335	77,061	76,841
Office of Scientific and Technical Information			
Geothermal Technology	84	0	0
Total, Office of Scientific and Technical Information	84	0	0

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Pacific Northwest National Laboratory			
Hydrogen Technology	6,649	4,086	5,700
Biomass and Biorefinery Systems R&D	7,000	6,500	6,500
Water Power	0	500	300
Vehicle Technologies	7,197	6,835	11,097
Building Technologies	12,203	12,916	14,666
Industrial Technologies	775	1,600	1,870
Federal Energy Management Program	1,649	1,572	1,980
Weatherization and Intergovernmental Activities	200	0	0
Program Support	1,101	496	1,101
Total, Pacific Northwest National Laboratory	36,774	34,505	43,214
Sandia National Laboratories			
Hydrogen Technology	6,412	5,545	4,400
Solar Energy	18,440	20,554	15,628
Wind Energy Systems	6,030	6,840	7,100
Geothermal Technology	354	4,000	5,000
Water Power	0	250	0
Vehicle Technologies	9,562	8,443	10,562
Industrial Technologies	331	0	0
Federal Energy Management Program	31	253	220
Weatherization and Intergovernmental Activities	250	400	300
Program Support	400	175	400
Total, Sandia National Laboratories	41,810	46,460	43,610
Savannah River National Laboratory			
Hydrogen Technology	1,344	873	2,200
Total, Savannah River National Laboratories	1,344	873	2,200

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Washington Headquarters			
Hydrogen Technology	132,458	148,610	92,963
Biomass and Biorefinery Systems R&D	133,127	147,600	170,500
Solar Energy	60,770	78,482	71,578
Wind Energy Systems	3,732	7,277	7,600
Water Power	0	1,800	0
Geothermal Technology	295	1,818	2,000
Vehicle Technologies	80,143	94,509	103,574
Building Technologies	67,007	70,921	80,528
Industrial Technologies	33,844	49,597	47,338
Federal Energy Management Program	5,872	6,335	7,700
Weatherization and Intergovernmental Activities	260,574	276,922	57,700
Program Direction	63,571	66,816	81,071
Program Support	3,485	2,161	7,743
Total, Washington Headquarters	844,878	952,848	730,295
Western Area Power Administration			
Wind Energy Systems	200	175	200
Total, Western Area Power Administration	200	175	200
Sub Total, Energy Efficiency and Renewable Energy	1,457,241	1,722,407	1,256,131
Less Use of Prior Year Balances	0	0	-738
Total, Energy Efficiency and Renewable Energy	1,457,241	1,722,407	1,255,393

Major Changes or Shifts by Site

National Energy Technology Laboratory

Geothermal Technology

- The Geothermal Program was restructured in FY 2007 and Congress provided funds in FY 2008 in support of this refocused program. Funding is increased in FY 2009 to provide planned expansion and support for Enhanced Geothermal System (EGS) research and development activities.

National Renewable Energy Laboratory

Hydrogen Technology

- The significant reduction in Hydrogen funding at NREL from FY 2008 to FY 2009 reflects the decision to defer further funding for hydrogen production R&D beginning in FY 2009. In the FY 2008 request, a great majority of the requested funding was for renewable-energy and renewable-fuel based approaches to hydrogen production, and much of that work was centered at NREL.

Geothermal Technology

- The Geothermal Program was restructured in FY 2007 and Congress provided funds in FY 2008 in support of this refocused program. Funding is increased in FY 2009 to provide planned expansion and support for Enhanced Geothermal System (EGS) research and development activities.

Facilities and Infrastructure

- General Capital Equipment increases to maintain EERE's general scientific and administrative equipment to a corporate standard of 50 percent (average) remaining portfolio value through maintenance, repair, or replacement

Washington Headquarters

Hydrogen Technology

- The Hydrogen Technology budget declines from FY 2008 to FY 2009; about two-thirds of that reduction relates to grants and cooperative agreements with industry in the following areas: hydrogen production manufacturing R&D, systems analysis, and fuel processor R&D. In addition, several activities previously funded in Hydrogen Technology in FY 2008 are moved to the Vehicle Technologies budget in FY 2009: Technology Validation; Safety & Codes & Standards; and Education.

Vehicle Technologies Program

- The total Vehicle Technologies budget increased from FY 2008 to FY 2009. The increase reflects the net result oftransfer of several activities (Technology Validation; Safety and Codes and Standards; and Education) from Hydrogen Technology to Vehicle Technologies to better integrate and coordinate Vehicle and fuels related activities within the EERE portfolio along with a focusing of current VT activities to accelerate development of plug-in hybrid electric vehicles (PHEVs).

Building Technologies Program

- In FY 2009, there will be a substantial increase in reviewing and developing new test procedures under the subprogram Equipment Standards and Analysis.
- In FY 2009, there will be increased activities in EnergySmart Schools, EnergySmart Hospitals, deployment of energy efficiency technologies within existing home and provision of certified audits and installers.

Weatherization and Intergovernmental Activities Program

- In FY 2009, Weatherization Assistance Program funds are redirected to R&D programs which deliver greater benefits. EERE's Energy Efficiency portfolio has historically provided approximately 20 to 1 benefit to cost ratio. In comparison, Weatherization has a benefit cost ratio of 1.53 to 1.
- The value of the Renewable Energy Production Incentive (REPI) program has diminished over time as renewable energy technologies have reduced in cost and become more competitive. The steadily growing pool of eligible applicants has resulted in increasingly smaller amounts which can be paid out, given the limited availability of funds to distribute. No funding is requested for REPI in FY 2009.

Site Description

Ames Laboratory

Introduction

Ames Laboratory is a multi-discipline laboratory located in Ames, Iowa, providing support to Vehicle Technologies and Industrial Technologies.

Vehicle Technologies

Ames Laboratory is conducting research on new materials with unique properties. It also is working on power electronics to improve magnetic powders for bonded permanent magnets.

Industrial Technologies

Ames Laboratory work includes the development of a new class of materials with extreme resistance to abrasive and erosive wear for use in industrial tools and components.

Argonne National Laboratory East

Introduction

Argonne National Laboratory (ANL) is located in Argonne, Illinois. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Vehicle Technologies, Industrial Technologies, Weatherization and Intergovernmental Activities, and Program Support.

Hydrogen Technology

ANL is conducting research and development of advanced hydrogen storage concepts including modeling of storage systems and life cycle analyses, and provides technical assistance in the management of DOE cooperative agreements with industry. ANL is the lead laboratory in the research and development of fuel processor catalysts and fuel cell system analysis. To minimize the cost of fuel cell cathode catalysts, ANL is developing non-platinum cathode electrocatalysts based on bimetallic base metal-noble metal systems.).

Biomass and Biorefinery Systems R&D

ANL conducts research on biomass conversion processes and environmental benefits analysis for several EERE programs, including energy balance and emissions for biofuels in conventional and advanced vehicles with and without fuel cells.

ANL will conduct R&D related to convert biomass to bio-based products with the goal of making the technologies more competitive with petroleum-based alternatives.

Vehicle Technologies

ANL provides the Vehicle Technologies (VT) program with expertise in materials, combustion chemistry, electrochemistry, systems simulation, computational fluid dynamics, and techno-economic analysis. In materials ANL performs research on non-destructive testing, recycling of lightweight materials, novel bonding techniques for dissimilar materials, and lubrication and friction reduction. Many of these efforts take advantage of ANL's unique Advanced Photon Source to characterize materials and sprays.ANL's combustion research includes development of in-cylinder emission-control methods for CIDI (direct-injection Diesel) engines as well as post-combustion emissions control. The lab's expertise in materials and combustion comes together in development of catalysts and sensors to improve engine efficiency and reduce emissions.

ANL's capabilities in system simulation and fluid dynamics support VT efforts to improve under-hood thermal management (including nanofluid technology and novel heavy-vehicle cooling systems) and to reduce aerodynamic drag on heavy vehicles. ANL also develops the system simulation software necessary for "hardware-in-the-loop" testing and validation of component and subsystem performance and develops test procedures for advanced vehicles. Systems simulation also supports development of optimal control strategies for both combustion and hybrid-vehicle propulsion and battery systems. ANL uses its expertise in electrochemistry to perform both R&D and standardized testing of advanced batteries and ultracapacitors. The lab uses both its system simulation and techno-economic analysis capabilities to support VT planning and program evaluation with energy, economic, and environmental analyses. ANL also provides general technical and analytical support to VT's battery R&D activity, the Graduate Automotive Technology Education (GATE) activity, and VT's student vehicle competitions.

Industrial Technologies

ANL performs research and development for the chemical industry R&D area. Argonne provides unique expertise in advanced separations process technologies and new innovative membrane systems. The laboratory also conducts research on refractory materials for the steel industry, and provides unique expertise in anode and cathode development for the aluminum industry using technology to analyze the surface effects conditions on the advanced candidate materials.

Weatherization and Intergovernmental Activities

Funding to ANL has supported international activities, primarily in the Asia-Pacific Economic Cooperation (APEC) area, and included technical assistance and support to the program's APEC related projects. No work will be performed in FY 2009.

Program Support

Provide analytical support for major crosscutting issues, such as market and benefit analyses.

Brookhaven National Laboratory

Introduction

Brookhaven National Laboratory (BNL) is located in Upton, New York. It is a multi-disciplinary research laboratory dedicated to basic, non-defense scientific research. BNL provides support to Hydrogen Technology, Solar Energy, Vehicle Technologies, Industrial Technologies, Weatherization and Intergovernmental Activities, and Program Support.

Hydrogen Technology

Brookhaven supports the Hydrogen Technology Program in the development of advanced metal hydride hydrogen storage concepts primarily based on alane. BNL also conducts research and development of electrocatalysts alloys fuel cells focusing on synthesis and characterization of the materials.

Solar Energy

BNL performs research and development for the Photovoltaic Energy Systems efforts. BNL has the responsibility for environmental, health, and safety (ES&H) impacts associated with photovoltaic energy production, delivery, and use. BNL also conducts ES&H audits, safety reviews, and incident investigations and assists industry to identify and examine potential ES&H barriers and hazard control strategies for new photovoltaic materials, processes, and application options before their large-scale commercialization.

Vehicle Technologies

BNL performs analysis, studies and conducts research in advanced materials to improve the performance and abuse tolerance of lithium battery systems and provides research support for analysis of internal combustion (IC) engine emissions for program.

Industrial Technologies

BNL supports Industrial Technologies Program activities in the area of hierarchical nanoceramics for industrial process sensors. These materials will enable a new generation of sensors for industrial process environments, including furnaces and process heaters.

Weatherization and Intergovernmental Activities

BNL supports the Asia Pacific Partnership by providing technical assistance and in developing concepts, designs, constructing, and operating complex, leading edge, user-oriented facilities in response to the needs of DOE and its APP partners.

Program Support

Provides analytical support for crosscutting issues such as market and benefit analyses.

Golden Field Office/PMC

Introduction

The Golden Field Office (GO) is located in Golden, Colorado. It provides project management and procurement support for Solar Energy, Wind Energy, Water Power, and Program Direction.

Solar Energy

In FY 2009, there will be a substantial increase in support due to increased activities in project management and procurement support for the Solar America Intiative. These activities include Technology Pathyway Partnerships, University Process and Product Development, Future Generation and Grid Integration Inverter solicitations.

Wind Energy

GO administers outreach to the States for Wind Powering America activities, monitors Congressionally-directed projects, and helps to manage solicitations.

Water Power

GO administers cost-shared activities with universities and private sector interests to advance water power technologies and resource assessments.

Program Direction

In FY 2009, functions formerly provided by the Regional Offices (consolidated in the third quarter of FY 2006) will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powering America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP).

Idaho National Laboratory

Introduction

Idaho National Laboratory (INL) is located in Idaho Falls, Idaho. It is a multi-discipline laboratory providing support to Biomass and Biorefinery Systems R&D, Wind Energy Systems, Water Power, Geothermal Technology, Vehicle Technologies, Industrial Technologies, and Federal Energy Management Program.

Biomass and Biorefinery Systems R&D

INL provides biomass-related R&D services and support for the feedstock infrastructure development effort. This work is performed in close collaboration with ORNL and NREL.

Wind Energy Systems

INL provides technical support to the program to enhance government, military applications and Tribal use of Wind Energy Systems, and to address technical and market barriers to wind.

Water Power

INL provides engineering support in the area of hydropower engineering and system assessments.

Geothermal Technology

INL served as the lead laboratory for research and development in geosciences and reservoir management. INL conducted research in exploration technologies, Enhanced Geothermal Systems, and advanced heat and power systems.

Vehicle Technologies

INL benchmarks and assesses the performance of new ultracapacitors for hybrid vehicles. The laboratory also conducts tests of high-power batteries, develops battery test procedures, tests and simulates hybrid vehicle performance, and develops energy storage models for electric and hybrid vehicles. INL conducts field testing and evaluation and collects performance data from electric, plug-in hybrid and hydrogen light duty vehicles and infrastructure, and supports Federal Fleet acquisition reporting as required.

Industrial Technologies

INL provides critical support in project management and analysis for the Forest Products and Steel activities. Work is ongoing for an advanced black liquor spray atomization process for the Forest Products industry, and on the development of controlled thermal-mechanical processing of tubes and pipes for enhanced manufacturing performance and in the development and application of laser-assisted arc welding in the steel industry.

Federal Energy Management Program

INL will support FEMP with continued enhancement and maintenance of the Federal Automotive Statistical Tool (FAST). In addition, it will provide management and organizational support to the Department of Energy (DOE) sponsored Interagency Committee on Alternative Fuels and Low Emission Vehicles (INTERFUEL).

Lawrence Berkeley National Laboratory

Introduction

Lawrence Berkeley National Laboratory (LBNL) is located in Berkeley, California. It is a multi-discipline laboratory providing support to Hydrogen Technology, Wind Energy Systems, Water Power, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Support.

Hydrogen Technology

LBNL develops membranes for fuel cells that do not require water for proton conduction thus easing water and thermal management. LBNL has also supported the development of advanced materials-based hydrogen storage technology.

Wind Energy Systems

LBNL performs analyses of opportunities for Wind Energy Systems applications in the electricity market.

Geothermal Technology

LBNL performs research on Enhanced Geothermal Systems, including studies of reservoir dynamics and seismic phenomenon.

Vehicle Technologies

LBNL conducts exploratory research in advanced battery technology, including development of new electrode and electrolyte materials and understanding of fundamental electrochemical phenomena. BNL develops devices to measure particulate matter from engines and also develops nondestructive testing techniques for evaluation of aluminum and composite structures in manufacturing environments.

Building Technologies

LBNL conducts research and development activities in lighting, windows, appliance standards, analysis tools and design strategies and space heating and cooling.

Industrial Technologies

LBNL supports technology delivery activities of the Best Practices Program including assistance in facilitating Allied Partners with supplier industry organizations (e.g., Hydraulic Institute, Compressed Air and Gas Institute). The laboratory supports the tracking of Best Practices implementation results including the impact of training, software tools and other program delivery mechanisms on manufacturing plants.

Federal Energy Management Program

LBNL facilitates projects, develops guidelines and provides expert advice on the monitoring and verification protocols for energy projects savings, laboratory sustainable design principles, public benefit funds, and lighting.

Weatherization and Intergovernmental Activities

LBNL performs research and technical assistance for the Asia Pacific Partnership. Activities include technical assistance for U.S.-China energy cooperation, and support for Collaborative Labeling and Appliance Standards Projects (CLASP). It previously supported the International Renewable Energy Program.

Program Support

LBNL provides analytical support for major crosscutting issues, such as market and benefit analyses.

Lawrence Livermore National Laboratory

Introduction

Lawrence Livermore National Laboratory (LLNL) is located in Livermore, California. It is a multi-discipline laboratory providing support to Hydrogen Technology, Geothermal Technology, Vehicle Technologies and Industrial Technologies. It previously supported the Geothermal Technology Program.

Hydrogen Technology

LLNL serves as the lead laboratory in the research and development of a novel concept known as cyro-compressed tank technology for hydrogen storage. LLNL is capable of producing composite and conformable storage tanks for environmental testing to verify the advantages of various engineering concepts to increase the storage capacity while reducing the cost of manufacturing. LLNL also conducts research and development of high surface area materials such as carbon aerogels in support of DOE's Hydrogen Sorption Center of Excellence in hydrogen storage. LLNL has applied these materials to metal hydrides to reduce the temperatures and increase the rates of hydrogen release.

Geothermal Technology

LLNL conducted research and development in Enhanced Geothermal Systems and exploration technology, including isotope and geochemical studies.

Vehicle Technologies

LLNL applies advanced methods of computational fluid dynamics to the aerodynamics drag of heavy vehicles for increased energy efficiency. It also performs studies of combustion under diesel and homogeneous charge compression ignition (HCCI) conditions (including natural gas engines) using chemical kinetic modeling and other methods to determine means for increasing fuel efficiency, reducing emissions, and increasing peak output power of advanced internal combustion engines (ICEs). LLNL develops specialized materials like aerogel-based NO_x catalysts for CIDI engines and high-voltage ultracapacitors based on nanostructure multilayer oxide materials. The lab's expertise in materials science is also applied to advanced automotive manufacturing concepts such as metal treatment using Plasma Surface Ion Implantation (PSII). LLNL's sensor expertise is applied to development of advanced NOx sensors for diesel engines and to both nondestructive evaluation of cast light metals and development of in-line sensors for improved metal casting. The lab is also constructing and testing hydrogen sensors for both safety and fuel stream monitoring in a fuel cell vehicles.

Industrial Technology

LLNL provides expert resources for the investigation of innovative forming in the aluminum industry.

Los Alamos National Laboratory

Introduction

Los Alamos National Laboratory (LANL) is located in Los Alamos, New Mexico. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Vehicle Technologies, and Industrial Technologies.

Hydrogen Technology

LANL is conducting research and development of advanced hydrogen storage concepts supporting chemical hydrogen storage and leads DOE's Chemical Hydrogen Storage Center of Excellence. The primary focus of LANL's work in hydrogen storage is on ammonia borane based materials and improving the regeneration of spent fuels applicable to on-board vehicular hydrogen storage technologies. LANL serves as the lead laboratory in research and development of fuel cell components, reduction of precious metal loading while maintaining performance, and understanding the effects of impurities on fuel cell performance. Other fuel cell related work at LANL includes identification and analysis of component water transport properties, modeling of water transport, and characterization of the durability of fuel cell stacks operating on hydrogen (targets are 5,000 hours for transportation applications and 40,000 hours for stationary applications).

Biomass and Biorefinery Systems R&D

LANL supports the program's technical analysis activity to enhance the probability of achieving cost reduction goals for the biorefinery concept.

Vehicle Technologies

LANL performs research on combustion in internal combustion engines using simulation and modeling to increase efficiency and reduce NO_x in lean-burn engines and develops microwave regeneration components and design tools for emission controls. Los Alamos is also performing R&D to discover and develop next-generation emission-control catalysts for lean burn engines and developing technology for onboard generation of chemical reductants from diesel fuel.

Industrial Technologies

LANL supports program work for the Chemical industry R&D area. The laboratory provides unique capabilities in theoretical scientific analysis, including modeling fluid flows and understanding chemical reactions and catalysis phenomena. LANL provided the computer analysis of industrial fluid flows, and the computer technology prepared for use by the civilian sector. LANL also supports the Industrial Materials of the Future activities in the development of new materials for membrane separation systems.

National Energy Technology Laboratory

Introduction

The National Energy Technology Laboratory (NETL) is located in Morgantown, West Virginia. It provides project management and procurement support to Hydrogen Technology, Industrial Technologies, Federal Energy Management Program, the Weatherization and Intergovernmental Activities, Program Direction and Program Support.

Hydrogen Technology

In accordance with a Memorandum of Agreement with the Office of Fossil Energy, NETL co-manages hydrogen research and development efforts to improve the efficiency and lower the cost of fossil-based hydrogen production processes. Collaboration also occurs with the Office of Fossil Energy and NETL for producing hydrogen from coal. Specifically, NETL researchers will be developing separation and purification methods critical to producing high quality hydrogen used in fuel cells.

Industrial Technologies

NETL supports ITP activities in the area of technology development for fuel and feedstock flexibility.

Federal Energy Management Program

NETL provides technical and financial analyses support for the Biomass Alternate Methane Fuels Technology Specific Super Energy Savings Performance Contract activities.

Weatherization and Intergovernmental Activities

NETL provides project management and procurement support for energy efficiency and renewable energy technology deployment. Activities include: review, award, and monitoring of grants to States; stakeholder outreach; grants management system integration; and technical assistance and tools development for Weatherization and Intergovernmental Activities.

Program Direction

In FY 2009, administrative, management, and oversight functions will be performed from the Washington Headquarters, and the Project Management Centers located at the Golden Field Office, and the National Energy Technology Laboratory. These functions include program and project management, coordination and liaison with other Federal Government organizations, with state and local governments, and with stakeholders.

Program Support

Program Support funds are provided to NETL for the purpose of assisting in utilizing enhanced planning, analytical, and evaluation methodologies and tools; supporting cost/benefits analyses, road maps, data collection, and performance methodologies to support the Government Performance and Results Act (GPRA) as well as OMB's Performance Assessment Rating Tool (PART) and the Research and Development Investment Criteria (RDIC).

National Renewable Energy Laboratory

Introduction

The National Renewable Energy Laboratory (NREL) is located in Golden, Colorado. NREL is the principal research laboratory for the DOE Office of Energy Efficiency and Renewable Energy and also provides research expertise for the Office of Science, and the Office of Electricity Delivery and Energy Reliability. NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the Nation's energy and environmental goals. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy Systems, Water Power, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Facilities and Infrastructure, Weatherization and Intergovernmental Activities, and Program Support.

Hydrogen Technology

NREL serves as the lead laboratory for DOE's Hydrogen Sorption Center of Excellence and is conducting research and development on sorbent and carbon-based materials for hydrogen storage. NREL also leads the Systems Integration and Analysis function for the program. Models of the technical, economic, and integration aspects of the hydrogen infrastructure and fuel cell vehicle systems provide guidance for the development of hydrogen fuel cell components and materials. NREL also performs data analysis from the vehicle and infrastructure validation activity which includes more than 75 hydrogen vehicles and 14 hydrogen refueling stations. NREL has also been involved in facilitating the development of codes and standards and working with code officials and other key stakeholders.

Biomass and Biorefinery Systems R&D

NREL is the lead laboratory for biomass R&D. NREL also develops analytical methodologies (chemical and life-cycle) that are used to facilitate industry's commercialization efforts, including economic assessment of technologies. NREL operates two user facilities, the Thermochemical Users Facility (TCUF) for syngas technologies, and the Alternative Fuels Users Facility (AFUF) for bioconversion technologies. Private sector participants may use the facilities after appropriate arrangements are made. NREL contributes to bio-based product tasks.

Solar Energy

NREL serves as the lead laboratory for the Solar Energy Technology Program. NREL conducts fundamental and applied materials research on photovoltaic devices, photovoltaic module reliability and systems development, data collection and evaluation on solar radiation, and implementation of cost-shared government/industry partnerships. Basic research teams investigate a variety of photovoltaic materials, such as amorphous silicon, polycrystalline thin films, high-efficiency materials and concepts, and high-purity silicon and compound semiconductors. NREL conducts simulated and actual outdoor tests on photovoltaic cells, modules, and arrays. The test results are used in developing standards and performance criteria for industry and to improve reliability.

Wind Energy Systems

NREL is the lead laboratory for national wind R&D, performing research in aerodynamics, structural dynamics, and advanced components and control systems related to Wnd Energy Systems. The National Wind Technology Center (NWTC), located at NREL, provides research and testing facilities for fatigue testing of turbine blades, dynamometer testing of wind turbine drive trains and generators, atmospheric testing of turbines, and certification testing which are required for sales and operation in many overseas markets. NWTC staff also implements the Department=s Cooperative Research and Development Agreements (CRADAs) and cost-shared R&D industry partnerships for large (> 100kW) wind turbine systems, and provides technical assistance for the Wind Powering America activity.

Water Power

NREL is the lead laboratory for ocean energy, participating in water power resource assessments, leading technology characterization activities, and developing CRADAs for technology development and demonstration of water power technologies.

Geothermal Technology

NREL serves as the lead laboratory for Systems Analysis and supports HQ with Planning, R&D Integration and Deployment activities.

Vehicle Technologies

NREL develops system models and provides analysis and simulation of advanced hybrid and fuel cell configurations using analytical software developed at the lab, as well as other tools; provides CAD/CAE for optimized vehicle system solutions in support of FreedomCAR and Fuels Partnership goals; and general engineering assessments of HEV and AFV technologies. The laboratory investigates and develops advanced battery thermal management for hybrid and fuel cell vehicles. For heavy duty vehicles, NREL provides analysis, modeling, and technical support for power electronics and electric machines; conducts engine/vehicle integration and platform studies; and leads an effort to identify the effects of sulfur levels in diesel fuels on emissions control devices.

NREL also leads an effort to determine the lube oil effects on exhaust after treatment devices; and conducts tests of bio-based diesel fuel blending agents to determine their ability to act as reductants in the exhaust stream of diesel engines. Additionally, NREL supports EPACT 1992 regulatory programs including Federal Fleet, State and Fuel Provider, Private and Local, and Fuel petitions; and supports the Clean Cities deployment program with technical assistance to regional coalitions and fleet partners, and program analysis and evaluation.

Building Technologies

NREL provides technical leadership, conducts research and provides technical management support in a number of BT activities. The primary one is Building America (Residential Building Integration). For the past five years (until the function was transitioned to the PMC at NETL), NREL also performed the contract management and procurement function for the Building America project. They will now integrate the BT Stage Gate Management process into the Building America and Commercial Buildings technical management processes. They will also manage and report on the accomplishment of the Joule requirement for Building America. They also provide technical support to the implementation of Building America by conducting research, providing technical assistance to the teams and coordinating the research among the partners. They also develop and implement tools such as BEOpt for the management of the project. For Commercial Buildings Integration NREL conducts analyses (Assessment of Energy Savings Opportunities); provides technical support for development of the Advanced Energy Design Guide for Schools; provides technical support to national retail building owners such as Food Lion, PETCO and Wal-Mart, enabling Commercial Building initiative to quickly develop a new commercial buildings technical assistance project called the Retail Energy Alliance; and provides support for the new National Retail Energy Alliance in FY2008. Other NREL activities in support of BT include technical support for Energy Smart Schools and Hospitals in New Orleans and in Greensburg, KS., development and implementation of new models and features that expand the capabilities of EnergyPlus, and development of tests for the durability of dynamic fenestration products.

Industrial Technologies

NREL supports the Best Practices Program in communication activities and products. NREL also supports overall Industry Program analysis of the logic of individual program activities including the relationship between program goals, milestones and the budget formulation process for several areas including Industrial Materials of the Future, Aluminum and Metal Casting.

Federal Energy Management Program

NREL facilitates projects, develops guidelines and provides expert advice on sustainable and renewable facility designs, green power procurement, and alternative financing.

Facilities and Infrastructure

The Facilities and Infrastructure Program provides funding for plant and capital equipment (PCE) which provides routine upgrades and maintenance of the National Renewable Energy Laboratory's office, research, user facilities, and infrastructure. The program also supports major construction projects at NREL that will further the research and development mission of EERE, such as: the Science and Technology Facility (completed in FY 2007); the Research Support Facility and the Integrated Biorefinery Research Facility (design/construction selections will occur in FY 2008); and the Energy Systems Integration Facility and the South Table Mountain Infrastructure project (first phases recently funded in the FY 2008 appropriations; solicitation development underway).

Weatherization and Intergovernmental Activities

NREL assisted in the development of communication strategies for the Weatherization and Intergovernmental Program; improves program and subprogram web pages; and provides technical assistance on energy efficiency and renewable energy technologies, practices, and opportunities for States, Tribes and international partners.

Program Support

Provides analytical support for crosscutting issues, such as market and benefit analyses.

Oak Ridge National Laboratory

Introduction

Oak Ridge National Laboratory (ORNL) is located in Oak Ridge, Tennessee. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Wind Energy Systems, Water Power, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Support.

Hydrogen Technology

ORNL performs research and development activities in hydrogen storage in support of the lead labs, NREL and Sandia National Laboratories as part of DOE's Centers of Excellence in hydrogen storage. ORNL has collaborated with NREL and UC Berkeley to develop a microalgae system for the production of hydrogen. Oak Ridge National Laboratory is the primary National Laboratory for materials R&D aimed at reducing cost and increasing the durability of fuel cell components. ORNL carries out R&D on metal bipolar plates with nitride surface layers. ORNL also characterizes the structure of membranes and membrane electrode assemblies .

Biomass and Biorefinery Systems R&D

ORNL conducts biomass technologies R&D, evaluates harvesting technology for biomass, and conducts environmental research, residue and forests research, and resource and market analysis. These efforts are closely coordinated with INL and NREL.

ORNL provided assistance on biomass technology assessment and information transfer.

Wind Energy Systems

ORNL provides analysis and support to wind integration studies and applications.

Water Power

ORNL will participate in the resource assessment of ocean energy in the United States, including current (tidal) resources. ORNL is the lead laboratory for hydropower activities. It will also participate in water power resource assessments, lead technology characterization activities, and develop CRADAs for technology development and demonstration of water power technologies.

Vehicle Technologies

ORNL provides the Vehicle Technologies (VT) program with expertise in materials, combustion, electrical engineering, systems analysis, vehicle testing and data collection, and techno-economic analysis. ORNL uses its materials expertise to develop and test a wide range of lightweight materials for vehicle applications, including carbon-fiber, lightweight alloys, and novel materials such as thermally-conducting carbon foams for high-performance engine radiators. ORNL also operates the High-Temperature Materials Lab as a user facility for materials characterization, funded by VT. ORNL supports VT's combustion R&D with development of in-cylinder diagnostics, development and testing of catalytic converters, measuring and modeling the chemical kinetics of emissions-treatment devices including NOx absorbers and selective catalytic reduction, and toxicity analysis of unregulated emissions from engines operating on advanced fuels. This work also supports VT's Fuels R&D activity by analyzing and modeling the fuel characteristics that affect emissions control and efficiency `in diesel engines. ORNL uses its electrical engineering expertise to research and test power electronics (converters and controllers) and electric motor/generators for hybrid vehicles. The lab performs system cost analyses and techno-economic trade-off studies for advanced combustion, emissions-control, and power-electronic components. ORNL backs up its modeling of engine and emissions-control processes with the collection of real-world, on-road heavy truck performance data. ORNL also maintains the legislatively-mandated automobile *Fuel Economy Guide* and website.

Building Technologies

ORNL is part of a National Laboratory/industry/university consortium conducting research and development for the following activities: Building America; space heating and cooling; envelope and emerging technologies.

Industrial Technologies

In support of the Best Practices effort, ORNL provides support to Plant-Wide Assessments and other technical assistance and also assists in the tracking of program impacts. The lab also helps in the development and delivery of software tools and training. ORNL is the primary laboratory supporting the Industrial Materials of the Future activities to develop advanced materials for industrial use that meet technical requirements identified by industry in the visions and technology roadmaps.

Federal Energy Management Program

ORNL facilitates projects, develops guidelines, and provides expert advice on combine heat and power systems, biomass opportunities, whole building design, and alterative financing.

Weatherization and Intergovernmental Activities

ORNL assists in the implementation of the national evaluation of the State Energy Program and assists in stakeholder outreach for DOE energy efficiency initiatives.

Program Support

ORNL provides analytical support for major crosscutting issues, such as market and benefit analyses.

Office of Scientific and Technical Information

Introduction

The Office of Scientific and Technical Information (OSTI) is located in Oak Ridge, Tennessee. It provides technical support for Geothermal Technology.

Geothermal Technology

OSTI distributes information for the Geothermal Technology Program, including publishing and maintaining on-line full text of electronic publications.

Pacific Northwest National Laboratory

Introduction

Pacific Northwest National Laboratory (PNNL) is located in Richland, Washington. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Water Power, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Support.

Hydrogen Technology

PNNL is the lead laboratory in the development of safety materials and systems for various end use applications. PNNL performs research and development tasks such as hydrogen storage and other technical support to address safety issues involved with various technologies, including underground storage, pipeline transmission and hydrogen sensing. PNNL also supports LANL in a leadership role for DOE's Chemical Hydrogen Storage Center of Excellence, focusing primarily on ammonia borane materials.

PNNL is also a key contributor in the hydrogen safety panel, safety analysis and risk mitigation activities, working with safety/code officials and other key stakeholders.

Biomass and Biorefinery Systems R&D

The Pacific Northwest National Laboratory provides thermochemical research and development in support of the syngas platform and related products. Major program components include thermocatalysts for fuels and chemicals and wet biomass for syngas production.

Water Power

PNNL participates in environmental studies and marine life impacts related to the Water Power Program.

Vehicle Technologies

PNNL supports Vehicle Technologies (VT) primarily through their expertise in a variety of materials technologies. PNNL evaluates advanced energy storage materials for battery R&D. PNNL supports VT materials R&D effort by developing energy-efficient production and processing techniques for magnesium, titanium, polymer, natural fiber and glass composite components for advanced automotive and heavy vehicle designs. The laboratory also develops environmentally friendly processes for the manufacture of planar thin film ceramic sensors. To improve combustion efficiency and reduce emissions, PNNL develop tools and analytic techniques for developing new catalytic materials for engines using computational methods and materials-by-design approaches, and also develops materials for high-durability lean-burn spark plugs and NO_x sensors. PNNL supports development of thermoelectric devices for recovering waste heat in diesel engines (thus improving fuel efficiency) by working on the scale-up process for depositing Si/SiGe super-lattice materials.

Building Technologies

The Pacific Northwest National Laboratory conducts research and development activities for: building codes; appliance standards; and emerging technologies.

Industrial Technologies

In support of the Industries of the Future (Specific) and (Crosscutting) activities, Pacific Northwest National Laboratory provides key support to track past program impacts including the over 190 commercial technologies, as well as their energy and environmental impacts. Other efforts include the evaluation of emerging technologies The laboratory produces an impacts report summarizing commercial and emerging technologies and past program results and methodologies. The laboratory also provides support to Aluminum, Sensors and Controls, Glass, Industrial Materials of the Future and Forest Products.

Federal Energy Management Program

PNNL developed guidelines and provides expert advice on energy efficient buildings maintenance and operations, utility load management, utility restructuring, building commissioning, building diagnostic systems, resource energy management, and analytical support for benefits modeling.

Weatherization and Intergovernmental Activities

PNNL increases energy capacity and reduces dependence on imported oil through research of hydrogen and biomass-based fuels. The lab also works to reduce the effects of energy generation and use on the environment. PNNL conducts research and provides technical assistance for the Asia Pacific Program.

Program Support

Provide analytical support for major crosscutting issues, such as market and benefit analyses.

Sandia National Laboratories

Introduction

Sandia National Laboratories (SNL) is located in Albuquerque, New Mexico and in Livermore, California. It is a multi-discipline laboratory providing support to Hydrogen Technology, Solar Energy, Wind Energy Systems, Water Power, Geothermal Technology, Vehicle Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Support.

Hydrogen Technology

SNL in California serves as the lead laboratory in the research and development of metal hydride storage materials and leads DOE's Metal Hydride Center of Excellence in hydrogen storage. SNL also serves as the lead for the design, implementation, and testing of hydrogen systems to verify building codes and equipment standards for many applications. In addition, SNL conducts material property characterization and testing to determine material reactivity for hydrogen storage. Safety and combustion analysis related to hydrogen has been another core capability area at SNL. These studies are valuable in determining set back distances and codes and standards for hydrogen infrastructure.

Solar Energy

SNL supports the Photovoltaic Energy Systems efforts with the principal responsibility for systems and balance-of-systems technology development and reliability. Indoor and outdoor measurement and evaluation facilities provide support to industry for cell, module, and systems measurement, evaluation, and analysis. Systems-level work concentrates on application engineering reliability, database development, and technology transfer. SNL is the lead laboratory for the Concentrating Solar Power activity; technical responsibilities include power tower R&D, dish R&D, and the management of technical tasks and subcontracts to industry and universities.

Wind Energy Systems

SNL department staff work closely with counterparts at the National Renewable Energy Laboratory to provide the program and the U.S. wind industry with engineering expertise to further the program's knowledge and goals.

Water Power

Sandia provides expertise on technology development and assessment, particularly related to hydrokinetic systems.

Geothermal Technology

Sandia National Laboratories (SNL) serves as the lead laboratory for Research and Development in drilling technologies. SNL will also provide technical expertise to manage cost-shared exploration activities with industry partners.

Vehicle Technologies

SNL supports the Vehicle Technologies (VT) program with its capabilities in aerodynamics and fluid dynamics, combustion chemistry and kinetics (especially using the laser diagnostic tools at SNL's Combustion Research Facility), materials R&D, and advanced manufacturing technologies. SNL performs modeling and simulation to reduce aerodynamic drag on heavy vehicles. The lab's expertise in fluid dynamics, combustion kinetics, and laser diagnostics are combined for research on the formation of pollutants in piston combustion and the effects of fuel-borne oxygen using optically and non-optically instrumented engines. SNL also uses laser diagnostics to characterize diesel engine particulate emissions to improve exhaust treatments. SNL develops and evaluates abuse-tolerant electrode materials for lithium-based batteries and rugged high-temperature film capacitors for power electronics. The lab's experience in advanced manufacturing supports VT propulsion and lightweight materials efforts by developing techniques and instrumentation for forging, heat-treatment, coating, welding, and other factory processes.

Federal Energy Management Program

SNL develops guidelines and provides expert advice on renewable technologies for military applications and on distributed generation.

Weatherization and Intergovernmental Activities

SNL provides technical assistance on energy efficiency and renewable energy options available to Tribal governments.

Program Support

SNL provides analytical support for crosscutting issues such as market and benefit analyses.

Savannah River National Laboratory

Introduction

Savannah River National Laboratory is located in Aiken, South Carolina. It is a multidisciplinary research laboratory that provides support to Hydrogen Technology.

Hydrogen Technology

Savannah River leverages its history and expertise in understanding the properties of hydrogen and its effects on materials, to support DOE's metal hydride hydrogen storage research program and the Metal Hydride Center of Excellence. Savannah River is capable of producing metal hydride materials for use in research and validation projects. Another key capability involves understanding material reactivity properties related to hydrogen storage. Savannah River leads an international project in this area and is a key player in developing test protocols for determining storage material properties.

Washington Headquarters

Introduction

Washington, D.C. is the headquarters for the Office of Energy Efficiency and Renewable Energy operations. The Headquarters operation provides specialized, technical expertise in program planning, formulation, execution, and evaluation, in order to support the responsible guidance and management of the budget. In addition, competitive Program Announcements and solicitations are planned and implemented through Headquarters. It provides support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy Systems, Water Power, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, Program Direction, and Program Support.

Western Area Power Administration

Introduction

Western Area Power Administration (WAPA) is located in Lakewood, Colorado. It is a multi-region power-making agency that is providing support to Wind Energy Systems.

Wind Energy Systems

WAPA is conducting analysis of integrating wind into its power system, including assessment of opportunities for coordinating operation with its hydropower assets.

Hydrogen Technology

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation[a]	FY 2008 Original Appropriation	FY 2008 Adjustments[b]	FY 2008 Appropriation	FY 2009 Request
Hydrogen Technology					
Hydrogen Production and Delivery R&D	33,702	40,000	-364	39,636	0
Hydrogen Storage R&D	33,728	43,900	-399	43,501	59,200
Fuel Cell Stack Component R&D	37,100	44,000	-400	43,600	62,700
Technology Validation	39,413	30,000	-273	29,727	0 [c]
Transportation Fuel Cell Systems	7,324	8,000	-73	7,927	6,600
Distributed Energy Fuel Cell Systems	7,257	7,700	-70	7,630	10,000
Fuel Processor R&D	3,952	3,000	-27	2,973	0
Safety and Codes and Standards	13,492	16,000	-146	15,854	0 [a]
Education	1,978	3,900	-35	3,865	0 [a]
Systems Analysis	9,637	11,500	-105	11,395	7,713
Manufacturing R&D	1,928	5,000	-46	4,954	0
Total, Hydrogen Technology	189,511	213,000	-1,938	211,062	146,213

Public Law Authorizations:

P.L. 93-275, “Federal Energy Administration Act” (1974)
P.L. 93-577, “Federal Non-Nuclear Energy Research and Development Act” (1974)
P.L. 94-163, “Energy Policy and Conservation Act” (EPCA) (1975)
P.L. 94-413, “Electric and Hybrid Vehicle Research, Development and Demonstration Act” (1976)
P.L. 95-91, “Department of Energy Organization Act” (1977)
P.L. 95-238, Title III – “Automotive Propulsion Research and Development Act” (1978)
P.L. 96-512, “Methane Transportation Research, Development and Demonstration Act” (1980)
P.L. 96-294, “Energy Security Act” (1980)
P.L. 100-494, “Alternative Motor Fuels Act” (1988)
P.L. 101-566, “Spark M. Matsunaga, Hydrogen Research, Development, and Demonstration Act of 1990” (1990)
P.L. 102-486, “Energy Policy Act" (1992)
P.L. 104-271, “Hydrogen Future Act of 1996” (1996)

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[a] Excludes amounts transferred to the Science appropriation for carrying out SBIR/STTR. All subsequent tables in this program also reflect this transfer.

[b] Reflects amounts rescinded by General Provision, section 312, of the Omnibus Appropriations Act, 2008.

[c] Funding for this activity appears in the Vehicle Technologies budget starting in FY 2009.

P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Hydrogen Technology Program in DOE's Office of Energy Efficiency and Renewable Energy is to research and develop hydrogen and fuel cell technologies, working in coordination with other EERE programs (including Vehicle Technologies, and Building Technologies R&D) and the DOE Offices of Fossil Energy, Nuclear Energy, and Science.

For the near term, the program will focus on hydrogen storage and fuel cell technologies. By addressing critical-path barriers, the program aims to make it technically and economically viable to use hydrogen in a clean, safe, reliable, and affordable manner in fuel cell vehicles and stationary power applications. Accomplishing the mission will benefit the supply side of the Department's energy security equation accelerating the arrival and use of the new fuels and technologies that we need.

Hydrogen Technology is one component of the President's Advanced Energy Initiative (AEI), which aims to reduce our Nation's dependence on foreign energy sources by powering our buildings and vehicles with clean domestic energy. The AEI includes the activities under the Hydrogen Fuel Initiative (FY 2004- FY 2008) and the Department's other light-duty transportation technology development activities, which include applied research related to advanced vehicle technologies, plug-in hybrid vehicles and biofuels. Together, under the Advanced Energy Initiative, the Hydrogen Technology Program and the Vehicle Technologies Program aim to help industry to achieve technology readiness for hydrogen-powered fuel cell vehicles. If widespread commercialization of hydrogen-powered vehicles ensues, and hydrogen is produced from domestic sources of fuel, our energy security would be improved by significantly reducing our reliance on oil. Hydrogen can be produced from domestic resources in an environmentally sound manner, and could provide significant reductions in transportation-related criteria pollutants and greenhouse gases.

Hydrogen Technology pursues its mission through integrated activities designed to improve the efficiency, flexibility, and productivity of our energy economy. We expect these improvements to reduce susceptibility to energy price fluctuations; reduce greenhouse gas emissions; reduce EPA criteria and other pollutants; and enhance energy security by increasing the production and diversity of domestic fuel supplies. Realization of the Hydrogen Technology goals would provide the opportunity to reduce conventional energy use. Specifically reducing highway petroleum use by more than 20 percent and atmospheric carbon by nearly 3 gigatons by 2050. The program's economic, environmental and security benefits are described in more detail under the "Expected Program Outcomes" sections.

Hydrogen technologies for example, can enable the use of fuel cells for the transportation and stationary power sectors, thereby eliminating carbon dioxide emissions from the point of use. Hydrogen could also be used as an energy storage medium to enable full utilization of solar, wind and other intermittent renewables. For renewable and transportation technologies to achieve their full potential, enabling applications which provide only modest direct carbon benefit, are critical for other technologies to achieve their full potential benefit.

Hydrogen technologies can make significant contributions to reducing CO_2 emissions from transportation activity. In the long term, hydrogen may prove to be a low- or no-net-carbon energy carrier, if it can be cost-effectively produced with few or no GHG emissions, such as with renewable or nuclear energy, or with fossil fuels in conjunction with carbon capture and storage. Hydrogen and biofuels as substitutes for petroleum-based fuels in the transportation and other sectors also offer significant national security benefits. Hydrogen can be used in internal combustion engines, but its use in highly efficient fuel-cell-powered vehicles is considered a more important future option.

While its simple molecular structure makes hydrogen an efficient synthetic fuel to produce and use, the storage and delivery of hydrogen are more challenging than for most fuels. Consequently, most hydrogen today is produced at or near its point of use, from other fuels (e.g., natural gas) that are easier to handle and distribute.

In the near term, initial deployment of hydrogen fleet vehicles and distributed power systems may provide early adoption opportunities and demonstrate the capabilities of the existing hydrogen delivery and on-site production infrastructure. This will also contribute non-climate benefits, such as improving urban air quality and strengthening electricity supply reliability. This phase of hydrogen use may also serve as a commercial proving ground for advanced distributed hydrogen production and conversion technologies using existing storage technology, both stationary and vehicular.

In the midterm, light-duty vehicles likely will be the first large mass market (10-15 exajoules (EJ) per year in the United States) for hydrogen. Fuel cells may be particularly attractive in automobiles, given their efficiency versus load characteristics and typical driving patterns.

In the long term, production technologies must be able to produce hydrogen at a price competitive with gasoline for mass market commercial fuel use in automobiles and other transportation applications. This would likely require efficient production means and large quantities of reasonable-cost energy supplies, such as from coal with CO_2 sequestration, advanced nuclear power (high-efficiency electrolysis and thermochemical decomposition of water), fusion energy, renewables (wind-powered electrolysis, direct conversion of water via sunlight, and high-temperature conversion of water using concentrated solar power), or a variety of methods using biomass. Other important factors in the long term include the cost of hydrogen storage and delivery. Finally, advances in basic science associated with direct water-splitting and solid-state hydrogen storage could permit even lower-cost hydrogen production and more efficient storage, delivery, and utilization in the context of low or near-net-zero emission futures for transportation and electricity generation.

Deliverables and Interdependencies

- Under the Advanced Energy Initiative, the Hydrogen Technology Program and the Vehicle Technologies Program aim to help industry to achieve technology readiness for hydrogen-powered fuel cell vehicles.
- Successful deployment of hydrogen as a major energy carrier requires that technology targets are met, as well as market acceptance and large investments in infrastructure. A comprehensive array of policy instruments will be integral to stimulating market entry for mobile and stationary fuel cell applications. Grid integration issues must be addressed to realize the benefits of hydrogen for electricity generation.

Interdependencies include:

- Coordination across four Departmental elements – EERE, Nuclear Energy, Fossil Energy, Science, and the Office of Electricity Delivery and Energy Reliability's Distributed Energy Resources Program – and the Department of Transportation (DOT) to update the DOE Hydrogen strategic plan periodically to support the Department's Hydrogen Crosscut budget request. EERE is the Departmental lead and coordinates research, development and demonstration planning, budget formulation and budget execution activities under the Hydrogen Fuel Initiative;

	(dollars in thousands)
	FY 2009 Request
Hydrogen Funding	
Energy Efficiency and Renewable Energy (EERE) – Hydrogen Technology	146,213
Energy Efficiency and Renewable Energy (EERE) – Vehicle Technologies	31,500
Nuclear Energy (NE)	16,600
Fossil Energy (FE)	11,430
Office of Science (SC)	60,400
Subtotal, Department of Energy	266,143
Department of Transportation (DOT) (est.)	1,425
Total, Hydrogen Fuel Initiative	267,568

- Participation in the Interagency Hydrogen and Fuel Cell Technical Task Force, in accordance with the Energy Policy Act of 2005, to leverage and coordinate Federal resources and activities;
- Participation in the International Partnership for the Hydrogen Economy to leverage R&D capabilities globally;
- DOT, the Environmental Protection Agency (EPA) and the National Institute for Standards and Technology (NIST) cooperation on research for safety and codes and standards.
- Closely coordination with the EERE Vehicle Technologies Program. The interdependency is depicted in the table that follows.

Vehicle Technologies has responsibility for these goals:

- Electric Propulsion Systems with a 15-year life capable of delivering at least 55 kW for 18 seconds and 30 kW continuous at a system cost of $12/kW peak.
- Internal Combustion Engine Powertrain Systems costing $30/kW, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards.
- Electric Drive train Energy Storage with 15-year life at 300 Wh with discharge power of 25 kW for 18 seconds and $20/kW.
- Material and Manufacturing Technologies for high volume production vehicles which enable/support the simultaneous attainment of: 50 percent reduction in the weight of vehicle structure and subsystems, affordability, and increased use of recyclable/renewable materials.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. (Shared responsibility with the Hydrogen Technology Program.)

- Demonstrate hydrogen refueling with developed commercial codes and standards and diverse renewable and non-renewable energy sources. (Prior to FY 2009 was the Hydrogen Technology Program's responsibility.) Goal: cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $2.00-3.00 per gallon gasoline equivalent produced and delivered to the consumer independent of pathway by 2015.

Hydrogen Technology has responsibility for these goals:

- 60 percent peak energy-efficient, durable fuel cell power systems (including hydrogen storage) with 325 W/kg specific power and 220 W/L power density operating on hydrogen. Cost targets are $45/kW by 2010 and $30/kW by 2015.
- On-board Hydrogen Storage Systems demonstrating specific energy of 2.0 kWh/kg (6 percent by weight hydrogen) and energy density of 1.5 kWh/L at a cost of $4/kWh by 2010 and specific energy of 3.0 kWh/kg (9 percent by weight hydrogen), 2.7 kWh/L, and $2.00/kWh by 2015.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. (Shared responsibility with the Vehicle Technologies Program.)

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for the nuclear, energy, science, management, and environmental aspects of the Department's mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Hydrogen Technology Program principally supports the following goal:

Strategic Theme 1, Energy Security

Strategic Goal 1.1, Energy Diversity: Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs.

The Hydrogen Technology Program has one program goal which contributes to Strategic Goal 1.1 in the "goal cascade":

And concurrently supports:

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Goal 1.4, Energy Productivity: Cost-effectively improve the energy efficiency of the U.S. economy.

GPRA Unit Program Goal 1.1.01.00: Hydrogen/ Fuel Cell Technology - Develop fuel cell and on-board vehicle storage technologies to the point that they are cost and performance competitive and are being used by the Nation's transportation, energy, and power industries. Development of these technologies will also make our clean domestic energy supplies more flexible, dramatically reducing or even ending dependence on foreign oil.

Contribution to GPRA Unit Program Goal 1.1.01.00 (Hydrogen/Fuel Cell Technology)

The key Hydrogen Technology contribution to General Goal 4, Energy Security, is domestic energy supply and energy efficiency through:

- Hydrogen Storage R&D, to develop and demonstrate commercially-viable hydrogen storage technology that enables greater than 300-mile vehicle driving range, while meeting vehicular packaging, cost and performance requirements. Specifically, develop and demonstrate by 2010 a hydrogen storage technology with capacity of 2.0 kWh/kg, compared to 0.5-1.3 kWh/kg in 2003, and 1.5 kWh/L(kilowatt-hours per liter), compared to 0.5-0.6 kWh/L in 2003;

- Transportation Fuel Cell Systems and Fuel Cell Stack Component R&D, to improve fuel cell durability and performance while reducing cost. The manufacturing cost of hydrogen-fueled fuel cell power systems will be reduced from $275/kW in 2002 for a 50 kW system to $45/kW in 2010 for an 80 kW system at production levels of 500,000 units per year (projected cost);

- Distributed Energy Fuel Cell Systems to increase the electrical efficiency of 5-250 kW stationary fuel cell systems operating on natural gas or propane from 29 percent in 2002 to 40 percent in 2011; and

- Technology Validation/Learning Demonstrations; Education; and Safety, Codes and Standards activities also contribute to the goal, but beginning in FY 2009 those activities as they apply to vehicular technologies, are moved into the Vehicle Technologies Program for coordination with similar activities that support other vehicle technologies besides hydrogen fuel cells.

Funding by Strategic and GPRA Unit Program Goal

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Strategic Goal 1.1, Energy Diversity			
GPRA Unit Program Goal 1.1.01.00, Hydrogen/Fuel Cell Technology			
Hydrogen Production and Delivery R&D	33,702	39,636	0
Hydrogen Storage R&D	33,728	43,501	59,200
Fuel Cell Stack Component R&D	37,100	43,600	62,700
Technology Validation [a]	39,413	29,727	0
Transportation Fuel Cell Systems	7,324	7,927	6,600
Distributed Energy Fuel Cell Systems	7,257	7,630	10,000
Fuel Processor R&D	3,952	2,973	0
Safety and Codes and Standards [a]	13,492	15,854	0
Education [a]	1,978	3,865	0
Systems Analysis	9,637	11,395	7,713
Integrated Renewable Hydrogen	0	0	0
Early-Market Fuel Cells	0	0	0
Manufacturing R&D	1,928	4,954	0
Total, GPRA Unit Program Goal 1.1.01.00, Hydrogen/Fuel Cell Technology	189,511	211,062	146,213
Total, Strategic Goal 1.1 (Hydrogen Technology)	189,511	211,062	146,213

[a] Beginning in FY 2009, these activities are funded in the Vehicle Technologies budget.

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.1.01.00 (Hydrogen/Fuel Cell Technology)					
Hydrogen Production and Delivery R&D – Renewable					
Complete research for biomass syngas reforming catalysts to improve durability and reduce cost towards achieving 5,000 psi hydrogen produced for $5.70/gallon of gasoline equivalent (untaxed, modeled cost) at the station by 2005. [MET]	Model cost of hydrogen produced from renewable sources and assess versus the 2010 target of $2.85/gge, untaxed at the station at 5,000 psi. [MET]	Due to Congressionally Directed Activities, there will be little activity in FY 2006. Target has been delayed into FY 2007.	Complete lab-scale electrolyzer test to determine whether it achieves 64 percent energy efficiency and evaluate systems capability to meet $5.50/gge hydrogen cost target, untaxed at the station, and with large equipment production volumes [e.g., 500 units/year]. [MET]	Complete benchmark demonstration of reforming technologies and identify development pathways to meet the 2012 target of producing hydrogen from distributed reforming of renewable liquids at 5,000 psi for $<3.80 gge at large equipment production volumes (e.g., 500 units/yr). Reduced costs of hydrogen production will support technology readiness for hydrogen powered vehicles.	
Hydrogen Production and Delivery R&D-Non Renewable					
Complete research for natural gas-to-hydrogen production and dispensing component development and fabrication towards achieving 5,000 psi hydrogen for $3.00/gge (untaxed and without co-production of electricity) at the station in 2006. [MET]	Complete the research for a distributed natural gas-to-hydrogen production and dispensing system that can produce 5,000 psi hydrogen for $3.00/gge (untaxed and without co-producing electricity) at the station in 2006. [MET]	Complete the development of a laboratory scale distributed natural gas-to-hydrogen production and dispensing system that can produce 5,000 psi hydrogen for $3.00/gge. [MET]	Complete preliminary lab scale tests to identify technologies that produce 5,000 psi hydrogen from natural gas for $2.50/gge, untaxed at the station and with large equipment production volumes [e.g., 500 units/year]. [MET]		
Hydrogen Storage R&D					
Complete draft of standard test protocol and construction of test facility for solid-state hydrogen storage materials in support of the targets of 1.2 kWh/L and 4.5 wt. percent and the 2010 targets of 2.0kWh/kg (6 wt. percent), 1.5 kWh/L at $4/kWh. [MET]	Identify materials with the potential to meet 2010 targets of 2.0 kWh/kg (6 wt percent), 1.5 kWh/L, at $4/kWh. [MET]	Complete fabrication and testing of a sub-scale prototype materials-based storage system to demonstrate projected system capacity of 2.5 wt. percent (0.8 kWh/kg); evaluate progress toward the 2007 target of 4.5 wt. percent (1.5 kWh/kg). [MET]	Complete baseline on-board storage systems analyses, down select materials, and evaluate against 2007 targets of 1.5 kWh/kg (4.5 percent by weight) and 1.2 kWh/L. [MET]	Develop chemical hydrogen storage regeneration methods at laboratory-scale, obtain initial data for efficiency and systems analysis, and demonstrate lab-scale reactions capable of at least 40 percent energy efficiency, leading to greater effective storage density and driving range for fuel cell vehicles.	Develop solid-state or liquid materials with the potential to meet 2010 targets of 2.0 kWh/kg (6 percent by weight), 1.5 kWh/L, develop system design and evaluate against 2009 interim goal of 5 percent by weight (modeled) or 1.7 kWh/kg.

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Hydrogen Storage R&D: Tanks					
Complete development of 5,000 psi cryo-gas tank and 10,000 psi compressed gas tank achieving 1.3 kWh/kg and 0.8 kWh/L. [MET]	Complete testing of 10,000 psi hydrogen storage tanks; evaluating against the hydrogen storage system target of 1.5 kWh/kg (4.5 percent by weight), and identify approaches to meet the cost target of $6/kWh. [MET]				
Technology Validation					
Identify and complete feasibility and system design of an isothermal compressor to be incorporated in hydrogen refueling stations to produce hydrogen at $3.00/gge by 2009. [MET]	Complete validation of an energy station that can produce 5,000 psi hydrogen from natural gas for $3.60 per gallon of gasoline equivalent (including co-production of electricity) untaxed at the station with mature equipment production volumes (e.g., 100 units/year). [MET]	Complete installation and 1,000 hours of testing of a refueling station; determine system performance, fuel quality and availability; and demonstrate the ability to produce 5,000 psi hydrogen from natural gas for a projected cost of $3.00 per gallon of gasoline equivalent, untaxed at the station, assuming commercial deployment with large equipment production volumes (e.g., 100 units/year) by 2009. [MET]	Validate achievement of a refueling time of 5 minutes or less for 5 kg of hydrogen at 5,000 psi through the use of advanced sensor, control, and interface technologies. [MET]		
Industry contracts are awarded and initial vehicles delivered that support the 1,000 hour durability target. [MET]	Fuel Cell demonstration vehicles' durability can be projected to 1,000 hours based on voltage measurements. [PARTIALLY MET]	Operate fuel cell vehicle fleets to determine if 1,000 hour vehicle fuel cell durability, using fuel cell degradation data, was achieved by industry. [MET]		Fuel Cell vehicle(s) demonstrate the ability to achieve 250 mile range without impacting cargo or passenger compartments, leading to greater adoption of fuel cells. Technology Validation showed 103-190 mile range under real world operating conditions.	[Targets moved to Vehicle Technologies in FY 2009.]

Transportation Fuel Cell Systems and Fuel Cell Stack Component R&D

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Achieve $200/kW for a hydrogen-fueled 50 kW fuel cell power system. [MET]	DOE-sponsored research will reduce technology cost to $125/kW for a hydrogen-fueled 50kW fuel cell power system. [MET]	DOE-sponsored laboratory scale research will reduce the modeled technology cost to $110/kW for a hydrogen-fueled 80 kW fuel cell power system. [MET]	DOE-sponsored laboratory scale research will reduce the modeled technology cost of a hydrogen-fueled 80kW fuel cell power system to $90/kW. [MET]	DOE-sponsored research will reduce the modeled technology cost of a hydrogen-fueled 80kW fuel cell power system to $70/kW. Reducing automotive fuel cell costs accelerates the market viability and deployment of fuel cell technologies, which contribute to the Department's goal of increased energy security and reduced greenhouse gas and pollutant emissions.	DOE-sponsored research will reduce the modeled technology cost of a hydrogen-fueled 80kW fuel cell power system to $60/kW. Reducing automotive fuel cell costs accelerates the market viability and deployment of fuel cell technologies, which contribute to the Department's goal of increased energy security and reduced greenhouse gas and pollutant emissions.
Distributed Energy Fuel Cell Systems and Fuel Processor R&D					
Achieve 31 percent efficiency at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell system. [MET]	Achieve 32 percent efficiency at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell system. [MET]	Due to Congressionally Directed Activities, there was no activity in this area in FY 2006.	DOE-sponsored research will improve electrical efficiency to 34 percent at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell power system verified by a prototype (5-50 kW system). [MET]	DOE-sponsored research will improve electrical efficiency to 35 percent at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell power system verified by a 5-250 kW prototype. This will support development of fuel cell power systems as alternative power sources to grid-based electricity for buildings and other stationary applications.	DOE-sponsored research will improve electrical efficiency to 36 percent at full power for a natural gas or propane fueled stationary fuel cell power system verified by a 5-250 kW prototype. This will support development of fuel cell power systems as alternative power sources to grid-based electricity for buildings and other stationary applications.
Education					
Determine the baseline level of knowledge and develop a plan for educating target audiences (students and teachers, state and local governments, and large-scale end-users nationwide). [MET]					[Activity moved to Vehicle Technologies in FY 2009.]

Safety and Codes and Standards

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Complete the harmonized technical standard for high pressure vehicle storage that can be incorporated into a regulation (i.e., incorporating the various standards of different countries into a single regulation) for hydrogen storage. Complete the draft technical standard for vehicular safety. [MET]				Develop a hydrogen materials technical reference which reports on embrittlement issues for hydrogen usage up to 10,000 psi delivered. Publish a Best Practices Manual describing hydrogen safety guidelines and lessons learned. Wide acceptance of hydrogen technologies depends on developing and meeting safety standards in which the public has confidence.	[Activity moved to Vehicle Technologies in FY 2009.]
Systems Analysis					
Define requirements for system analysis and integration to link the program's technical objectives to cost and schedule. [MET]				Complete and validate Macro-System Model for complete hydrogen and delivery pathway analysis. This will aid in understanding and assessing technology needs and progress, potential environmental impacts, and the energy-related economic benefits of various hydrogen supply and demand pathways.	Complete feedstock, capital, capacity and utility sensitivity analyses on the cost of delivered hydrogen for 6 pathways using the Macro-System Model. This will aid in understanding and assessing technology needs and progress, potential environmental impacts, and the energy-related economic benefits of various hydrogen supply and demand pathways.
<u>Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (2003) until the target range is met</u>. [MET]	<u>Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the Hydrogen/Fuel Cell Program FY 2004 end of year adjusted uncosted baseline ($29,283K) until the target range is met.</u> [MET]	<u>Maintained total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent</u>. [MET]	<u>Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent</u>. [MET]	<u>Maintain administrative costs as a percent of total program costs less than 12 percent.</u>	<u>Maintain administrative costs as a percent of total program costs less than 12 percent.</u>

Means and Strategies

Hydrogen Technology will use various means and strategies to achieve its GPRA Unit program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" including program, policy, management and legislative initiatives and approaches to implement the President's Hydrogen Fuel Initiative and carry out the program in accordance with the Energy Policy Act of 2005. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

Hydrogen Technology will implement the program through the following means:

- Develop hydrogen storage technologies to achieve cost, efficiency, and other required targets to meet program goals;
- Conduct long-term research, development, and deployment activities, which are aimed at reducing oil consumption across a range of energy applications and sectors of the economy;
- Conduct research and development to address the key technical barriers of performance, cost and durability of fuel cell systems for transportation, stationary, auxiliary power units (APUs), and portable power applications;
- Conduct demonstration and validation activities for stationary APU and portable applications.
- For transportation applications, focus R&D on critical requirements to enable technology readiness, primarily focusing on on-board hydrogen storage to achieve a 300 mile driving range, lowering the high-volume system cost of fuel cells to $45/kW by 2010, and then to $30/kW by the technology readiness target date of 2015. Other significant criteria for transportation fuel cell systems include the need to have fuel cell technologies developed and validated that enable: (1) full performance over 5,000 hours of operation; (2) 60 percent efficiency (hydrogen-fueled) at ¼ of rated power; and (3) operation in vehicles with comparable performance, safety, and reliability to the gasoline internal combustion engine;
- For stationary applications, work towards removing technical barriers to facilitate the near-term introduction of fuel cells in a variety of applications that include energy generation for buildings, uninterruptible power systems, and portable power devices such as consumer electronics;
- Support the introduction of fuel cell vehicles (in collaboration with Vehicle Technologies), stationary and portable fuel cell systems to controlled user-groups such as Federal agencies, utilities, or military installations as early adopters. These activities validate technology performance, provide experience to both manufacturers and end-users supporting the successful introduction of commercial products, help build early public awareness; and help Federal agencies achieve energy efficiency goals;
- Develop systems models and conduct trade-off analyses to guide effective technology decisions;
- Conduct cross-cutting analyses and focus on life cycle cost, emissions, and efficiency of transportation and stationary fuel cell systems in the near (2015), mid (2030), and long-term (post 2050); and

- Conduct research, development and demonstration activities through competitive selected projects with industry, universities, and national laboratories.

Hydrogen Technology will implement the program through the following strategies:

- Ensure that activities follow the key critical path elements of the Hydrogen Posture Plan (which outlines the research and development needed); the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-year Research, Development and Demonstration Plan (which establishes technical targets and schedules to address key technology barriers); and the National Hydrogen Energy Roadmap (which identifies research and development pathways to guide hydrogen and fuel cell R&D);

- Perform formal merit reviews across the Department's portfolio of Hydrogen activities (this process includes the merit review of EERE; Nuclear Energy (NE); Fossil Energy; (FE) and Science (SC) hydrogen and related technologies). The Merit Review evaluation incorporates the principles of the Administration's R&D investment criteria and is conducted in compliance with the Department's Merit Review Guidelines. Additionally, field project managers and technology development managers evaluate progress formally on a quarterly basis;

- Compete the National Laboratories and the private sector for new applied R&D activities;

- Conduct meetings of the Hydrogen and Fuel Cell Technical Advisory Committee (per the Energy Policy Act of 2005 (EPACT 2005)) to advise the Energy Secretary regarding the Department's hydrogen activities;

- Coordinate with the Vehicle Technologies Program to enable uniform codes and standards at the international level to ensure that the U.S. industry can compete globally;

- Use Centers of Excellence as well as independent projects for R&D in hydrogen storage to support the storage goals for materials-based systems;

- Investigate and implement the pilot use of inducement prizes and recognition in hydrogen and fuel cell technologies, aligned with the mission of the program, in accordance with the Energy Policy Act of 2005 (e.g., Title X, Section 1008) and other congressional direction, to complement current R&D efforts.

These means and strategies could result in improving energy security by increasing use of reliable, affordable, renewable and other environmentally sound hydrogen, adding to the diversity and security of the Nation's energy supply.

The following external factors could affect Hydrogen Technology's ability to achieve its strategic goal:

- Congressionally directed projects that do not contribute to the program's goals;

- Price, performance and availability of alternative technologies and conventional fuels that will compete with hydrogen fueled vehicles and will affect the market;

- Decisions on the nature and timing of supporting tax, market and infrastructure policy instruments to help stimulate end-use markets; and

- Public acceptance and concerns regarding the safe use of hydrogen.

In carrying out the program's mission, Hydrogen Technology performs the following collaborative activities:

- Coordinates across four Departmental elements – EERE, Nuclear Energy, Fossil Energy, Science, and the Office of Electricity Delivery and Energy Reliability's Distributed Energy Resources Program – and the Department of Transportation (DOT) to update the DOE Hydrogen strategic plan periodically to support the Department's Hydrogen Crosscut budget request. EERE is the Departmental lead and coordinates research, development and demonstration planning, budget formulation and budget execution activities under the Hydrogen Fuel Program.

Vehicle Technologies has responsibility for these goals:

- Electric Propulsion Systems with a 15-year life capable of delivering at least 55 kW for 18 seconds and 30 kW continuous at a system cost of $12/kW peak.
- Internal Combustion Engine Powertrain Systems costing $30/kW, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards.
- Electric Drive train Energy Storage with 15-year life at 300 Wh with discharge power of 25 kW for 18 seconds and $20/kW.
- Material and Manufacturing Technologies for high volume production vehicles which enable/support the simultaneous attainment of: 50 percent reduction in the weight of vehicle structure and subsystems, affordability, and increased use of recyclable/renewable materials.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. (Shared responsibility with the Hydrogen Technology Program.)
- Demonstrate hydrogen refueling with developed commercial codes and standards and diverse renewable and non-renewable energy sources. (Prior to FY 2009 was the Hydrogen Technology Program's responsibility.) Goal: cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $2.00-3.00 per gallon gasoline equivalent produced and delivered to the consumer independent of pathway by 2015.

Hydrogen Technology has responsibility for these goals:

- 60 percent peak energy-efficient, durable fuel cell power systems (including hydrogen storage) with 325 W/kg specific power and 220 W/L power density operating on hydrogen. Cost targets are $45/kW by 2010 and $30/kW by 2015.
- On-board Hydrogen Storage Systems demonstrating specific energy of 2.0 kWh/kg (6 percent by weight hydrogen) and energy density of 1.5 kWh/L at a cost of $4/kWh by 2010 and specific energy of 3.0 kWh/kg (9 percent by weight hydrogen), 2.7 kWh/L, and $2.00/kWh by 2015.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of

$45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. (Shared responsibility with the Vehicle Technologies Program.)

Validation and Verification

To validate and verify program performance, Hydrogen, Fuel Cells and Infrastructure Technologies will conduct internal and external reviews and audits. Programmatic activities are subject to continuing review by, for example, the Congress, the Government Accountability Office, the National Academies, the Department's Inspector General, as well as by reviewers from other agencies, such as the U.S. Environmental Protection Agency and state environmental agencies through the Program's Annual Merit Review and Peer Evaluation process. Specific milestones, go/no-go decision points, and technical progress are systematically reviewed through the program's merit review process and independent assessments conducted through the Systems Integration Office. The table below summarizes validation and verification activities.

Data Sources: Merit Review and Peer Evaluation of R&D, Program Peer Reviews, and independent assessments are conducted. Engineering models and experimental results are used to validate technical progress, with documentation provided through quarterly and annual reports. Learning demonstration activities also verify and validate technical progress towards meeting targets and help guide R&D. Summary program plans and annual presentations by the program are used to communicate the status of verification/validation activities and to evaluate proposed approaches towards meeting technical targets.

Baselines: The following are the key baselines used in Hydrogen Technology:

- compressed hydrogen tank-only storage (2003): 1.3 kWh/kg (3.9 percent by weight) and 0.6 kWh/L system capacity
- solid state materials for storage systems (2003): 1 percent by weight system capacity and 0.5 kWh/L
- transportation systems/stack component R&D (2002): $275/kW fuel cell cost
- distributed energy systems/fuel processor R&D (2002): 29 percent electrical efficiency
- technology validation (2003, laboratory): 1,000 hours durability of fuel cell vehicle systems
- validated production (delivered) (2004): $3.60/gge (beginning of life testing)

Frequency: Expected results and benefits of the budget are estimated annually in response to PMA and GPRA, Merit Review and Peer Evaluation of R&D projects and Program Peer Review are conducted biennially. Quarterly reports are submitted to DOE Technology Development Managers. Summary program plans are submitted annually.

Data Storage: EERE Corporate Planning System

Evaluation: The program uses several forms of evaluation to assess progress and to promote program improvement:

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based on Joule (the DOE quarterly performance progress review of budget targets), PMA (the President's Management Agenda -- annual departmental and Program Secretarial Officer (PSO) based goals whose milestones are planned, reported and reviewed quarterly), PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputations of potential benefits for the Government Performance and Results Act (GPRA).

The National Academies (National Research Council and National Academy of Engineering) have performed an extensive review of the program and have published a 2004 report titled: "Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs." The committee's report indicated the four most fundamental technological and economic challenges are: 1) to develop and introduce cost-effective, durable, safe and environmentally desirable fuel cell systems and hydrogen storage systems; 2) to develop the infrastructure to provide hydrogen for the light-duty vehicle user; 3) to reduce sharply the costs of hydrogen production from renewable energy sources over a time frame of decades; and 4) to capture and store the carbon dioxide byproduct of hydrogen production from coal.

Additionally, in 2005, the National Academies published a report titled: "Review of the Research Program of the FreedomCAR and Fuel Partnership."[a] The committee's report indicated that DOE's FreedomCAR and Fuel Partnership "has already made an excellent start." The report noted that the partnership faces significant technical challenges, including hydrogen storage in vehicles, commercially viable fuel cells, and the need to build an infrastructure for hydrogen fueling. The report recommended that DOE pay special attention to the challenges of shifting from petroleum to hydrogen as a transportation fuel, including hydrogen safety issues and any environmental impacts of large-scale hydrogen production and use. It also recommended an overall program evaluation to help decide among trade-offs and determine priorities. Finally, the

[a] Report can be found at http://www.nap.edu/catalog.php?record_id=11406.

report noted that Congress has appropriated significant portions of the funding for specific projects that are not focused on the partnership's goals, and that the partnership will be unable to meet its milestones if the practice continues.

- Merit reviews and peer evaluations, conducted by energy, hydrogen, and fuel cell experts from outside of the U.S. Department of Energy, are held to evaluate the research, development and demonstration projects to ensure that they address the priorities and key technology barriers identified in the Hydrogen Technology planning documents.
- The program develops and implements planning documents and supports the development of technology roadmaps with industry.[a] These efforts are used to focus the program's investments on activities that are within the Federal Government's role and that address top priority needs. The Hydrogen Technical Advisory Committee will also be used to independently review the program.
- National Laboratories, industry, and universities receive funding through competitive processes. Hydrogen and fuel cell industry experts review each university, laboratory and industry project at the annual Merit Review and Peer Evaluation. Consistent with the principles of the Administration's R&D Investment Criteria, project peer reviews include evaluation of: 1) Relevance to overall DOE and Hydrogen Fuel Initiative objectives; 2) Approach to performing the research and development; 3) Technical accomplishments and progress toward project and DOE goals; 4) Technology transfer/collaborations with industry/universities/laboratories; and 5) Approach and relevance of proposed future research. The panel also evaluates the strengths and weaknesses of each project, and recommends additions to or deletions from the scope of work.
- Most projects are also evaluated by the FreedomCAR joint technical teams each year. The program facilitates supplier-customer relationships to ensure that R&D results from National Laboratories and universities are transferred to industry suppliers and that industry supplier developments are made available to automakers, energy industry and stationary power producers.
- Reviews are conducted by the Hydrogen Safety Panel to monitor the safety of procedures and facilities throughout the Hydrogen Technology Program.

Verification: Quarterly reports from DOE-funded industry, university and National Laboratory partners document the status of quarterly targets and milestones. An Annual Report is used to evaluate progress towards meeting program goals and technical targets. Data from Technology Validation projects implemented by the Vehicle Technologies

[a] See the following documents: Fuel Cell Report to Congress, Feb. 2003; A National Vision of America's Transition to a Hydrogen Economy, March 2002; National Hydrogen Energy Roadmap, November 2002; FreedomCAR Fuel Cell Technical Roadmap; EERE Hydrogen Program Multi-Year Research, Development and Demonstration Plan; Hydrogen Posture Plan; The 2004 National Academies' Report, The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs; and the National Academies' Report, Review of the Research Program of the FreedomCAR and Fuel Partnership, First Report, August 2005.

Program will be used to assess technology status for vehicular systems. Independent Systems Integration function will evaluate research results.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The Hydrogen Technology Program has incorporated feedback from OMB into the FY 2009 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The Hydrogen Technology Program was rated "adequate" in the latest PART assessment in 2007 (Purpose: 80 percent; Planning: 80 percent; Management: 81 percent; Program Results/Accountability: 58 percent). The 2007 PART assessment stated that "the program has established adequate long-term and annual measures and has demonstrated progress in achieving its targets. For example, the program has consistently met cost reduction targets for producing hydrogen and for an automotive fuel cell system powered by hydrogen. Independent evaluations have generally confirmed that the program is achieving results." Most PART recommendations within program control have been addressed and results-based planning continues to improve. For example, FreedomCAR (the partnership between DOE and USCAR) was expanded in 2003 to include energy industry partners and the expanded partnership was launched to coordinate hydrogen research activities with both automotive and energy industry partners (now called the FreedomCAR and Fuel Partnership). EERE and the DOE Office of Science (SC) coordinate extensively in developing solicitations and reviewing progress to enable basic research to support hydrogen production, storage and use. However, the PART assessment noted that a significant level of congressionally directed activities jeopardizes progress by reducing program funding available to address the most important barriers to the hydrogen economy.

The Department has responded to the PART recommendation of "Develop guidance that specifies a consistent framework for analyzing the costs and benefits of research and development investments, and use this information to guide budget decisions." The Department continues to work on the development and implementation of common assumptions, a consistent approach to incorporation of risk, and other issues. EERE continues to refine the methods it uses in support of this framework and Departmental processes.

Expected Program Outcomes

Hydrogen Technology pursues its mission through integrated activities designed to improve the energy efficiency, flexibility, and productivity of our energy economy. We expect these improvements to reduce susceptibility to energy price fluctuations; reduce greenhouse gas emissions; reduce EPA criteria and other pollutants; and enhance energy security by increasing the production and diversity of domestic fuel supplies. Realization of the Hydrogen Technology goals would provide the technical potential to reduce conventional energy use.

Estimates of the security, economic and environmental benefits from 2009 through 2050 that would result from realization of the program's goals are shown in the table below. The estimates do not include any complementary or R&D activities from other Federal programs. The program would increase the energy diversity of the Nation's transportation system by enabling 51 percent of the light duty vehicle stock to be hydrogen fuel cell vehicles in 2050. These results, based on the GPRA09 analysis, include contributions from the relevant technology development efforts under EERE's FreedomCAR and Vehicle Technologies Program. The results incorporate different assumptions and are significantly below the 11 mbpd savings by 2040 that we estimated when the initiative was launched because hydrogen is now considered to be only one component of a more diverse portfolio of options. The lower value of oil savings when compared to last year is based on the assumption that competing alternative fuels and vehicle technologies (such as biofuels and plug-in hybrids) will be available.

EERE's Hydrogen Technology Program Goal Case reflects the increasing penetration of hydrogen technology over time, as the program's goals are met. Not included are any policy or regulatory mechanisms, or other incentives not already in existence, that might be expected to support or accelerate the achievement of the program goals. Nor are all the effects of competition from alternative technologies considered. The expected benefits reflect solely the achievement of the program's goals.

The goals are modeled in contrast to the "baseline" case, in which no DOE R&D exists. The baseline case is identical to those used for all DOE applied energy R&D programs.[a] Further, across EERE, and across all of DOE's applied energy R&D programs, the expected outcome benefits are being calculated using the same fundamental methodology. Finally, the metrics by which expected outcome benefits are measured are identical for all of DOE's applied energy R&D programs.[b] This standardization of methods and metrics has been undertaken to address the R&D investment criterion that "Programs and projects must articulate public benefits of the program using uniform benefit indicators across programs and projects with similar goals."[c]

The difference between the baseline case and the program goal case results in economic, environmental and security benefits. For example, achievement of program goals could result in cumulative oil import savings of 0.5 billion barrels by 2030 and more than 10.6 mbpd in 2050. Achieving these goals would also result in carbon emission savings of 16 million metrics tons by 2030 and 3 gigatons tons by 2050. Finally, the program's advances would also result in a cumulative consumer savings of more than $100 billion in 2050. The results are generated by modeling the program goals within two integrated energy-

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[a] The starting point for the baseline case is the Energy Information Administration's "reference case," as published in the AEO 2007. Program analysts from across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO's technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

[b] The set of expected outcome metrics being used this year differs in substantial ways to that of previous years. In addition to the standardization across DOE's applied energy R&D programs, the list is expanded and more comprehensive than in past years. Further, the list maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

[c] See OMB-OSTP priorities memo, p. 10. http://www.whitehouse.gov/omb/memoranda/m03-15.pdf.

economy models: NEMS-GPRA09 for benefits through 2020, and MARKAL-GPRA09 for benefits through 2050.[a] The full list of modeled benefits appears below.

Primary Benefits Metrics for FY09– NEMS and MARKAL

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	0.01	N/A
		MARKAL	ns	ns	0.5	10.6
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	-0.3	-10.2
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	1%	22%
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	ns	16	N/A
		MARKAL	0	0	264	2931
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	ns	1.4	N/A
		MARKAL	ns	ns	-9	113
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	-6	-65
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	-15	11

1. “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

[a] Final documentation on the analysis and modeling can be found at http://www.eere.energy.gov/ba/pba/gpra.html .

Hydrogen Production and Delivery R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Hydrogen Production and Delivery R&D	33,702	38,526	0
SBIR/STTR	0	1,110	0
Total, Hydrogen Production and Delivery R&D	33,702	39,636	0

Description

EERE Hydrogen Production and Delivery R&D is being deferred as of the end of FY 2008. The Production R&D had focused on renewable energy based approaches to hydrogen production. The Delivery R&D had focused on reducing the cost of fueling site delivery components including hydrogen compression, storage and dispensing as well as cost effective technology to deliver hydrogen from centralized production facilities. Within constrained budgets, the EERE Hydrogen Program will devote resources to fuel cell research, hydrogen storage, and their supporting activities. Work involving coal and nuclear-based hydrogen production is funded by the DOE Fossil Energy and Nuclear Energy offices, respectively.

Hydrogen Production Costs (modeled)[a]: Renewable delivered at 5000 psi

	($/gge)							
	2003	2004	2005	2006	2007	2008	2009	2010
Hydrogen from renewables								
Target	6.20	6.00			$4.30	$4.30		
Actual	6.20	5.45	5.88[b]	4.40[c]	$4.40			

Hydrogen Production Costs (modeled)[b]: Non-renewable delivered at 5000 psi, untaxed, based on natural gas at $ 5.25/MBtu. Note that the modeled cost of $3.00/gge allows hydrogen from distributed

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[a] Hydrogen production cost estimates use laboratory data and assume high equipment manufacturing volumes, i.e., 500 units/year.

[b] The increase of the FY 2005 actual value of modeled cost of hydrogen produced from renewables is due to two factors: (a) increase in the assumed industrial electricity price from 5 cents/kWh to 5.5 cents/kWh from the EIA Annual Energy Outlook (2004 vs 2005) and (b) increase of capital cost estimate of electrolyzer. Targets and status post 2005 are based on distributed reforming of renewable liquids. Previous targets and status were based on distributed electrolysis, which will not likely be a major renewable technology when used in applications with grid power. In addition, the post-2005 timeline has been extended consistent with reduced funding available for renewable production due to previous years' appropriations and Congressionally-directed projects.

natural gas to be competitive with gasoline at $2.00 to $3.00/gge; hence no further targets are specified below.

	($/gge)							
	2003	2004	2005	2006	2007	2008	2009	2010
Hydrogen from natural gas								
Target	5.00			3.00	N/A	N/A	N/A	N/A
Actual	5.00		3.10	3.00	$2.50			

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Hydrogen Production and Delivery R&D	**33,702**	**38,526**	**0**

Consistent with revised EERE portfolio and DOE priorities, further work on Hydrogen Production and Delivery R&D is being deferred because the critical-path hydrogen production cost goal for 2015 technology readiness has been met with natural gas reforming. The EERE Hydrogen Program will devote resources to fuel cell research, storage, and their supporting activities. Work involving coal and nuclear-based hydrogen production is funded by the DOE Fossil Energy and Nuclear Energy offices, respectively.

SBIR/STTR	**0**	**1,110**	**0**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Hydrogen Production and Delivery R&D	**33,702**	**39,636**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Hydrogen Production and Delivery R&D	
Consistent with revised EERE portfolio and DOE priorities, further work on Hydrogen Production and Delivery R&D is being deferred because the critical-path hydrogen production cost goal for 2015 technology readiness has been met with natural gas reforming. Within constrained budgets, the EERE Hydrogen Program will devote resources to fuel cell research, hydrogen storage, and their supporting activities. Work	-38,526

	FY 2009 vs. FY 2008 ($000)
involving coal and nuclear-based hydrogen production is funded by the DOE Fossil Energy and Nuclear Energy offices, respectively.	
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-1,110
Total Funding Change, Hydrogen Production and Delivery R&D	**-39,636**

Hydrogen Storage R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Hydrogen Storage R&D	33,728	42,282	57,542
SBIR/STTR	0	1,219	1,658
Total, Hydrogen Storage R&D	33,728	43,501	59,200

Description

Hydrogen Storage R&D will focus primarily on the research and development of on-board vehicular storage systems that allow for a driving range of more than 300 miles within the constraints of weight, volume, safety, durability, refueling time, efficiency, and total cost, to meet consumer expectations. The Hydrogen Storage portfolio will concentrate on materials-based technologies and will also explore advanced conformable and low cost tank technologies for hydrogen storage systems to meet 2010 and 2015 performance targets.

Hydrogen storage is a key enabling technology for the advancement of hydrogen and fuel cell technologies for transportation, stationary power, and portable power applications. Current hydrogen storage systems for vehicles are inadequate to meet customer driving range expectations without intrusion into vehicle cargo or passenger space. The Hydrogen Storage R&D activity supports the mission of the Hydrogen Technologies Program by focusing on the development of safe, compact, light-weight, low-cost, durable, and efficient storage systems to achieve a driving range of greater than 300 miles.

The research will enable the system volumetric (kWh/L) and gravimetric (kWh/kg or % by weight) storage capacities (while meeting cost targets) to be improved as indicated below.

Hydrogen Storage Performance Metrics

	2003[a]	2004	2005	2006	2007	2008	2009	2010
Materials-Based								
Volumetric (kWh/L)								
Target					1.2	1.2		1.5
Actual	0.5	0.6	0.65	0.8				
Gravimetric (% by weight)								
Target	1	1.7		2.5	4.5	4.5	5.0	6.0
Actual	1	1.7	1.9	2.3	3.0			

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Hydrogen Storage R&D	**33,728**	**42,282**	**57,542**

To address the critical challenge of hydrogen storage, the program will continue with its overarching strategy to conduct research and development through the framework of the "*National Hydrogen Storage Project,*" consisting of both Centers of Excellence (which include teams of competitively selected university, industry and Federal Laboratory partners) and competitively selected independent projects aimed at meeting the following technical goals by 2010: storage density of 2.0 kWh/kg (6 percent hydrogen by weight) and 1.5 kWh/L or 45 g/L. A solicitation is planned for awards in FY 2009 to broaden the portfolio of innovative materials-based concepts for hydrogen storage.

Also broadening the portfolio is the continuation of a new competitively awarded Center of Excellence expected to start in FY 2008 for engineering science of hydrogen storage material-based systems. To complement hydrogen storage R&D, the program will continue to implement an inducement prize to foster a broader spectrum of ideas and participants and to support the Energy Policy Act of 2005, Title X, Section 1008 (e.g., Freedom Prize or other cash prizes).

Hydrogen storage efforts will focus on applied, target-oriented research of advanced concepts, innovative chemistries and novel materials, with the potential to meet long term performance metrics. Advanced concepts include high-capacity metal hydrides, chemical hydrogen storage including solid and liquid chemical hydrogen carriers and boron-based materials, sorbents including novel metal-carbon hybrids, metal-organic framework materials, polymers, and other nanostructured high surface area materials, as well as novel material synthesis and treatment processes. The applied R&D

[a] 2 kWh/kg = 6 percent hydrogen by weight. 6 percent hydrogen by weight storage system contains 6 kg of hydrogen in a system weighing 100 kg. 1 kg of hydrogen contains 33.3kWh (on a lower heating value basis), so 6 kg contains approximately 200kWh. A 200 kWh hydrogen/100 kg system = 2kWh/kg.

investment will also increase critical engineering efforts to enable compact, efficient and light-weight reactor designs and components for the vehicular storage system, including thermal management issues. Overall technical progress for hydrogen storage in FY 2009 will be moving from the FY 2007 interim system target of 4.5 percent hydrogen by weight towards the 2010 system target of 6 percent hydrogen by weight.

Building on the research conducted through the end of FY 2008, R&D will focus on the most promising material technologies down-selected from the overall portfolio at the end of FY 2007 that have the potential to meet the DOE 2010 system targets. Also continuing is research on material concepts with the potential to meet the longer term DOE targets of 9 percent hydrogen by weight in 2015. A key milestone in FY 2009 will be to select the most promising material(s) for sub-scale prototype demonstration for the 2010 storage system targets.

Chemical hydrogen storage research will focus on laboratory-scale engineering development of storage system components to improve volumetric, gravimetric and transient performance as well as improving spent fuel regeneration efficiencies for materials down-selected in FY 2008. The milestone for FY 2009 is to select chemical hydrogen storage approaches with the potential to meet the 2010 storage system targets. In addition, chemical hydrogen storage research will continue to develop high capacity storage materials that offer pathways to meet the 2015 system targets.

Metal hydride research will focus on developing high-capacity materials that have the potential to meet the 2010 system targets and offer pathways to meet the 2015 system targets. Following the FY 2007 materials down-select, the R&D investment will focus on improving volumetric, gravimetric and transient performance of the materials. The milestone for FY 2009 is to reproducibly demonstrate advanced metal hydrides at the laboratory-scale and update the system projections for volume and weight.

Research on sorbents will focus on innovative ways to store hydrogen with lower binding energies (as compared to metal hydrides and chemical hydrides) to enable close to room temperature storage at nominal pressure. The sorbent portfolio in FY 2009 will continue investments towards the planned end-of-year materials down-select decision point on advanced sorbents.

Investment will be accelerated in the new Engineering Center of Excellence competitively selected in FY 2008. This new Center will complement and coordinate with the existing three materials-based Centers (in metal hydrides, sorbents and chemical hydrogen storage). The Engineering Center's mission will be to research and develop the necessary engineering models, analyses and data to enable the design of improved systems and components that have the potential to meet DOE's 2010 and ultimately 2015 system targets. Engineering R&D will also address thermal management.

Material studies initiated in FY 2007 will be expanded to include a diverse set of material reactivity properties, such as tolerance to moisture and air, generating critical information for a safe, commercially viable technology. Independent testing to validate materials performance for selected materials will also be conducted. Through storage systems analysis, the program will rigorously

(dollars in thousands)

	FY 2007	FY 2008	FY 2009

assess the emerging technologies based on performance, cost, life-cycle energy efficiencies, and environmental impact. System analysis and engineering activities will also update projections of volume and weight of a system based on the most promising materials.

A cross-cutting area to be initiated in FY 2009 will include competitively selected projects on high-throughput/combinatorial methods for hydrogen storage materials. The program will coordinate these projects with the existing materials Centers of Excellence and independent projects to validate the methods proposed and to determine the most promising compositions to explore for new materials.

This subprogram is aligned with DOE's assessment of hydrogen storage as one of the highest priority, technically challenging barriers. The applied R&D will be closely coordinated with the DOE Office of Science basic research efforts.

In addition, these funds may be used to support efforts such as such as EPACT 2005 requirements, peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**1,219**	**1,658**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Hydrogen Storage R&D	**33,728**	**43,501**	**59,200**

Explanation of Funding Changes

FY 2009 vs. FY 2008 ($000)

Hydrogen Storage R&D

The requested increase recognizes the significant technical challenge of on-board hydrogen storage and the need to achieve a 300 mile driving range to meet consumer expectations and be competitive with current vehicles. The majority of the requested increase supports competitive, merit-reviewed, cost-shared R&D on materials-based hydrogen storage technologies by industry, universities and Federal Laboratories (e.g. DOE National Laboratories, the Jet Propulsion Laboratory, and the National Institute of Standards and Technology). The research focuses on metal hydrides, chemical hydrogen storage, and sorbent materials, as well as continuation of engineering science of sub-systems and storage materials safety for the overall storage systems planned for FY 2010 (+$8 million). Included in this increase is investment in the new Engineering Center of Excellence (which includes teams of competitively selected university, industry and Federal Laboratory partners) started in FY 2008. Specifically, the Engineering Center recognizes the need for complementing the portfolio's materials research with systems engineering to enable meeting total storage system targets.

The increased funding will also support new awards from the annual solicitation for new materials and concepts including high throughput synthesis and testing of novel hydrogen storage materials (+$5.8 million). These new projects, planned to start in FY 2009, will complement the work being done at existing materials-based Centers of Excellence and in existing independent projects. The planned additional funding supports critical R&D that is required to meet the 2010 performance targets (2.0 kWh/kg and 1.5 kWh/L) and for meeting the longer term 2015 targets of 3.0 kWh/kg and 2.7 kWh/L. Investment in the hydrogen storage inducement prize (up to $1.0 million) will continue.

The R&D of materials-based hydrogen storage technologies is consistent with the National Academies' recommendations in their *Hydrogen Economy* report and is supported by multiple Research Development Investment Criteria factors: it is a Presidential priority; it addresses market barriers (e.g., no current market) and provides a public benefit; it builds on existing technology and complements current R&D in support of the DOE Hydrogen Posture Plan; it incorporates industry involvement in planning, industry cost-sharing, performance indicators, "off ramps" (such as a "no-go" decision in the specific area of pure single walled carbon nanotubes for room temperature hydrogen storage in FY 2006 and the "no-go" decision on sodium borohydride in FY 2007); and, it is competitively awarded and peer reviewed. +15,260

	FY 2009 vs. FY 2008 ($000)
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+439
Total Funding Change, Hydrogen Storage R&D	**+15,699**

Fuel Cell Stack Component R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Fuel Cell Stack Component R&D	37,100	42,379	60,944
SBIR/STTR	0	1,221	1,756
Total, Fuel Cell Stack Component R&D	37,100	43,600	62,700

Description

For fuel cell vehicles to be competitive, fuel cell systems must become less expensive and more durable than they are presently. The high cost and insufficient durability of polymer electrolyte membrane (PEM) fuel cell stack components (polymer electrolyte membranes, oxygen reduction electrodes, advanced catalysts, bipolar plates, etc.) currently are the biggest hurdles facing the adoption of complete fuel cell systems. The National Academies recognized the importance of stack component R&D in their 2004 recommendation to focus the research on breakthroughs in fuel cell costs and materials for durability. The program's collaborative R&D efforts with industry, National Laboratories and academia are focused on the critical technical barriers of cost, durability, efficiency, and overall performance of fuel cell stack components for both transportation and stationary applications. A 2005 National Academies' report[a] recommended an expanded activity and raised the priority of membrane R&D, new catalyst systems, and electrode design (in collaboration with DOE's Office of Basic Energy Sciences (BES)). In particular, research will focus on failure mechanisms, including a better understanding of the chemistry, physics and materials involved.

Fuel cells have the potential to enable the reduction of our energy use and the Nation's dependence on imported petroleum because they are highly efficient and generate zero emissions. Stack Component R&D supports the program's mission by focusing on improvement of overall fuel cell performance and durability, while lowering cost. The improvements will help to make fuel cells competitive with conventional technologies so that their potential benefits in energy security and environmental quality can then be realized.

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[a] National Research Council of the National Academies; Committee on Review of the FreedomCAR and Fuel Research Program, Phase 1; Board on Energy and Environmental Systems, Division on Engineering and Physical Sciences, Transportation Research Board; *Review of the Research Program of the FreedomCAR and Fuel Partnership: First Report,* (Washington, DC: National Academies Press, 2005)

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Fuel Cell Stack Component R&D	**37,100**	**42,379**	**60,944**

A key to meeting the program's goals for fuel cell systems will be developing proton-conducting membranes that are low-cost, durable, and operate at low relative humidity (RH) over the target temperature range (-20 to 120°C), with good mechanical and chemical stability under highly oxidizing conditions. In FY 2009, Stack Components research will focus on the synthesis of ionomer and membrane materials that conduct protons at low relative humidity (25-50% RH) and at temperatures up to 120°C and are electrically insulating. Ionomer and membrane failure and degradation mechanisms will be elucidated, and strategies that address and mitigate the failure mechanisms will be developed.

Advances are needed to improve the activity and durability and reduce the cost of cathode catalysts in PEM fuel cells. In 2009, Stack Components research will elucidate catalyst degradation mechanisms and develop strategies to meet the targets for electrochemical area loss as well as increase catalyst activity and utilization. *In situ* and end-of-life characterization techniques will be developed. The study of alloys to increase activity and reduce cost of cathode catalysts will be ramped up. In addition, the performance of precious metal and non-precious metal catalysts will be evaluated and assessed against 2010 targets. Carbon support degradation mechanisms will be explored and strategies to mitigate electrocatalyst support loss will be developed. In 2009, Stack Component research will focus on development and fabrication of prototype innovative stack designs to simplify, integrate or eliminate components or functions. In addition, R&D will be included for low-cost fabrication technologies.

The performance of membrane electrode assemblies (MEAs) in a single cell and short stacks will be evaluated and compared to the 2010 targets. The cost of a hydrogen-fueled 80 kW fuel cell power system based on current technology will be analyzed and compared to the FY 2009 target of $60/kW.

Gas diffusion layers (GDLs) between the membrane electrode assembly and bipolar plates enhance fuel cell performance and ease water management. In 2009, test protocols for GDLs will be developed. Water transport within the fuel cell stack will be optimized and models will be developed to describe transport through porous media and to understand the structure and transport at the catalyst interface. Effective water management in a full-area (≥ 250 cm^2) short stack (≥ 10 cells) will be demonstrated and engineering solutions to mitigate freeze/thaw damage and improve subfreezing operation will be developed and evaluated. Progress toward extending durability to > 5000 hours with cold start and simplified cycling will be evaluated. Seals between bipolar plates ensure the purity and integrity of the fuel cell stack environment. In FY 2009, Stack Components research will include development of durable PEM fuel cell seal materials. The mechanical and chemical stability of interfacial seals will be improved. Accelerated testing of seals in *ex situ* experiments and at the single cell level will also be performed.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

Impurities present in both the hydrogen fuel stream and the air intake are known to negatively impact a fuel cell's performance and durability. In 2009, Stack Component research will investigate and quantify the effects of impurities on fuel cell performance and include development of novel mitigation strategies to increase fuel cell tolerance to impurities. A uniform single cell testing protocol will be developed, including standard test conditions and operating parameters. Progress towards cleaning sulfur-poisoned platinum catalyst layers in stacks with minimum interruption of fuel cell operation will be evaluated. Finally, this key activity addresses technology development applicable to portable power systems, which may have an earlier market entry. Activities may include promoting early adoption of these systems to validate performance, durability, and reliability and to conduct field testing.

In addition, these funds may be used to support efforts such as EPACT 2005 requirements, peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**1,221**	**1,756**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Fuel Cell Stack Component R&D	**37,100**	**43,600**	**62,700**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Fuel Cell Stack Component R&D	
The requested increase will allow examination of innovative concepts to simplify, integrate or eliminate components or functions in fuel cell systems. Fuel cell performance will be improved with alternative designs, materials, and configurations. Ionomer and membrane materials that conduct protons at low relative humidity (25-50% RH) and at temperatures from below freezing up to 120°C will be synthesized. Catalyst degradation mechanisms will be determined and strategies will be developed to meet the targets for electrochemical area loss, catalyst activity and utilization.	
The fuel cell stack component R&D activity is consistent with the National Academies' recommendations and is supported by multiple Research Development Investment Criteria factors: it is a Presidential priority; it addresses market barriers and provides a public benefit; it builds on existing technology and complements current R&D in support of the DOE Hydrogen Posture Plan; it incorporates industry	+18,565

	FY 2009 vs. FY 2008 ($000)
involvement in planning, industry cost-sharing, performance indicators, "off ramps" (such as the shift after FY 2004 from building full-scale 50kW fuel cell systems to focusing on materials and component R&D), and it is competitively awarded and peer reviewed.	
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+535
Total Funding Change, Fuel Cell Stack Component R&D	**+19,100**

Technology Validation

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Technology Validation	39,413	29,310	0
SBIR/STTR	0	417	0
Total, Technology Validation	39,413	29,727	0

Description

Technology Validation includes both Fuel Cell Technology Validation and Hydrogen Infrastructure Validation. In FY 2009 this activity is funded in the Vehicle Technologies program, within the Hybrid Electric Systems subprogram.

This activity has funded the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project, structured as a 50/50 cost-shared effort between the government and industry, including automobile manufacturers, energy companies, suppliers, universities, and state governments. The project is both a "Learning Demonstration" to manage the hydrogen and fuel cell component and materials research and a validation of the technology under real-world operating conditions against time-phased performance-based targets. Extensive data has been collected on vehicles operating on-road and during dynamometer testing. Validation of the hydrogen infrastructure includes verification of hydrogen production cost and fill times while gaining experience in the safe operation of stations.

Technology Validation provides the most accurate assessment of technology readiness and the risks to success facing continued government and industry investment. To enable the automotive, energy and utility industries to determine if technology readiness has been achieved, integrated vehicle and infrastructure systems need to be validated and individual component targets need to be met under real-world operating conditions. This activity has supported the Hydrogen Technology Program's mission by providing critical statistical data to predict whether fuel cell vehicles can meet the 2015 targets of 5,000-hour fuel cell durability, 300+ mile range hydrogen storage, 5-minute fill time, and hydrogen fuel costs between $2.00 and $3.00 per gallon gasoline equivalent (gge). Specifically, the program will validate the performance and vehicle interfaces of hydrogen fuel cell vehicles to demonstrate a 250 mile range by 2008 and an increase in durability from approximately 1,000 hours in 2003 (laboratory) to 2,000 hours by 2011 in a vehicle fleet. (2,000 hours is equal to approximately 50,000 vehicle miles.). Technology Validation has also provided information in support of codes and standards development and for the development of best practices regarding safety.

Specifically, the research will enable validation of the parameters indicated in the table below.

Performance Targets to be Verified by the Technology Validation Subprogram

	2004[a]	2005	2006	2007	2008	2009	2010	2011
Durability (hours)								
Target		1,000 (Projected)[b]	1,000					2,000
Actual			950 (max)					
Range (miles)								
Target					250+			
Actual								
Cost of hydrogen production[c] ($/gge untaxed)								
Target		3.60				3.00		
Actual	3.60	3.60						
Fill Time (minutes)								
Target				5				
Actual								

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Technology Validation	**39,413**	**29,310**	**0**

Funding for this activity in FY 2009 is included within the Vehicle Technologies Hybrid Electric Systems subprogram.

Five automobile manufacturers and energy company partnerships were selected in April 2004 to design and construct hydrogen fuel cell vehicles and fueling stations to support "learning demonstrations" in the Controlled Hydrogen Fleet and Infrastructure Technology Demonstration and

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[a] The program plan in effect in 2004 did not include quantitative targets for that year. The $3.60/gge includes co-production of electricity and hydrogen fuel, and is only for limited testing.

[b] FY 2005 durability target was changed to 1,000 hours "projected" due to the delay in selecting projects from the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Solicitation.

[c] The validation activity will confirm the 2006 laboratory data for estimated hydrogen production costs in real world conditions. Hydrogen production cost estimates use real world data and assume high equipment manufacturing volumes, e.g., hundreds of units/year.

(dollars in thousands)

Validation Project. The primary goals are to validate progress towards the 2011 target of 2,000 hours fuel cell durability and 250+ mile range. The fuel cell vehicle technology validation effort will quantify the performance, reliability, durability, maintenance requirements and environmental benefits of fuel cell vehicles under real world conditions and provide valuable information to researchers to help refine and direct future R&D activities related to fuel cell vehicles.

In FY 2008, the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project will complete the fourth year of data collection on first generation vehicles, including chassis dynamometer tests. This data collection will facilitate a better understanding of vehicle and infrastructure interface issues of hydrogen fueled vehicles. An initial composite system efficiency assessment and an interim evaluation of data collected from first-generation hydrogen-fueled vehicles will be completed. Second generation vehicles, introduced in FY 2007, will begin their first full year of testing with more advanced fuel cell and storage systems that will ultimately validate the 2011 fuel cell system durability and range targets.

To support fueling of the fuel cell vehicles, the partnerships will design and construct hydrogen refueling stations and associated infrastructure using new hydrogen production technology to validate whether the new technologies reach the 2009 target of $3.00/gge hydrogen (untaxed) with 68 percent natural-gas-based well-to-pump efficiency.

The infrastructure efforts through FY 2008 will include installing and operating stations in Northern and Southern California, Michigan, Washington, D.C., and Florida. Hydrogen production concepts being demonstrated will explore viable options for the near and long term. Additional stations for low-cost hydrogen production will be deployed by FY 2008 that will explore the use of local distributed natural gas reformation plants, renewable systems, and mid-size natural gas reformation plants with pipelines and mobile refueling systems to local distribution stations. High-efficiency energy stations that co-produce electricity and hydrogen fuel for vehicles will be deployed as potential low-cost fuel providers and early infrastructure options in FY 2008. Data relevant to key vehicle and refueling interface issues such as refueling times, hydrogen purity impacts, energy efficiency of the hydrogen generation plant, and plant availability and reliability will be produced and published to provide a database for system modelers.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**417**	**0**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Technology Validation	**39,413**	**29,727**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Technology Validation	
Funding for this activity in FY 2009 is included in the Vehicle Technologies Program, within the Hybrid Electric Systems subprogram.	-29,310
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-417
Total Funding Change, Technology Validation	**-29,727**

Transportation Fuel Cell Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Transportation Fuel Cell Systems	7,324	7,705	6,415
SBIR/STTR	0	222	185
Total, Transportation Fuel Cell Systems	7,324	7,927	6,600

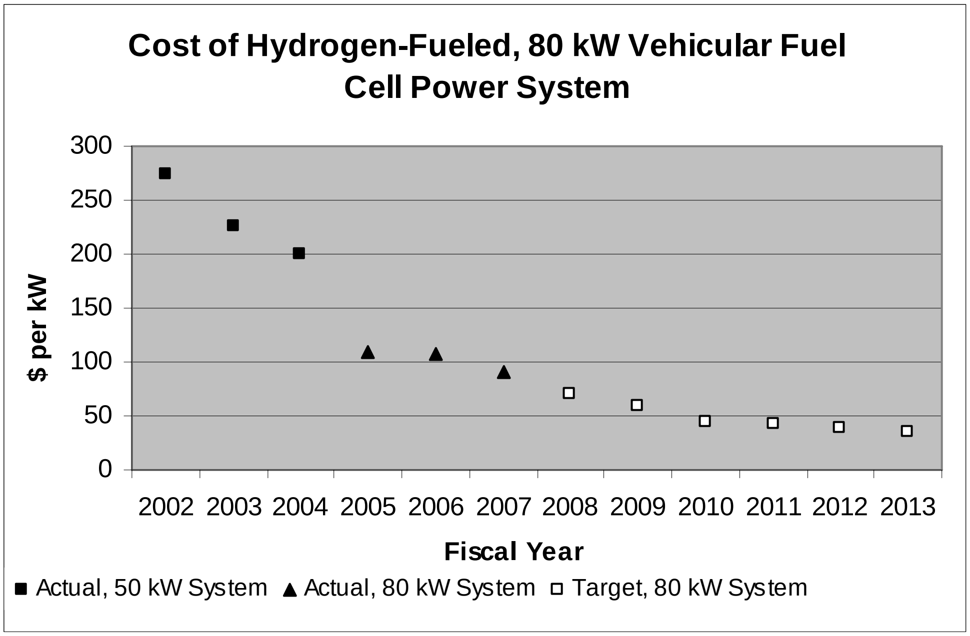
Description

Transportation Fuel Cell Systems conducts research, development and analyses that address key barriers to fuel cell systems for transportation. Key system-level challenges addressed in this subprogram include the cost of compressor/expanders, the durability and performance of water-management devices, and thermal management that meets automotive packaging and cost requirements. Because of the ability of industry to develop complete systems, Transportation Fuel Cell Systems does not develop complete, integrated systems for transportation applications. Instead, Transportation Fuel Cell Systems supports the development of individual component technologies critical to systems integration as well as systems-level modeling activities that serve to guide R&D, benchmark systems progress, and explore alternate system configurations in conjunction with fuel cell system cost analyses. Other activities include modeling of impurity effects and evaluating water and thermal management strategies. For off road applications, Transportation Fuel Systems addresses issues such as vibration, dust, contaminants, and harsh duty cycles that could have a deleterious effect on stack performance and life. Transportation Fuel Cell Systems R&D also supports development of fuel cells for auxiliary power units for automotive or heavy vehicle applications. These highly efficient systems are used to power a vehicle’s accessories for significant durations when their primary engine would typically be idling at very low efficiency to provide accessory power. Activities may include promoting early adoption of these systems to validate performance, durability, and reliability and to conduct field testing.

Transportation Fuel Cell Systems R&D supports the program’s mission by addressing balance of plant components and optimizing operating strategies to improve performance and durability, while lowering cost. The improvements will help to make energy efficient and zero emissions fuel cells competitive with conventional technologies, contributing to the Department’s Strategic Goals for energy security, environmental quality and energy productivity.

Research activities for transportation applications (including transportation systems and stack component R&D) will reduce the cost of the hydrogen-fueled, 80 kW vehicle fuel cell power systems as indicated below[a]

[a] Cost of 80 kW vehicle fuel cell power systems estimated for production rate of 500,000 units yearly and includes fuel cell stack and balance of plant.



Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Transportation Fuel Cell Systems	**7,324**	**7,705**	**6,415**

Water management continues to be a challenge because of the extremes in the environment in which a fuel cell must operate. In FY 2009, Transportation Fuel Cell Systems will continue to explore novel means to increase performance and efficiency of water management components, while decreasing the size, weight and cost of humidifiers and other devices needed to manage the water generated in the fuel cell system. These devices will be optimized for robust operation in all applicable environments and be evaluated using fuel cell system modeling. In FY 2009, third-party evaluation of fuel cell stacks and systems will increase as these technologies mature. This evaluation is necessary for benchmarking the technologies and for providing relevant and reliable specifications of equipment to system designers. Field evaluations of fuel cell powered material handling equipment for durability and total system performance under harsh, continuous duty cycles will be conducted.

Fuel cell systems for auxiliary power in heavy duty trucks are being developed as alternate power supplies to avoid idling the diesel engine to provide overnight power to the cab. The development of fuel-cell APUs will feed new technologies into the Vehicle Technologies Program's 21st Century Truck initiative. Solid oxide fuel cell (SOFC) technology is being explored for these APU applications, and its development is conducted in coordination with the Office of Fossil Energy's (FE) Solid Oxide Fuel Cell R&D effort. FE is responsible for developing large stationary SOFC

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

applications. Hydrogen Technology has responsibility for developing prototype SOFC systems at the smaller size, and EERE's Vehicle Technologies Program will be responsible for vehicle system integration. In FY 2009, Solid Oxide Fuel Cell auxiliary power unit hardware will be designed and built. APU system modules will be tested and developed, and an integrated SOFC APU unit will be demonstrated onboard an operating heavy duty truck.

Activities may include promoting early adoption of transportation systems to validate performance, durability, and reliability and to conduct field testing.

In addition, these funds may be used to support efforts such as EPACT 2005 requirements, peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**222**	**185**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Transportation Fuel Cell Systems	**7,324**	**7,927**	**6,600**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Transportation Fuel Cell Systems	
This decrease reflects the transfer of portable power activities to the Distributed Energy Systems key activity due to synergies between small distributed fuel cells and fuel cells for portable power.	-1,290
The Transportation Fuel Cell Systems Subprogram is supported by multiple Research Development Investment Criteria factors: it is a Presidential priority; it addresses market barriers and provides a public benefit; it builds on existing technology and complements current R&D in support of the DOE Hydrogen Posture Plan; it incorporates industry involvement in planning, industry cost-sharing, performance indicators, and "off ramps" (such as the upcoming go/no-go decision point in the second quarter of FY 2008 on whether to initiate new R&D activities in the area of compressor/expander technology development); and, it is competitively awarded and peer reviewed.	
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-37
Total Funding Change, Transportation Fuel Cell Systems	**-1,327**

Distributed Energy Fuel Cell Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Distributed Energy Fuel Cell Systems	7,257	7,449	9,761
SBIR/STTR	0	181	239
Total, Distributed Energy Fuel Cell Systems	7,257	7,630	10,000

Description

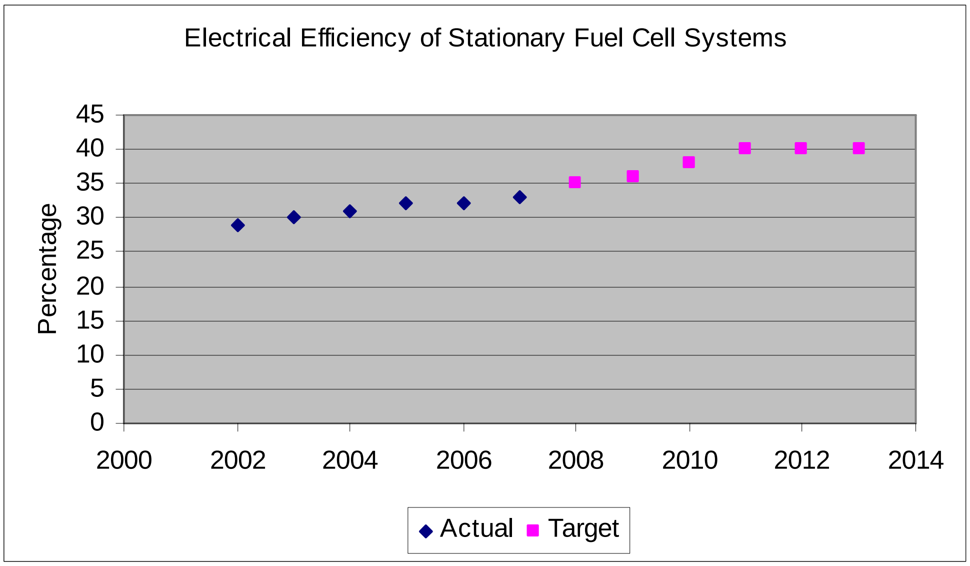
Distributed Energy Systems supports development of high-efficiency fuel cell power systems as alternative power sources to grid-based electricity for buildings and other stationary applications. The research focuses on overcoming the barriers to stationary fuel cell systems, including cost, durability, heat utilization, start-up time, and managing power transients and load-following requirements. FE conducts research and development focused on solid oxide fuel cells for large stationary power applications. The Hydrogen Program coordinates its Distributed Energy Systems R&D with the FE activities. Improved heat usage and recovery are addressed for combined heat and power generation to maximize overall efficiency of (thermal and electrical) systems. This subprogram also takes advantage of the synergy between transportation systems and distributed energy systems, particularly in the areas of developing improved materials for high-temperature membranes and improving fuel cell component durability. In addition, DOE has established a go/no-go milestone for the distributed energy systems activity in 2011, which will determine whether DOE continues to request funding after 2011.

Finally, Distributed Energy Systems addresses technology development applicable to portable power systems, which may have an earlier market entry. These small scale applications require a high system energy density and the small scale and packaging requirements of these systems require a unique flow-field and packaging design. Unlike automotive applications, the fuel supply need not be direct hydrogen; methanol, sodium borohydride, or other fuels may be considered. In some cases, the behavior of liquid reactants, or the release of hydrogen from a solid hydrogen carrier must be addressed. These systems typically will not have a sophisticated balance of plant for pressurization and therefore must operate with ambient air. Activities may include promoting early adoption of these systems to validate performance, durability, and reliability and to conduct field testing.

Distributed generation provides high efficiency and reliability for uninterruptible power sources, remote power, and back-up power. Distributed Energy Systems supports the program's mission by focusing on overcoming barriers to stationary fuel cell systems, including improving durability and performance, while lowering cost to enable the widespread use of fuel cells in distributed energy and other small stationary applications. The improvements will help to accelerate commercialization of fuel cells by achieving an ultimate durability requirement of 40,000 hours and cost of $750 per kW, making fuel cells competitive with conventional technologies.

Research activities will improve the electrical efficiency of 5-250 kW stationary fuel cell systems. Specifically, stationary fuel cell R&D activities will increase the electrical efficiency of these systems as indicated in the performance indicator graph below.

Fuel cell systems for portable power are being developed as an early market application where the market accepts a higher cost per kilowatt. Commercialization of fuel cells for portable power will aid in developing the manufacturing base and will introduce the technology to consumers, thus paving the way for fuel cell systems being used in other applications.



Target and Actual are the same for FY 2002-2005.[a]

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Distributed Energy Fuel Cell Systems	**7,257**	**7,449**	**9,761**

In FY 2009, DOE's Distributed Energy Fuel Cell Systems, in cooperation with the Department of Defense, will complete development and demonstration of a stationary fuel cell system. This activity should show progress towards the 2011 stationary fuel cell system targets. Research and development will focus on increasing the durability of a 5-250 kW stationary fuel cell system. Durability of membranes will continue to improve towards the 2011 stationary system durability target of 40,000

[a] No change in 2006: virtually all work is deferred due to Congressionally directed funding and reduced total funding.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

hours. Work will focus on increasing fuel cell stack performance operating on reformate. Field evaluations of a stationary fuel cell power system will be completed. These evaluations will include assessment of durability and the effective utilization of fuel cell thermal energy for heating to determine combined heat and power efficiencies. In FY 2009, Distributed Energy Systems will focus on improving performance and reducing the cost of fuel cells for portable power applications. The systems will be evaluated against the 2010 consumer electronics targets delineated in the Hydrogen Technology multi-year Program Plan. Field evaluations of other near term applications such as back-up and remote power will be conducted to determine start up performance and durability characteristics. Economic analysis of distributed energy systems and other early fuel cell markets will be performed.

The Distributed Energy Systems Subprogram is supported by multiple RDIC factors: it addresses market barriers and provides a public benefit; it builds on existing technology and complements current R&D in support of the DOE Hydrogen Posture Plan; it incorporates industry involvement in planning, industry cost-sharing, performance indicators, and "off ramps" (such as the planned go/no go decision point in 2011); and it is competitively awarded and peer reviewed.

In addition, these funds may be used to support efforts such as EPACT 2005 requirements, peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**181**	**239**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Distributed Energy Fuel Cell Systems	**7,257**	**7,630**	**10,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Distributed Energy Fuel Cell Systems	
Existing projects will be continued, with the requested increase focused on development and demonstration of stationary fuel cell systems that should show progress towards the 2011 stationary fuel cell system targets delineated in the Hydrogen Technology Multi-Year Program Plan. Research and development will concentrate on increasing the durability of a 5-250 kW stationary fuel cell system. The increase also accommodates the shift of portable power fuel cell R&D from the Transportation Systems subprogram to Distributed Energy Systems. In FY 2009, this work will also focus on improving performance and reducing cost of fuel cells for portable power applications. The systems will be evaluated against the 2010 consumer electronics targets. Field evaluations of near term applications, such as back-up and remote power, will be conducted to determine performance and durability characteristics.	+2,312
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+58
Total Funding Change, Distributed Energy Fuel Cell Systems	**+2,370**

Fuel Processor R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Fuel Processor R&D	3,952	2,890	0
SBIR/STTR	0	83	0
Total, Fuel Processor R&D	3,952	2,973	0

Description

Fuel Processor R&D has developed fuel processors for integrated distributed applications and fundamental catalysts suitable for a variety of fuel processing applications. Fuel processing technology can be fuel-flexible – capable of processing multiple fuels – such as methanol, ethanol, biomass derived liquids, natural gas, propane or diesel – into hydrogen. On-board fuel processing for transportation applications was discontinued several years ago, and FY 2008 will conclude development of fuel processors for stationary (distributed energy) fuel cell applications.

Fuel Processor R&D has supported the program's mission by developing the subsystem that aids the widespread use of fuel cell power technology in distributed applications. Processing conventional fuels (such as natural gas, propane, methanol, ethanol, biomass derived liquids, or diesel) will enable environmental and efficiency advantages of hydrogen fuel cell technologies to be realized in an integrated fuel cell system without needing a hydrogen-delivery infrastructure. The option of using a diversity of fuels to produce hydrogen to power fuel cells will be a significant contributor to energy independence.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Fuel Processor R&D	**3,952**	**2,890**	**0**

In FY 2009, there will be no work performed in this key activity.

SBIR/STTR	**0**	**83**	**0**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Fuel Processor R&D	**3,952**	**2,973**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Fuel Processor R&D	
The decrease reflects termination of fuel processor R&D for on-board vehicle applications.	-2,890
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-83
Total Funding Change, Fuel Processor R&D	**-2,973**

Safety and Codes and Standards

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Safety and Codes and Standards	13,492	15,521	0
SBIR/STTR	0	333	0
Total, Safety and Codes and Standards	13,492	15,854	0

Description

In FY 2009 the Safety and Codes and Standards subprogram will be funded in the Vehicle Technologies Program.

The Safety and Codes and Standards subprogram has funded research to provide the technical data on hydrogen technologies (such as fuel cells and hydrogen production, storage, and distribution systems) that is necessary to support and inform the codes and standards development process. Its work in FY 2008 includes fundamental studies to determine the flammability, explosive, reactive, and dispersion properties of hydrogen. It will also subject components, subsystems, and systems to environmental conditions that could result in failure in order to check design practices and failure-mode prediction analysis. Once the critical failure modes and safety issues for hydrogen and fuel cell technologies are identified, this technical data will be provided to the appropriate codes and standards developing organizations (e.g., International Code Council, National Fire Protection Association) to write and publish applicable codes and standards for hydrogen production and delivery processes as well as for hydrogen storage and fuel cell systems for both transportation and stationary applications. The DOE will not be involved directly in writing codes and standards, but instead will facilitate the development of these standards through R&D and support for appropriate technical representation in working groups. Safety-related information will be disseminated through a hydrogen incident and safety bibliographic database, publication and presentation of safety-related R&D results, and reports on investigations of hydrogen-related incidents. The subprogram will also support the development of passive and active safety systems based on new sensor technologies, and will fund comprehensive safety analysis of hydrogen components and systems. DOE and DOT will closely coordinate hydrogen safety and codes/standards development activities.

Wide acceptance of hydrogen technologies depends on meeting safety standards in which the public has confidence. This requires a comprehensive and defensible database on component reliability and safety to enable the publishing of performance-based domestic standards and international standards or regulations that will allow the technologies to compete in a global market. This activity supports the Hydrogen Technology Program's mission by providing the critical data needed to write and adopt standards, and the safety criteria and systems that meet or exceed current technologies, and will eventually lead to new Federal Motor Vehicle Safety Standards for fuel cell vehicles issued by the Department of Transportation.

Activities under Safety and Codes and Standards will facilitate and provide data to support the establishment of a global technical regulation for hydrogen and fuel cell vehicles and infrastructure.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Safety and Codes and Standards	**13,492**	**15,521**	**0**

In FY 2009 this subprogram is included in the Vehicle Technologies budget.

This activity has supported the drafting and adoption of hydrogen codes and standards through the development of hydrogen characterization and behavior data and through limited direct support of Standards Development Organizations (SDOs) and Codes Development Organizations (CDOs). Hydrogen release data and incident scenario analysis in FY 2008 will support codes and standards development activities focused on enabling technology readiness. DOE collaborates with DOT, EPA, NIST and other government agencies to ensure that hydrogen codes and standards development proceeds in agreement with existing regulatory authorities. The cooperating agencies will maximize available resources and expertise in areas such as hydrogen dispensing measurement (NIST), vehicle safety (DOT National Highway Traffic Safety Administration) and international standards development (DOT, EPA).

In FY 2008 DOE drafted a handbook on Best Practices for Safety, which will provide guidance for ensuring the safe use of hydrogen, to be published late in 2008. This will be a living document that compiles "lessons learned" from safety reviews and incident analysis. The handbook will also compile hydrogen safety information available from other resources such as state and international hydrogen programs.

DOE compiled and updated a hydrogen incident database in FY 2008 and the Hydrogen Safety Review Panel will continue to monitor the safety of DOE hydrogen projects. The Panel will conduct site visits, interviews and safety plan reviews of DOE projects.

The Safety and Codes and Standards subprogram will design and build safety training devices that enable firefighters and first responders to conduct "hands on" training related to likely hydrogen fuel safety incidents. The resources and expertise available at the Volpentest HAMMER Training and Education Center will be leveraged in the development of mobile and stationary training devices, also known as "props," which will be designed to simulate devices such as hydrogen bulk storage, fuel dispensing and piping systems. These training devices will be used as part of a comprehensive training program developed in collaboration with the Hydrogen Technology Program's Education activity. The program's training efforts will target fire marshals, code officials, first responders and other stakeholders.

One of the program's objectives in FY 2008 is to conduct an analysis of potential accident scenarios to identify both potential hydrogen systems weaknesses and the R&D required to improve systems

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

safety. The scenarios report will also help guide a risk analysis effort that uses Probabilistic Risk Analysis (PRA) and Failure Modes Effects Analysis (FMEA) methods to quantitatively estimate hydrogen systems risk. Risk assessment activities will provide information to guide the codes and standards development process. This information also will be made available to key industry stakeholders such as fuel providers and the insurers.

FY 2008 funding also supports the development of computational fluid dynamics models to support risk assessment activities for fueling, production infrastructure, and vehicle operation in tunnels and garages.

The program will conduct comprehensive R&D to provide critical data and develop a database to characterize the properties of releases of hydrogen when impeded by obstacles/equipment for input into calculation of code on setback distances.

Practical tests to be performed in FY 2008 include high-pressure refueling tests to determine optimal temperature and flow rate characteristics and verification tests of systems components (e.g., valves, regulators) to determine their performance relative to appropriate component standards and to highlight areas where existing standards or equipment need to be changed.

In FY 2008 the program will quantify the effects of hydrogen contaminants on system components to support development of a hydrogen quality standard, and it will also develop analytical methods to allow verification of hydrogen purity on a cost-effective basis. Hydrogen metering technologies will also be supported to allow accurate measurement of delivered hydrogen.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**333**	**0**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Safety and Codes and Standards	**13,492**	**15,854**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Safety and Codes and Standards	
In FY 2009, Hydrogen Safety and Codes and Standards activities are funded in the Vehicle Technologies budget. Vehicle Technologies already is engaged in codes and standards efforts for alternative fuels, so this shift is intended to create synergies with the existing knowledge base and programs.	-15,521
SBIR/STTR	
Appropriate provisions for SBIR and STTR transfers are included in the Safety & Codes & Standards subprogram in the Vehicle Technologies budget in FY 2009.	-333
Total Funding Change, Safety and Codes and Standards	**-15,854**

Education

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Education	1,978	3,865	0
SBIR/STTR	0	0	0
Total, Education	1,978	3,865	0

Description

In FY 2009, hydrogen education activities are funded within the Vehicle Technologies budget.

Education activities are designed to increase understanding of hydrogen and fuel cell technologies, the facts about hydrogen safety, and the role that certain key target audiences can play in advancing the development and use of hydrogen as an energy carrier. Target audiences, identified by key government and industry stakeholders in the National Hydrogen Energy Roadmap, include state and local government representatives, safety and code officials, potential end-users, and the public. Over the long term, education of teachers and students will also be required. The education activity responds to the President's National Energy Policy recommendation to the Secretary of Energy to develop an education campaign that communicates the benefits of alternative energy, including hydrogen. The Energy Policy Act of 2005 also calls for enhanced education relating to hydrogen and fuel cells, including activities in conjunction with hydrogen demonstrations to raise awareness among the public, information exchange to facilitate the development and adoption of codes and standards, and support for institutes of higher education.

Education aids in overcoming institutional barriers to widespread use of hydrogen. DOE's 2004 Hydrogen Baseline Knowledge Assessment measured the technical knowledge and opinions of hydrogen among key target audiences, including the public. This national, statistically-valid survey was developed to help guide the program's hydrogen education activities and provide a baseline from which to measure changes over time. The 2004 baseline results show a direct correlation between technical understanding and opinions about the safe use of hydrogen – across all surveyed populations, respondents who scored lower on technical knowledge questions about hydrogen fuel cell technology also expressed the greatest fear about the use of hydrogen as an energy carrier. With an emphasis on hydrogen safety, near-term education activities will enable not only the successful implementation of early hydrogen demonstration projects but also future market adoption and acceptance, which are required to realize the long-term benefits of using hydrogen as an energy carrier.

State and local governments lay the foundation for long-term change and, with safety and code officials, facilitate the adoption of appropriate codes and approve hydrogen project installations. As they are with other commonly-used fuels, safety officials and emergency responders must be trained to handle potential hydrogen incidents. Public misunderstanding and false perceptions about the safe use of hydrogen threaten the implementation of near-term hydrogen fueling station demonstrations, as well as the success of a future hydrogen economy. Education can overcome these significant challenges and build public confidence in hydrogen and the safe use of hydrogen as an energy carrier. In addition, hydrogen education at universities will ensure the availability of scientists and engineers needed for critical near-term research in government, industry, and academia, as well as foster development of a trained workforce required to maintain hydrogen fuel cell equipment in the future. Over the long term, hydrogen education can engage younger students in the study of science and technology and enable an informed first-generation of hydrogen technology users.

Hydrogen Education Survey Targets[a]

	2004	2005	2006	2007	2008	2009 [b]	2012 [b]
State and local government representatives	66%					73% (10% increase)	80% (20% increase)
General public	33%					38% (15% increase)	43% (30% increase)
End users[c]	44%					50% (15% increase)	57% (30% increase)
Students	32%					35% (10 % increase)	38% (20% increase)

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Education	**1,978**	**3,865**	**0**

Hydrogen Education activities are funded in the Vehicle Technologies budget in FY 2009.

The Education subprogram collaborates with Safety and Codes and Standards to develop and expand the availability of hydrogen training for first responders to facilitate the approval and implementation of hydrogen demonstration projects. The target audiences include fire fighters, police, and emergency medical technicians, as well as code officials, fire marshals, city planners, and other hydrogen users.

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[a] The 2004 Hydrogen Baseline Knowledge Assessment measured key target audiences' understanding of hydrogen technologies. The results provide a baseline from which to evaluate future increases in knowledge. Modified targets reflect analysis of the results; target dates have been shifted because Education activities were not funded as originally expected. The baseline and outyear targets are a population's average score on technical knowledge questions. Target increases refer to an increase in the average number of correct answers relative to the 2004 baseline.

[b] The target increases for state and local government officials were determined according to a higher baseline (average score on technical questions). The target increases for students reflect near-term program priorities and interest in educating this target audience over the long term.

[c] Survey for this target audience includes safety and code officials.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

Education activities will leverage training resources available at the Volpentest HAMMER Training and Education Center. In FY 2008 the subprogram will complete the development of hydrogen training for code officials and will work with partners to make it available to a national audience through distance learning and in-person "train-the-trainer" courses. The subprogram will also build on prior-year efforts by working with partners to expand the availability of introductory hydrogen safety training for first responders and to develop the next, more advanced level of responder safety training modules that will incorporate the use of hands-on training devices or props.

In cooperation with automotive and energy industry partners involved in hydrogen infrastructure validation projects, the program will conduct activities to educate the public and key target audiences in communities where new hydrogen fueling stations will be implemented. The subprogram will develop and conduct targeted outreach, including training seminars, to educate the community and build public familiarity and confidence with the safe use of hydrogen as an energy carrier.

The Education subprogram also works in partnership with state hydrogen and fuel cell initiative leaders and state energy offices to expand the availability of training opportunities for state and local government officials. Training will has included “Hydrogen 101” overview workshops as well as more intensive “hydrogen energy institute” seminars to help ensure an understanding of hydrogen technologies, hydrogen safety issues, and opportunities to facilitate the emergence of a new energy economy.

In support of the Hydrogen Program’s overall market transformation efforts in FY 2008 and related provisions in the Energy Policy Act of 2005, the Education subprogram in FY 2008 will fund new activities to educate potential end users in early markets for hydrogen and fuel cell applications. In collaboration with related DOE programs, the Education subprogram is developing new resources and reach out to potential end users with technically-accurate and objective information to help them make informed decisions about near-term opportunities for early adoption.

The Education subprogram in FY 2008 also funded new efforts to develop and expand hydrogen and fuel cell undergraduate and graduate programs at universities and to train the future workforce of scientists and engineers needed for hydrogen fuel cell research in government, industry, and academia. These efforts will be coordinated with leading universities in other countries through the International Partnership for the Hydrogen Economy. The subprogram also ramped up prior-year efforts in FY 2008 to develop classroom guides and hands-on activities for middle and high school students, and will provide training and professional development for teachers, whose understanding of the technology is critical to the successful introduction of the subject to their students in the classroom.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
Total, Education	**1,978**	**3,865**	**0**

Explanation of Funding Changes

	FY 2008 vs. FY 2007 ($000)
Education	
Hydrogen Education activities are funded in the Vehicle Technologies budget in FY 2009.	-3,865
Total Funding Change, Education	**-3,865**

Systems Analysis

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Systems Analysis	9,637	11,076	7,497
SBIR/STTR	0	319	216
Total, Systems Analysis	9,637	11,395	7,713

Description

The Systems Analysis subprogram supports the development of independent systems analysis and independent evaluation functions consistent with the recommendations of the National Academies. One of the findings of the Academies' report on hydrogen states, "The effective management of the Department of Energy Hydrogen Program will be far more challenging than any activity previously undertaken on the civilian energy side of the DOE."[a] The Academies also recommended that a systems analysis capability be established to identify the impacts of various hydrogen technology pathways, assess associated cost elements and drivers, identify key costs and technological gaps, evaluate the significance of actual research results, and assist in the prioritization of research and development directions. The Systems Analysis subprogram provides the analytical and technical basis for understanding the development of a hydrogen infrastructure and supports informed decision-making with regard to research and development direction and prioritization.

Systems Analysis is an essential component of the Hydrogen Technology Program in terms of understanding and assessing technology needs and progress, potential environmental impacts, and the energy-related economic benefits of various hydrogen supply and demand pathways. This analysis is done to directly support program decision-making, planning and budgeting, and interactions with other energy domains. In addition, the results support the annual updates to key planning documents, including the Hydrogen Posture Plan, which describes the current direction and the planned milestones for the DOE Hydrogen Program.

[a] National Research Council and National Academy of Engineering, Committee on Alternatives and Strategies for Future Hydrogen Production and Use, *The Hydrogen Economy: Opportunities, Barriers, and R&D Needs* (Washington, DC: National Academies Press, 2004).

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Systems Analysis	**9,637**	**11,076**	**7,497**

Systems Analysis provides the analytical and technical basis for understanding how hydrogen can perform a significant role in transportation and stationary power sectors and supports informed decision-making with regard to research and development direction and prioritization. The subprogram will build on the efforts of FY 2008 to examine the details of hydrogen supply and demand associated with how vehicle market penetration and hydrogen production and delivery might evolve. In FY 2009, the subprogram will complete and validate the new analytical models and tools developed in FY 2008. The new models, combined with existing systems analysis models, will enable the program to identify resource limitations, production options for hydrogen supply, the hydrogen supply evolution, delivery restrictions and the potential environmental impacts of wide scale commercialization.

Building on efforts initiated in 2008 to develop the Macro System Model which provides overarching and hierarchal economic analysis for the program, additional linkages will be developed in FY 2009 to provide analytical capabilities for higher-level economic analysis in the near- and mid-term. This analysis supports the National Academies' recommendation (in *The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs*, February 2004) to evaluate a transition phase consistent with developing the infrastructure and hydrogen resources.

In collaboration with the Technology Validation and Hydrogen Production and Delivery R&D Subprograms, the Systems Analysis subprogram will:

- Validate the models utilized for program analysis with emerging cost, performance, yield and environmental information from demonstration programs, independent reviews, and research projects. Model experts and project representatives will perform required model maintenance to improve model capabilities and representation of actual technology performance.
- Update models for new renewable production and delivery technologies based on the results of technology research and development.
- Focus analysis on the relationship between hydrogen purity changes and production cost among all key program elements of Production and Delivery, Storage, and Fuel Cells as well as Safety and Codes and Standards activities conducted in the Vehicle Technologies Program. Evaluate the purity/cost relationship for various pathways and technologies and the impact of hydrogen purity on fuel cell performance.
- Provide system analysis support and input for all the program elements such as go/no-go decisions.
- Provide analysis of CO_2 sequestration effects by working with the Carbon Sequestration program within the Office of Fossil Energy.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

- Update and maintain the Analysis Portfolio, the prioritized analysis list, and the Hydrogen Analysis Resource Center database, which were all developed in FY 2005 to ensure analysis consistency and transparency. The program will also update the Systems Analysis Plan, Technical Requirements Document and the Posture Plan.

The research results and validation data of the Production and Delivery, Storage, Fuel Cells and Technical Validation program elements will be used in the benefits analysis of reducing petroleum dependency and greenhouse gas emissions.

In FY 2009, the Systems Analysis subprogram will fund analysis focused on assessing technology progress towards meeting the goals of the Hydrogen Program and AEI to reduced dependency on imported oil and greenhouse gas emissions. The evaluation will include technology cost, emissions and risk analyses for early market adopter and market transformation activities. Analysis will be focused on the well-to-wheels of near-term and renewable hydrogen pathways, including the impact of hydrogen quality and integration with the electrical sector. Cross-cutting analysis of tradeoffs and synergies amongst regions for infrastructure and resource availability will be completed. The platinum life cycle cost impact on the fuel cell cost and program element risk analysis will be conducted.

In addition, these funds may be used to support efforts such as such as EPACT 2005 requirements, peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**319**	**216**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Systems Analysis	**9,637**	**11,395**	**7,713**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Systems Analysis	
Decrease reflects the completion of the development of key models for systems analysis. Requested funding will be devoted to basic analysis to support the Hydrogen Program using the models already developed. Funding for model validation and refinement, as well as analysis of selected cross-cutting issues – such as life-cycle costs and environmental, climatic and emissions impacts – will be deferred for multiple hydrogen production pathways. The systems analysis subprogram is consistent with the National Academies' recommendations and is supported by multiple Research Development Investment Criteria factors: it builds on existing technology and complements current R&D in support of the DOE Hydrogen Posture Plan; it incorporates industry involvement in planning, industry cost-sharing, and performance indicators; and it is competitively awarded and peer reviewed.	-3,579
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-103
Total Funding Change, Systems Analysis	**-3,682**

Manufacturing R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Manufacturing R&D	1,928	4,815	0
SBIR/STTR	0	139	0
Total, Manufacturing R&D	1,928	4,954	0

Description

The Manufacturing R&D subprogram is intended to support the development of manufacturing processes critical for hydrogen and fuel cell components and systems. The program's activities address the challenges of moving today's laboratory-produced technologies to high-volume manufacturing, thereby driving down the cost of hydrogen and fuel cell systems. Research will be conducted in coordination with the Department of Commerce and the White House Office of Science and Technology Policy's Interagency Working Group on Manufacturing R&D. The subprogram will address an array of fabrication and process techniques amenable to high volume production of fuel cells, hydrogen production, delivery, and storage components and systems. A research and development technology roadmap has been developed with industry to identify critical technology development needs for high volume manufacturing of fuel cell and hydrogen systems. The subprogram's initial focus will be manufacturing processes and techniques that are synergistic in terms of cross-cutting applications, such as high volume membrane fabrication techniques for both fuel cell stacks and electrolyzers.

While Manufacturing R&D supports the mission of the Hydrogen Technology Program by developing advanced fabrication and process technologies to meet the cost targets of critical hydrogen and fuel cell technologies, this activity is a lower priority and a funding request has been deferred. These activities will help realize fuel cell and hydrogen system costs that are equivalent to internal combustion engines and gasoline. Manufacturing R&D will focus on enabling technology readiness and building a domestic supply base.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Manufacturing R&D	**1,928**	**4,815**	**0**

Consistent with the reprioritization of the EERE portfolio, Manufacturing R&D will be discontinued in FY 2009. Manufacturing R&D is not a critical-path barrier to achieving the program's core technology-readiness goals for 2015; it will be one of the factors that industry will consider in making a decision whether to commercialize hydrogen technologies after that time.

SBIR/STTR	**0**	**139**	**0**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Manufacturing R&D	**1,928**	**4,954**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Manufacturing R&D The decrease is consistent with the reprioritization of EERE activities. Manufacturing R&D is not a critical-path barrier to achieving the program's core technology-readiness goals for 2015. Activities that began in FY 2007 will be closed down in an orderly manner and any remaining FY 2008 funds will be used for a small number of one-time funding awards. Reductions in manufacturing costs for fuel cells and high-pressure hydrogen storage will be delayed.	-4,815
SBIR/STTR Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-139
Total Funding Change, Manufacturing R&D	**-4,954**

Biomass and Biorefinery Systems R&D

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation[a]	FY 2008 Original Appropriation	FY 2008 Adjustments[b]	FY 2008 Current Appropriation	FY 2009 Request
Biomass and Biorefinery Systems R&D					
Feedstock Infrastructure	9,725	12,500	-114	12,386	15,500
Platforms Research and Development	49,306	67,900	-618	67,282	53,400
Utilization of Platform Outputs R&D	137,246	114,600	-1,043	113,557	156,100
Cellulosic Ethanol Reverse Auction	0	5,000	-45	4,955	0
Total, Biomass and Biorefinery Systems R&D	196,277	200,000	-1,820	198,180	225,000

Public Law Authorizations:

P.L. 93-577, "Federal Non-nuclear Energy Research and Development Act" (1974)
P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act" (1978)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 95-620, "Powerplants and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Conservation Act" (1987)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 101-549, "Clean Air Act Amendments" (1990)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 106-224, "Biomass Research and Development Act" (2000)
P.L. 107-171, "Farm Security and Rural Investment Act" (2002)
P.L. 108-148, "Healthy Forest Restoration Act" (2003)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

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[a] Excludes amounts transferred to the Science appropriation for carrying out SBIR / STTR. All subsequent tables in this program also reflect this transfer.

[b] Reflects amounts rescinded by General Provision, section 312, of the Omnibus Appropriations Act, 2008.

Mission

The mission of the Biomass Program is to develop and transform our domestic, renewable, and abundant biomass resources into cost-competitive, high performance biofuels, bioproducts and biopower through targeted RD&D leveraged by public and private partnerships.

This mission supports the AEI, first announced in the President's 2006 State of the Union Address, which calls for measures to addresses our dependence on foreign sources of energy, improve energy efficiency and enhance energy security.[a] Specifically, the President committed to making cellulosic ethanol cost competitive by 2012. Subsequently, in the 2007 State of the Union Address, the President recognized our "addiction to oil" and asked that America support a goal to reduce U.S. gasoline use by twenty percent over the next 10 years ("Twenty in Ten").[b] A major part of that commitment is the goal to increase the supply of renewable and alternative fuels to 35 billion gallons per year by 2017. Congress supported this commitment by passing the Energy Independence and Security Act of 2007 (EISA), which the President signed into law, including a Renewable Fuel Standard requiring 36 billion gallons per year of renewable fuel supply by 2022. The Administration continues to back their commitment to renewable fuels by increasing RD&D funding for the Biomass Program in the budget request.

Accomplishing the mission will benefit the supply side of the Department's energy security equation accelerating the arrival and use of the new fuels and technologies that we need.

The Biomass Program's research focus is to develop and validate technologies to support the successful deployment of biorefineries that can utilize a wide range of biomass resources to accelerate the growth of the bioindustry, increase and diversify domestic energy supply, increase energy security, emit less carbon, and reduce petroleum imports. The request includes the Biofuels Initiative that directly supports the President's AEI, aimed at dramatically reducing our dependency on imported oil, by increasing domestic, renewable liquid transportations fuels production. The program's R&D will contribute key technologies necessary to make cellulosic ethanol cost competitive by 2012, which could enable a much more significant volume of gasoline to be displaced than through corn ethanol alone. The program supports the President's goal to reduce our gasoline consumption by 20 percent in ten year (20 in 10), as outlined in his 2007 State of the Union Address. Additionally, this RD&D supports the U.S. Government's Climate Change Technology Program Strategic Plan by advancing technologies that can reduce greenhouse gas emissions in comparison to fossil fuels.

The program partners with universities, National Laboratories, industry, and other entities along with coordinating with other programs within DOE and other Federal Agencies to develop the next generation of biorefineries that will produce transportation fuels, value-added chemicals, and/or power from non-conventional, lower cost feedstocks such as agricultural residues (i.e., corn stover). Fuels from biomass have great potential to displace petroleum because ethanol and biodiesel are highly compatible with today's major transportation fuels (i.e., gasoline and diesel). Program efforts could lead to cost competitive cellulosic ethanol from various biomass feedstocks. Success in the program's R&D efforts will help enable biorefineries to be geographically dispersed, leading to increased energy security and

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[a] http://www.whitehouse.gov/stateoftheunion/2006/energy/

[b] 2007 State of the Union Address, "Twenty in Ten": Strengthening America's Energy Security, http://www.whitehouse.gov/stateoftheunion/2007/initiatives/energy.html

minimizing transportation and other concerns. Utilization of biomass for transportation fuels reduces greenhouse gas emissions and allows renewable carbon resources to be sequestered via photosynthesis.

Analogous to crude oil, biomass can be converted to heat, electrical power, fuels, hydrogen, chemicals, and intermediates. Biomass refers to both biomass residues (agricultural wastes such as corn stover and rice hulls, forest residues, pulp and paper wastes, animal wastes, etc.) and to fast-growing "energy crops," chosen specifically for their efficiency in being converted to electricity, fuels, etc. The CO_2 consumed when the biomass is grown essentially offsets the CO_2 released during combustion or processing. Biomass systems actually represent a net sink for GHG emissions when biomass residues are used, because this avoids methane emissions that result from land filling unused biomass. Biorefineries of the future could produce value-added chemicals and materials together with fuels and/or power from nonconventional, lower-cost feedstocks (such as agricultural and forest residues and specially grown crops) with no net CO_2 emissions.

The Biomass Program near-term strategy includes increasing the production of ethanol at existing grain-based facilities (already with the capacity to produce 7 billion gallons per year) by making the process more efficient. This will be demonstrated by increasing the quantity of ethanol through residual starch and fiber conversion. Converting fiber already collected and present at operating facilities will add cellulosic ethanol production with less capital costs than green field biorefineries and ultimately broaden the market for the protein component currently sold as animal feed. Further, the incorporation of agricultural residues as a fuel source would improve the ethanol energy balance and, consequently, improve the environmental sustainability of the existing industry. The inclusion of biochemicals as byproducts, made from the starch, oil and/or fiber components will improve the economic viability of the industry. These improvements to the existing industry will establish a baseline for future biorefineries. Demonstrations of biorefinery concepts could begin in the near term, producing one or more products (starch based ethanol, cellulosic ethanol, advanced protein products, bioproducts, heat and power, etc.) from one plant. Incorporating a multi product approach—coupled with diversifying the feedstock supply—not only enhances the existing industry but also develops advanced technologies necessary for future biorefinery development. Biodiesel and renewable diesel use will also continue to grow, replacing fossil-fuel-derived diesel fuel, as more advanced technologies and feedstocks are proven continue to grow.

In the midterm, biorefineries could begin using forest resources as primary feedstocks. Bioethanol and biodiesel could make substantial market penetration, beginning to lower U.S. dependence on imported petroleum. In the long term, biorefineries could be providing a wide range of cost-effective products as rural areas embrace the economic advantages of widespread demand for energy crops. Vehicle fuels could be powered by a combination of hydrogen fuel cells, with some bioethanol, biodiesel, and green diesel in significant markets.

By 2030 the Biomass Program expects its technologies to reduce oil imports by at least an extra 200 million barrels saving consumers nearly $29 billion and reducing carbon emissions by at least 50 MMTCE.

Program Deliverables and Interdependencies

Based on the Advanced Energy Initiative and "Twenty in Ten" goals, technology readiness, and market acceptance the program is developing, demonstrating and deploying cellulosic ethanol, over other biofuels, bioproducts or biopower to include:

- Regional feedstock partnerships for resource assessment and availability (in partnership with USDA).
- Industrial partnerships for feedstock infrastructure cost reductions.
- Thermochemical Integrated syngas cleanup and fuels Synthesis technology development.
- Biochemical Development of improved cellulases with increased activities.
- Integrated biorefinery technologies, including commercial scale projects for demonstrating integrated biorefinery operations for producing biofuels and chemical/materials products.
- Products R&D, including fermentation organism development for mixed sugars from biomass, biofuels infrastructure development, and feedstock development (jointly with USDA) issues.

Biofuels interdependencies include:

- Partnering with DOE's Office of Science on feedstock development and consolidated bioprocessing (technology aimed at reducing the number of unit operations needed in a biorefinery); an advanced conversion processes and techniques to help define the future of advanced biorefineries; and knowledge transfer from fundamental to applied technologies from the three bioenergy centers.
- Coordination with the Hydrogen Program to evaluate biomass as a feedstock for hydrogen production;
- Coordination with the Vehicle Technologies Program, Clean Cities, and FEMP along with other Federal Agencies that are part of the Biomass Research and Development Initiative such as EPA, DOT, and DOD to increase the use of biofuels in vehicle fleets and address biofuels infrastructure issues such as those identified in the June 2007 Government Accountability Office report on biofuels infrastructure;
- Collaboration with the Treasury Department to evaluate tax policy or other production incentives to more effectively develop cellulosic ethanol to achieve the volumetric goals;
- Working with the Regional Biomass Feedstock Development to enhance the coordination of feedstock R&D efforts with USDA and the Sun Grant Initiative recipients which includes land grant universities;
- An annual competitive university lead solicitation to promote state of the art research and to foster stronger university-program partnerships;
- Annual USDA-DOE solicitation for biomass technologies R&D and other coordination under the Biomass Research and Development Act of 2000 using guidance from the Biomass Technical Advisory Committee and the Biomass R&D Board established to develop a comprehensive interagency coordination and planning document; and
- Partnerships with existing biorefineries to develop technologies resulting in more cost-effective use of current feedstock and/or utilization of additional, and new feedstocks such as cellulosic residues.

Based on modeling the program's goals within energy-economy models the program is expected to displace concomitant amounts of imported oil, which will yield other energy security, environmental and economic benefits.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Biomass and Biorefinery Systems R&D Program supports the following goal:

Strategic Theme 1, Energy Security

Strategic Goal 1.1, Energy Diversity: Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs.

And concurrently supports:

Strategic Theme 3, Scientific Discovery and Innovation

Strategic Goal 3.3, Research Integration: Integrate basic and applied research to accelerate innovation and to create transformational solutions for energy and other U.S. needs.

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

The Biomass and Biorefinery Systems R&D Program has one GPRA Unit Program goal which contributes to Strategic Goal 1.1 in the "goal cascade:"

GPRA Unit Program Goal 1.1.06.00: Biomass and Biorefinery Systems R&D - Develop biorefinery-related technologies associated with the different biomass resource pathways to the point that they can compete in terms of cost and performance and are used by the Nation's transportation, chemical, agriculture, forestry, and power industries to meet their respective market objectives. This helps the Nation expand its clean, sustainable energy supplies, improve its energy infrastructure, and reduce its greenhouse gases emissions, fossil energy consumption and dependence on foreign oil.

Contribution to GPRA Unit Program Goal 1.1.06.00 (Biomass and Biorefinery Systems R&D)

The program directly supports the DOE's Energy Security theme by developing the Nation's biomass resource availability and conducting research, development and deployment on technologies that increase the production of biomass-based substitutes for petroleum-derived fuels, chemicals, materials, and/or heat and power, and thereby diversifying and expanding energy supply. It also addresses the goals and recommendations of the Biomass R&D Act of 2000, the Farm Security and Rural Investment Act of 2002, and the Energy Policy Act of 2005 and the Energy Security and Independence Act of 2007.

To increase the probability of success, the program funds key technology pathways that contribute to the achievement of this goal:

Feedstock Infrastructure contribution:

- Reduced costs associated with feedstock production, collection, storage and transportation address major barriers impeding the growth of the cellulosic ethanol industry.

Platforms Research and Development contribution:

- Platforms Research and Development includes Biochemical Platform R&D and Thermochemical Platform R&D. Biochemical Platform R&D will focus on reducing the cost of producing mixed, dilute sugars to enable biorefinery pathways. Work to overcome the recalcitrance of biomass will continue to be a priority. The program will make further improvements to feedstock interface, pretreatment and conditioning, enzymes and fermentation processes in addition to process integration in order to reduce sugar costs as the springboard to launching the next generation of cellulosic ethanol technology from a wide range of feedstocks.
- Thermochemical Platform R&D will focus on technologies for converting lignocellulosic feedstocks and bioconversion process residues into clean synthesis gas and bio-oil intermediates that are in turn used to produce cost competitive commodity fuels, like ethanol, as well as bioproducts and biopower.

Utilization of Platform Outputs R&D contribution:

- Utilization of Platform Outputs R&D includes Integration of Biorefinery Technologies and Products R&D. Integration of Biorefinery Technologies program will continue to support companies with the intent of commercializing biorefineries for the production of transportation fuels and co-products (such as materials and chemicals) as authorized by EPACT of 2005, Section 932. The program will also support industry in its efforts to validate advanced biomass conversion technologies for the production of transportation fuels and co-products (such as materials and chemicals) at a scale equal to approximately 10 percent of commercial scale (equivalent to 1-3 million gallons per year ethanol produced). These projects are critical to validate a modeled mature plant (i.e., n^{th} plant) production cost of $1.33 per gallon to $1.85 per gallon in 2012.[a] The program will also work with its partners on standards development and testing of low level ethanol blends such as E15 and E20, as well as associated distribution systems and vehicle end use. The program will continue to develop and contribute to a strategy for growing and maintaining E85 infrastructure on a regional basis.
- Products R&D, the program will continue to cost-share five industry partnership projects for developing a commercially viable fermentative micro-organism (aka "ethanologen") at a cost sufficiently low to achieve the 2012 cost target. These micro-organisms, capable of fermenting major sugars found in cellulosic biomass, could jump start the cellulosic ethanol industry.

An indicator of progress toward achieving those benefits includes:

- In FY 2009, initiate construction of at least one commercial-scale biorefinery project (700 tons/day feedstock processed) selected in FY 2007, including hard orders for all tangible equipment, vendor packages and structural steel.
- In FY 2009, approve final engineering design of two additional commercial scale biorefineries (3 in total) selected in FY 2007, including hard orders for all tangible equipment, vendor packages and structural steel.

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[a] This production cost range expressed in 2007 dollars is consistent with the original $1.07 per gallon cellulosic ethanol production cost expressed in 2002 dollars. The production costs are based on the National Renewable Energy Laboratory's 2002 design report, a range of feedstock types, and anticipated construction, labor, and material costs.

- In FY 2009, approve of preliminary engineering design package, market analysis and financial projections for at least five demonstration scale biorefinery (1-3 million gallons per year) selected in FY 2008.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goals 1.1, Energy Diversity			
GPRA Unit Program Goal 1.1.06.00, Biomass and Biorefinery Systems R&D			
Feedstock Infrastructure	9,725	12,386	15,500
Platforms Research and Development	49,306	67,282	53,400
Utilization of Platform Outputs R&D	137,246	113,557	156,100
Cellulosic Ethanol Reverse Auction	0	4,955	0
Total, GPRA Unit Program Goal 1.1.06.00, Biomass and Biorefinery Systems R&D	196,277	198,180	225,000
Total, Strategic Goals 1.1 (Biomass and Biorefinery Systems R&D)	196,277	198,180	225,000

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.1.06.00 (Biomass and Biorefinery Systems R&D)					
Feedstock Infrastructure					
			Complete a core R&D engineering design and techno-economic assessment of an integrated wet storage - biomass field pre-processing assembly system with a pretreatment process that could potentially be scaled up to produce feedstocks to achieve a reduction to $35 per ton by 2012 from $53 per ton as of 2003. This is based on the original baseline and cost reduction targets specific to corn stover. [MET]	Conduct replicated field trials across regions to determine the impact of residue removal on grain yield (in subsequent years); field trials (including genetic evaluations) to develop energy crops within a geographical region; resource assessments to determine regional feedstock supply curves (variable costs of feedstock across various sites); and economic studies that identify the best site conditions and general locations for biorefineries within a region, all of which can demonstrably contribute to the goal of producing feedstocks at $32 per dry ton by 2012.[a]	Initiate a GIS-based regional feedstock atlas system linked to the latest National Agricultural Statistic Service data, energy crop field test results, residue removal trial results, DOE and USDA funded biorefinery project results, and other assessments from public and private sources to provide the best information biomass information resource database available for a wide variety of users including Federal and State governments, biorefinery developers, growers, and researchers. These efforts can demonstrably contribute to the goal of producing feedstocks at $32 per dry ton by 2012.
Platforms Research and Development					
	Completed a technical and economic evaluation of integrated biomass to fuels systems to validate the sugar cost of $0.135 per pound and syngas cost of $6.13 per million Btu. [MET]	Complete laboratory and economic assessment of 2 different feedstocks, identifying operating conditions that link pretreatment with enzymes that could be scaled-up and have the potential of achieving the goal of $0.125 per pound sugar by 2007. [MET]	Complete integrated tests of pretreatment and enzymatic hydrolysis in conjunction with existing fermentation organisms at bench-scale on com stover that validate $0.125 per pound sugars on the pathway to achieving $0.064 per pound in 2012. [MET]	Achieve a modeled cost of a mixed, dilute sugar stream suitable for fermentation to ethanol of $0.13 per pound of sugars (equivalent to $2.39 per gallon of cellulosic ethanol) through the formulation of improved enzyme mixtures and pretreatments (in $2007). The cost of the sugar stream ties	Demonstrate alternative pretreatment technologies at bench-scale using advanced cellulase enzymes and integrated technologies that have the potential of achieving $0.12 per pound of sugars on the pathway to $0. 073 per pound by 2012 (in $2007). Reduced sugar costs will reduce

[a] The program has updated all technical targets based on improved data and modeling and updating to 2007 dollars. Previous 2012 feedstock target was stated as $35 per dry ton by 2012.

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
				directly to the price of ethanol, a substitute for gasoline and key output of a biorefinery. Reduction in the cost of sugars can lead to commercialization of biorefineries that produce fuels (such as ethanol), chemicals, heat, and power from biomass.	cellulosic ethanol costs, leading to increased adoption of ethanol and reduced consumption of petroleum.
			Demonstrate conversion of 50 percent of non-methane (C2+ higher) hydrocarbons that result in a syngas cost of $7.15/MBtu in 2007. [MET]	Achieve a modeled cost of a cleaned and reformed biomass-derived synthesis gas or oils of $6.88/MBtu by demonstrating pilot-scale technology capable of economically converting biomass residues, pulping liquors, or waste fats and greases. Reduction in the cost of syngas can lead to commercialization of biorefineries that produce fuels, chemicals, heat, and power from biomass.	Validate technology capable of economically converting biomass residues, pulping liquors or waste fats and greases to synthesize gas or bio-oils that are suitable for fuels and chemical production. The target is $5.81/MBtu in 2009.

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Utilization of Platform Outputs R&D					
Demonstrated clean syngas production in three thermochemical conversion systems. [MET]			Complete a preliminary engineering design package, market analysis, and financial projection for at least one industrial-scale project for near term agricultural pathways (corn wet mill, corn dry mill, oilseed) to produce a minimum of 15 million gallons of biofuels per year (as mandated by the Energy Policy Act. [MET]	Approve a final engineering design package of at least one commercial scale biorefinery capable of processing up to 700 metric tones per day of lignocellulosic feedstocks. The approved design package must address any findings from an independent engineering review to validate contractor costs and scheduled timeline. Validation of biorefinery concepts will reduce technological risk and attract additional sources of capital to accelerate deployment and oil displacement.	Initiate construction of at least one commercial-scale biorefinery project (700 tons/day feedstock processed) selected in FY 2007 including hard orders for all tangible equipment, vendor packages and structural steel. Validation of biorefinery concepts will reduce technological risk and attract additional sources of capital to accelerate deployment and oil displacement.
Completed testing of ethanol production from corn fiber in partnership with industry in order to achieve a 3 percent increase in ethanol production from each corn ethanol plant that successfully implements the technology without requiring additional corn feedstock. [MET]					Approve final engineering design of two additional commercial scale biorefineries (3 in total) selected in FY 2007 including hard orders for all tangible equipment, vendor packages and structural steel. The result of this will ultimately be to complete construction by 2011.
					Approve preliminary engineering design package, market analysis and financial projections for at least five demonstration scale biorefinery (1-3 MGY) selected in FY 2008. These efforts work toward validating the 2012 goal of the $1.33 - $1.85 per gallon cost target
Completed validation of one new bio based product technology, with long-term potential of greater than 2 billion lbs. /yr. sales, at the pilot-scale for economic, technical, and product viability	Established the technical and market potential of a new bio based product. [MET]	Identify at least one sugar-derived or biomass oil-derived bio-based chemical or material (among those being evaluated) that possesses sufficient potential to enter into the scaled-up developmental phase			

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
in partnership with industry. [MET]		of R&D from the previous bench-scale phase. [MET]			
With industry partners, a new bio based product technology advanced to scale-up partners' intention to commercialize in a new industrial biorefinery by FY 2008. The biorefinery will be at pilot-scale. [MET]					
Contributed proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funds]	Contributed proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the Biomass & Biomass Refinery Systems Program FY 2004 end of year adjusted uncosted baseline ($62,235K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent. [Baseline and targets under development.]

Means and Strategies

Fuels from biomass have great potential because ethanol and biodiesel are compatible with today's major transportation fuels (gasoline and diesel). Biofuels can begin to reduce oil consumption immediately and, in the long-term, and provide an environmentally sustainable, renewable, and domestic alternative to petroleum-based fuels and products (such as plastics). Additionally, biofuels will increase domestic farm incomes and strengthen both national and rural economies.

The Biomass Program will use various means and strategies to achieve its GPRA Unit program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals.

The Biomass Program will implement the following means in order to improve the cost-competitiveness of biomass technologies:

- R&D through competitive solicitations for industrial partnerships with appropriate cost sharing to attract innovation and ensure investment value for industry and university contracts;
- Management of R&D by a series of objectives, milestones, and Stage Gate and Peer Reviews, which are tracked by the Project Management Center[a] and verified with reviews from industry and university experts;
- Industrial-scale validation of integrated biorefineries through competitive solicitations to validate their economic and technical validity in order to help facilitate commercialization; and
- Input from peer reviews.[b] Peer reviews of program plans and activities are aimed at obtaining expert, independent opinion on the program's goals and objectives; feasibility of reaching the goals; appropriateness of technical barriers being addressed; appropriateness of the Federal role, and whether the level of Federal funding for projects is commensurate with technical objectives.

The Biomass Program will implement the following strategies:

- The Biofuels Initiative, part of the AEI, will take advantage of R&D platforms and technology development strategies already in place. Accelerating these R&D strategies will make significant inroads into achieving the goals of the Initiative and will help to support the "Twenty in Ten" plan, EISA and the Renewable Fuels Standard. DOE has strategies in the basic sciences as well as feedstock, conversion and biorefinery technology advancement that map directly to Initiative goals. The program will employ the extensive technical expertise available throughout the Federal sector, industry, academia and laboratories. Partnerships are already in place with the DOE Office of Science, the U.S. Department of Agriculture and other Federal agencies. The basic approach to implementing the program will include developing and employing a mix of basic and applied sciences related to biomass feedstocks and conversion technologies as well as efforts to help bridge the gap from technology validation to deployment.

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[a] EERE implemented the Project Management Center approach at the Golden Field Office and the National Energy Technology Laboratory to enhance the management of projects.
[b] The most recent program peer review was held in November 2007.

- For each feedstock targeted, program research will develop handling and conversion technologies specific to feedstock properties and validate the technical performance and projected economics at industrial scale.

- The program will collaborate with the Office of Science to further basic research in the areas of feedstock development, such as overcoming the recalcitrance of certain biomass feedstocks. Additionally, the Biomass Program will collaborate with the DOE Office of Science to target and conduct research on the development of new organisms and techniques that are able to process the various sugars in biomass collectively. This will consolidate several steps in bioprocessing and lead to a significant reduction in tanks and associated equipment currently needed to convert biomass feedstocks into ethanol. This will result in a large reduction in plant costs.

- The program will continue to support Regional Biomass Feedstock Development Partnerships, thus leveraging the local resources through partnerships with agriculture producers, universities, and industry which understand the regional opportunities and challenges. These Partnerships will fund research to develop new feedstocks tailored to industrial applications for conversion to specific fuels and applications. This will allow the availability of biomass fuels and chemicals to continue to grow beyond the limitations of present commodity crop and forest resources.

- In addition to current collaborations with academia, the program will promote the use of universities' research capabilities in the areas of feedstock interface, biochemical and thermochemical platforms, environmental analysis and infrastructure while maintaining competitive allocation processes.

- The program will support R&D on high-opportunity, high-impact technologies for converting biomass feedstocks to ethanol. R&D will include developing process integration methodologies, identifying effective pretreatment catalysts effective on multiple biomass feedstocks, and targeting efficient enzymes. Moreover, as biorefinery plants mature, advanced thermochemical technologies (e.g., catalytic hydroprocessing) will be pursued to increase biofuels production and value.

- The program will utilize guidance from the Biomass Technical Advisory Committee and the Biomass R&D Board established under the Biomass R&D Act of 2000 to integrate R&D across agencies. In November 2006, the board held a workshop with Federal agency experts. The workshop report will be followed by a comprehensive interagency coordination and planning document that will be reviewed by the National Academy of Sciences.[a] In addition to assessing the goals and plans for interagency biomass research, the Academy will be tasked with considering economic and other impacts of increased biomass utilization under various energy price and policy scenarios.

- The program will implement the Administration's R&D Investment Criteria and DOE's internal assessment modeled after the Administration's Program Assessment Rating Tool (PART), along with various inputs provided by external and internal entities to help target Federal investments.

The following external factors could affect the program's ability to achieve its strategic goal:

- Cost and availability of conventional fossil energy sources and infrastructure adjustments;

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[a] National Biofuels Action Plan Workshop Report is available at http://www.biofuelspostureplan.govtools.us/documents/NationalBiofuelsActionPlanWorkshopSummaryReportFinal-5-30-07.pdf

- Federal and state farm policies and grower's actual adoption rate for new crops;
- Widespread adoption of sustainable crop management practices;
- Consumer acceptance;
- Cost of competing technologies;
- Loan guarantee programs as authorized by EPACT 2005 and other future regulatory changes (i.e., 2007 Farm Bill) could accelerate the adoption and positively impact the deployment of biorefinery technologies; and
- The market penetration rate of bio-based technologies which is a function of all the external factors listed and technical breakthroughs, incentives; price trends of coal, oil and natural gas; and policy factors.

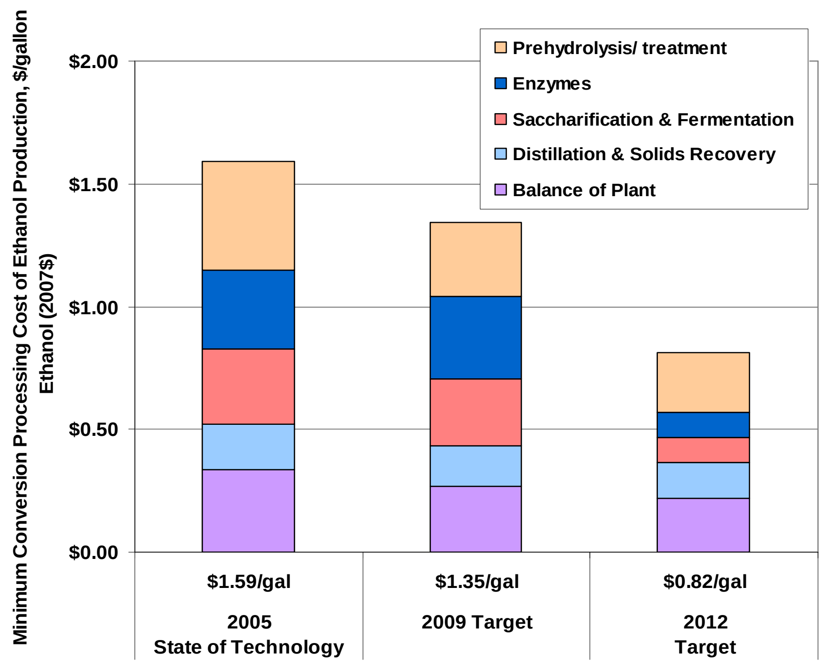
Collaborations are integral to achieving the planned investments, means and strategies, and to addressing external factors. In carrying out its mission, the program performs the following collaborative activities:

- Partnering with DOE's Office of Science on feedstock development and consolidated bioprocessing (technology aimed at reducing the number of unit operations needed in a biorefinery);
- Collaboration on advanced conversion processes and techniques with the DOE Office of Science will help define the future of advanced biorefineries;
- Coordination with the Hydrogen Program to evaluate biomass as a feedstock for hydrogen production;
- Coordination with the Vehicle Technologies Program, Clean Cities, and FEMP along with other Federal Agencies such as EPA, DOT, and DOD to increase the use of biofuels in vehicle fleets and address biofuels infrastructure issues such as those identified in the June 2007 Government Accountability Office report on biofuels infrastructure;
- Collaborate with the Treasury Department to evaluate tax policy to more effectively develop cellulosic ethanol to achieve the volumetric goals.
- The Regional Biomass Feedstock Development Partnerships will be used to enhance the coordination of feedstock R&D efforts with USDA and the Sun Grant Initiative recipients which includes land grant universities. Regional information is needed by potential biorefiners in order to assess and improve resource availability and feedstock economics;
- Annual USDA-DOE solicitation for biomass technologies R&D and other coordination under the Biomass Research and Development Act of 2000. The program will utilize guidance from the Biomass Technical Advisory Committee and the Biomass R&D Board established under the Biomass R&D Act of 2000 to integrate R&D across agencies.
- Partnerships with existing biorefineries to develop technologies resulting in more cost-effective use of current feedstock and/or utilization of additional, and new feedstocks such as cellulosic residues.

Validation and Verification

To validate and verify program performance, the Biomass Program will conduct internal and external reviews and audits. For example, during program peer reviews the programmatic activities are reviewed by experts from universities, State agencies, industry, and the U.S. Department of Agriculture. The table below summarizes validation and verification activities.

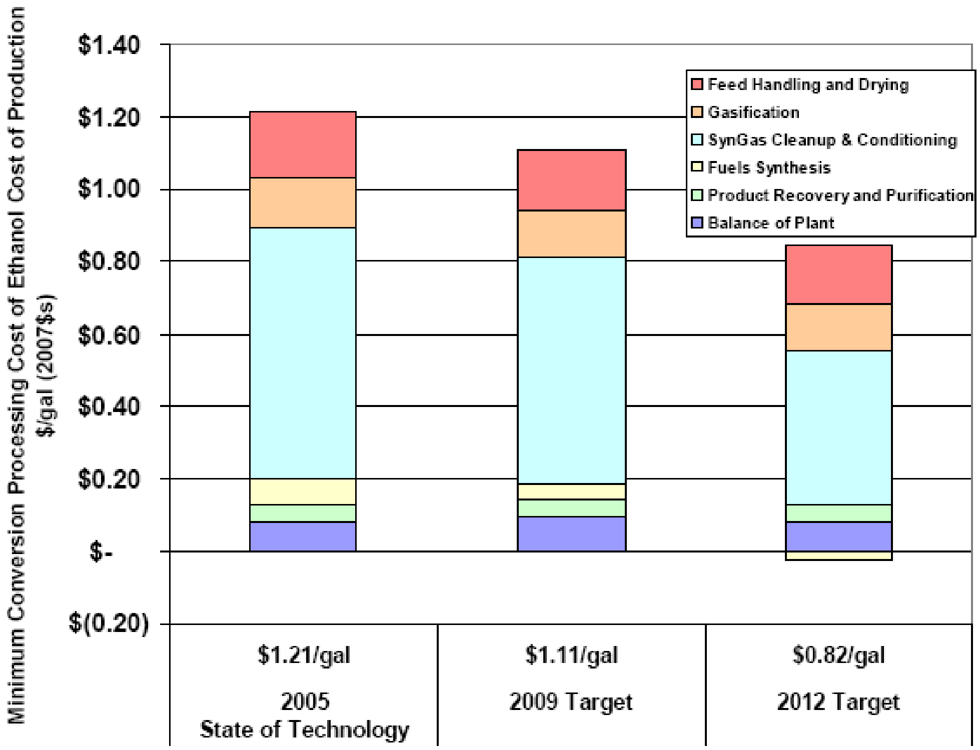
Data Sources:	The Renewable Fuels Association's production statistics; the National Renewable Energy Laboratory's Renewable Electric Plant Information System (REPIS); the Energy Information Administration's (EIA) Annual Energy Review, Renewable Energy Annual and Annual Energy Outlook; the Gas Technology Institute Survey of Distributed Resources; EIA Form 860 data analyzed by the Resource Dynamics Corporation. Individual projects develop production cost and quantity estimates for sugar, syngas, ethanol, and other fuels and chemicals (these are reviewed and monitored by managers).
Baselines:	The following are the key baselines used in the Biomass Program: ▪ In 2007, the feedstock logistics (collection, preprocessing, and delivery to a conversion facility inlet) baseline delivered cost (in 2007$) were $47.00 per dry ton for dry herbaceous (equates to $0.72/gallon) and $88.20 per dry ton for wet herbaceous feedstocks (equates to $1.35 per gallon). The baseline is still under determination for woody feedstocks. ▪ In 2005, Biochemical R&D baseline mature conversion costs for dry corn stover to ethanol was $1.59 per gallon (2007$) based on bench scale data (see figure below).



Process Area	2005 State of Technology	2009 Target	2012 Target
Processing Total	$1.59	$1.35	$0.82
Prehydrolysis/ Treatment	$0.44	$0.31	$0.25
Enzymes	$0.32	$0.33[a]	$0.10
Saccharification & Fermentation	$0.31	$0.27	$0.10
Distillation & Solids Recovery	$0.18	$0.17	$0.15
Balance of Plant	$0.34	$0.27	$0.22

- In 2005, Thermochemical R&D baseline mature conversion costs for hybrid poplar to ethanol via a gasification route was $1.21 per gallon (2007$) based on bench scale data (see figure below).

[a] The reason for the difference in numbers is inflation.



Processing Area	2005 State of Technology	2009 Target	2012 Target
Processing Total	**$ 1.21**	**$ 1.11**	**$ 0.82**
Feed Handling and Drying	$ 0.18	$ 0.17	$ 0.16
Gasification	$ 0.14	$ 0.13	$ 0.13
SynGas Cleanup & Conditioning	$ 0.69	$ 0.62	$ 0.43
Fuels Synthesis	$ 0.08	$ 0.05	$ (0.03)
Product Recovery and Purification	$ 0.05	$ 0.05	$ 0.05
Balance of Plant	$ 0.08	$ 0.10	$ 0.08

Processing Area	2005 State of Technology	2009 Target	2012 Target
Processing Total	**$ 1.21**	**$ 1.11**	**$ 0.65**
Feed Handling and Drying	$ 0.18	$ 0.17	$ 0.14
Gasification	$ 0.14	$ 0.13	$ 0.11
SynGas Cleanup & Conditioning	$ 0.69	$ 0.62	$ 0.34
Fuels Synthesis	$ 0.08	$ 0.05	$ (0.08)
Product Recovery and Purification	$ 0.05	$ 0.05	$ 0.05
Balance of Plant	$ 0.08	$ 0.10	$ 0.09

This table is being revised in the program's MYPP to reflect the 0.82 cost target for thermochemical conversion route. The current graphic and table are not correct. This revision will be in place by next week 9/27/07.

- In 2002, integrated biorefinery mature production costs were defined using an NREL design report for cellulosic ethanol costs from corn stover. This design report estimated n^{th} plant modeled cost for a specific integrated biorefinery design, among other assumptions. It provided the original definition for cost competitive cellulosic ethanol production from a biochemical conversion process using corn stover at $1.07 per gallon by 2012 (in $2002) – which has been adjusted to $1.33 per gallon by 2012 (in $2007). In 2005, an updated state of technology assessment estimated cellulosic ethanol production from a biochemical conversion process using dry corn stover, dilute acid pretreatment, enzymatic hydrolysis, co-fermentation, and lignin combustion for combined heat and power at $2.75 per gallon (in $2005). More cost baselines are being developed to be specific to various feedstock types (i.e., wet or dry, corn stover or woody) and conversion technologies options that could be used in integrated biorefineries. While n^{th} plant costs are currently being used to validate ethanol competitiveness, the program is assessing the potential for a metric in the future that would replace the nth plant cost with a pilot scale cost.

Evaluation: In carrying out the program's mission, the Biomass Program uses several forms of evaluation to assess progress and to promote program improvement.

- Stage-Gate review, technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and

subprogram portfolios;

- Biennial Technical Program Review of the Biomass Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and updated analysis of potential benefits for the Government Performance and Results Act (GPRA).

The National Laboratories receive direct funds for technology research and development, based on their capabilities and performance. Advisory panels consisting of non-Federal and industry experts review each laboratory and industry project at scheduled Stage-Gate reviews and peer evaluation of R&D. Projects are evaluated based on the following criteria: 1) Relevance to overall DOE objectives; 2) Approach to performing the research and development; 3) Technical accomplishments and progress toward project and DOE goals; 4) Technology transfer/collaborations with industry/universities/laboratories; and 5) Approach and relevance of proposed future research. The panels also evaluate the strengths and weaknesses of each project, and recommend additions to or deletions from the scope of work. The program organization facilitates relationships to ensure that Federal R&D results are transferred to industry.

Frequency: Potential benefits are estimated annually. Independent evaluation of R&D projects are performed according to schedule per the Stage-Gate process for moving each project through an independent review "gate", from a less costly stage (such as preliminary paper studies) to a more costly stage (such as bench-scale experiments). Program Peer Reviews are conducted annually.

Data Storage: EERE Benefits website, the EERE Corporate Planning System, and other computer-based data systems.

Verification: DOE technology managers verify the achievement of targets through project reviews, including reviews of cost and performance modeling results. Project leaders in the field must provide to the technology managers documentation of experimental and/or analytic results as evidence of success. The evidence is listed in material supporting the DOE Joule performance tracking system. Various trade associations review the data and the modeling processes (e.g., REPIS renewable), and the EIA verifies the REPIS database. Peer reviews are conducted by independent personnel from industry, academia and governmental agencies other than the U.S. Department of Energy.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The Biomass Program received its first OMB PART review in 2005. The 2005 PART review included ratings of 80 percent for program purpose, 90 percent for planning, 73 percent for management and 42 percent for program results and accountability with an overall rating of Adequate. These ratings reflect the commitment of EERE program management to good management and planning principles and the implementation of the EERE reorganization employing those principles. The program is evaluating its performance measures to ensure a better focus on the program's true results and improve accountability. Congressionally directed projects have accounted for approximately 40 to 57 percent of the program's budget in recent years, slowing program progress and reducing the management score because directed projects are not competitively selected, generally do not contribute to program goals, and sometimes result in high uncosted balances.

The Department has responded to the PART recommendation of "Develop guidance that specifies a consistent framework for analyzing the costs and benefits of research and development investments, and use this information to guide budget decisions."

Expected Program Outcomes

The Biomass Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources. Enabling policy and market activities could significantly affect market response. Domestic ethanol will displace imported oil, and thus yield energy security, economic and environmental benefits.

Estimates of the security, economic and environmental benefits from 2009 through 2050 that would result from realization of the program's goals are shown in the table below. If the program's technology goals are met, 0.2 billion and nearly 6 billion barrels of imported oil could be avoided in 2030 and 2050, respectively.[a] Further, the program would significantly increase the energy diversity of the Nation's transportation system.

EERE's Biomass Program Goal Case reflects the increasing penetration of ethanol over time, as the program's goals are met Not included is any policy or regulatory mechanisms, or other incentives, not already in existence, that might be expected to support or accelerate the achievement of the program goals. The expected benefits reflect solely the achievement of the program's goals.

The goals are modeled in contrast to the "baseline" case, in which no DOE R&D exists. The baseline case is identical to those used for all DOE applied energy R&D programs.[b] Further, across EERE and

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[a] The disproportionately declining oil import savings over time are due to the fact that lower ethanol prices lead to increased overall fuel demand (including petroleum derived fuels).

[b] The starting point for the baseline case is the Energy Information Administration's "reference case," as published in the AEO 2006. Program analysts from across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO's technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

all of DOE's applied energy R&D programs, the expected outcome benefits are being calculated using the same fundamental methodology. Finally, the metrics by which expected outcome benefits are measured are identical for all of DOE's applied energy R&D programs.[a] This standardization of methods and metrics has been undertaken as part of the Department's efforts to respond to the Under Secretary for Energy, Science, and Environment's Strategic Management System initiative and OMB's request to make all programs' outcomes comparable.

Benefits are estimated by modeling the program goals within two energy-economy models: NEMS-GPRA09 for benefits through 2030, and MARKAL-GPRA09 for benefits through 2050.[b] The full list of modeled benefits appears below.

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[a] The set of expected outcome metrics being used this year differs in substantial ways to that of most previous years. In addition to the standardization across DOE's applied energy R&D programs, the list is expanded and more comprehensive than in past years. Further, the list maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

[b] Results are presented as savings due to the programs. Documentation on the analysis and modeling can be found at http://www1.eere.energy.gov/ba/pba.

Primary Benefits Metrics for FY09 – NEMS and MARKAL

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	0.7	5.7
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	ns	0.5
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	1%	N/A
		MARKAL	ns	ns	2%	5%
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	ns	55	N/A
		MARKAL	3	33	327	2295
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	268	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	328	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	3	29	N/A
		MARKAL	ns	1	30	49
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	2	4	N/A
		MARKAL	ns	ns	2	-18
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	80	N/A
		MARKAL	ns	ns	11	4

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Basic and Applied R&D Coordination

The Biomass Program works with the DOE Office of Science (SC) to coordinate fundamental biomass research activities and share information about new partnerships, major research efforts, conversion and feedstock-related activities, and possible joint funding requests. For example, in December 2005 a joint SC-EERE workshop was held entitled "Breaking the Biological Barriers to Cellulosic Ethanol: A Joint Research Agenda". This resulted in the development of a joint research roadmap that outlined the basic science research needed to accelerate advances in cellulosic ethanol. The collaboratively developed document has guided the multiyear technical planning, roles, and investments for EERE and the SC.[a]

[a] http://genomicsgtl.energy.gov/biofuels/2005workshop/b2blowres63006.pdf.

The following are Scientific and Technical Roadmap Issues Being Jointly Addressed by OBP Funding with the Office of Science

- Mathematical and computational modeling of enzymes and interactions with biomass/water systems. Outyear considerations to achieve DOE's goals include expanding modeling effort to other enzyme and then to systems of enzymes and their interactions with cell wall components.
- Sequencing genomes of specific energy crop to determine which crops need sequencing from a regional feedstock perspective.
- Development of improved production of sustainable crops and cropping systems that offer a much greater yield (and improved ROI for farmers), are tolerant to stress factors such as drought and pests, have near zero potential for becoming invasive, contain traits that are tailored to conversion technologies, and allow for the widespread regional dissemination of biomass crops across all major crop producing regions of the US.
- Refine genomics tools needed for genetic marker aided selection for desirable traits that could be incorporated into breeding strategies at land grant universities through the Regional Feedstock Partnership and USDA efforts.
- Continue to build on the joint research agenda released in June 2006 entitle, "Breaking the Biological Barriers to Cellulosic Ethanol". Areas of potential collaboration to support DOE's long term goals include fundamental thermochemical and biochemical applications. Specifically, advanced conversion processes and techniques for future biorefinery concepts.

Feedstock Infrastructure

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Feedstock Infrastructure	9,725	12,060	15,092
SBIR/STTR	0	326	408
Total, Feedstock Infrastructure	9,725	12,386	15,500

Description

Feedstock Infrastructure activities are focused on increasing the availability and accessibility of our domestic biomass resources and improving the infrastructure technologies to supply reasonable cost lignocellulosic feedstocks to future large-scale biorefinery. It is necessary to make these improvements in resource availability and infrastructure costs because of the low bulk energy density (light weight nature) of biomass as compared to other fuel sources.

Specifically, the Feedstock Infrastructure R&D focuses on developing biomass production, harvesting, collection, preprocessing, storage, transport, and handling technologies, for wet and dry processes, different feedstock types, and various climatic regions. In addition, the Regional Feedstock Partnerships will be used to enhance the coordination of these R&D efforts with USDA and land grant universities. Regional information is needed by potential biorefiners in order to assess and improve resource availability and feedstock economics.

The Feedstock Infrastructure strategic goal is to develop sustainable technologies to provide cost-competitive sustainable biomass feedstock supplies for the U.S. bioindustry in partnership with USDA and other key stakeholders. The Feedstock Infrastructure has two high-level performance goals, one for biomass production and one for logistics. The Regional Feedstock Partnerships activities focus on the production goal and the Industrial Partnership activities are focused on meeting the logistics goals.

To a large degree, the size of the U.S. bioindustry will be determined by the quantity of biomass available. The ultimate outcome, or result, of the Feedstock Infrastructure effort is that technology and methods exist to produce and supply over one billion tons per year of biomass feedstocks in a sustainable and cost-effective manner.

In the near term, the feedstock production goal is to validate that a sufficient, high quality, accessible feedstock supply of 130 million dry tons per year would be available in 2012, growing to 250 million dry tons per year in 2017. This goal is necessary to spatially quantify the accessible resource and validate the percentage of the resource that could be recovered cost effectively. The near term feedstock logistics goal is to reduce the feedstock logistics costs, including harvesting, storage, preprocessing and transportation, to $0.35 per gallon of ethanol in 2012 (or approximately $32/dry ton in 2007).[a]

[a] See Biomass Program's 2007 Multi Year Program Plan, Figures 2.1-3 and 2.1-4 for additional information.

Indicators of progress toward the goal include cost shared industrial partnerships for developing feedstock logistics systems and implementing a GIS-based regional feedstock atlas linked to the latest National Agricultural Statistic Service data, energy crop field test results, residue removal trial results, DOE and USDA funded biorefinery project results, and other assessments from public and private sources. This process will provide the best information to the atlas and be available for a wide variety of users including Federal and State governments, biorefinery developers, growers, and researchers.

The Feedstock Infrastructure subprogram is an integral part of the Biomass Program's partnered strategic pathway of science to research to technologies to market interdependent approach using linkages and feedback among them to accelerate the benefits of technology development.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Feedstock Infrastructure	**9,725**	**12,060**	**15,092**

There are two main activities included in Feedstock Infrastructure: 1) the Regional Biomass Feedstock Development Partnerships; and 2) Infrastructure Core R&D. Regional Biomass Feedstock Development Partnerships address barriers to accessing the biomass resource including resource assessment, education & extension, sustainable agronomic systems development, and biomass crop development. Regional Biomass Feedstock Development Partnerships R&D will also establish a regional GIS-based feedstock atlas. Preliminary results of this atlas will be used to establish regionally-based industrial-scale energy crop demonstrations linked to major biorefinery efforts. These cost-shared demonstration projects will build upon several feedstock related activities. Some of these may develop as the feedstock component related to the biorefinery projects under the Utilization of Platform Outputs budget element (most likely the 10% of commercial scale projects). Feedstock Infrastructure R&D addresses barriers associated with accessing the feedstock supply. This includes harvest, collection, preprocessing, storage, queuing, handling, and transport for all major feedstock categories of cellulosic biomass (i.e., wet, dry and woody). The Feedstock Infrastructure R&D effort will expand from the laboratory design work into a solicitation for industrial partnerships that begin prototype development of advanced single pass harvesters, high capacity preprocessing, handling and transport systems, and storage and queuing systems for wet, dry and woody biomass. This three-year industrial partnership effort will require 50% cost-share.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**326**	**408**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Feedstock Infrastructure	**9,725**	**12,386**	**15,500**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Feedstock Infrastructure	
Infrastructure Core R&D will utilize these funds for second year funding of industrial partnership solicitations to begin prototype development of advanced single pass harvesters, high capacity preprocessing, handling and transport systems, and storage and queuing systems for wet, dry and woody biomass.	+3,032
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+82
Total Funding Change, Feedstock Infrastructure	**+3,114**

Platforms Research and Development

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Platforms Research and Development			
Thermochemical Platform R&D	16,461	26,356	19,863
Biochemical Platform R&D	32,845	39,156	32,131
SBIR/STTR	0	1,770	1,406
Total, Platforms Research and Development	49,306	67,282	53,400

Description

Platform Research and Development helps advance technologies within the Biochemical and Thermochemical platforms for converting feedstocks and intermediates into quality, cost competitive biofuels, like cellulosic ethanol, as well as materials and chemicals. Thermochemical Platform R&D areas include thermochemical processing, cleanup and conditioning, and upgrading for fuels synthesis. The initial focus will be on gasification technologies for synthesis gas production with a gradual increase in pyrolysis R&D. Biochemical Platform R&D will focus on further improvements to feedstock interface (pre-processing), pretreatment, and enzymatic hydrolysis, and process integration. These integrated steps are required to reduce sugar costs and enable ethanol to be produced as part of a biorefinery. This includes the awards from solicitations initiated in FY 2007 in the Biochemical Platform R&D for the development of improved cellulases with increased activities and in the Thermochemical Platform R&D for fuels synthesis technology development. Platforms R&D supports achievement of the Biofuels Initiative's 2012 cost target of $1.33 per gallon of cellulosic ethanol.

Reduce the costs of mixed biomass sugars to 6.4 cents per pound and clean syngas to $5.25 per million Btus. Sugars and syngas from biomass are the key biorefinery intermediates that are subsequently converted to biofuels, chemicals and materials within the biorefinery.

The Platforms Research and Development subprogram is an integral part of the Biomass Program's partnered strategic pathway of science to research to technologies to market interdependent approach using linkages and feedback among them to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Thermochemical Platform R&D	**16,461**	**26,356**	**19,863**

To help achieve integrated biorefinery goals, robust and cost-effective biomass thermal conversion processes that can convert a variety of biomass materials to suitable clean intermediates for subsequent conversion to fuels are under development. The Thermochemical Platform works to reduce costs of converting biomass and its intermediaries to fuels, chemicals and power via gasification, pyrolysis and catalytic hydrotreating and hydrocracking processing technologies. Intermediate products include clean synthesis gas, or syngas, (a mixture of primarily hydrogen and carbon monoxide), bio-oil (a liquid product from pyrolysis), and gases rich in methane or hydrogen. These intermediate products can then be upgraded to products such as ethanol, other alcohols, gasoline, diesel, ethers, synthetic natural gas, or high-purity hydrogen, or may be used directly for heat and power generation. Core research addresses key technical barriers.

In Fiscal Year 2009, specific objectives include validating technology capable of economically converting biomass residues, pulping liquors or waste fats and greases to synthesis gas or bio-oils that are suitable for fuels and chemicals production. The target is a modeled cost $5.81/MBtu in 2009. This objective is supported through continuation of projects selected under two Thermochemical Platform R&D solicitations to validate and demonstrate syngas to liquid fuels (initiated in Fiscal Year 2007) and for pyrolysis oil to liquid fuels (initiated in Fiscal Year 2008). The objective will also be supported by gasification modeling and R&D to inform gasification technology scale up. The gasification modeling effort will produce validated models that allow for different gasifiers, different operating conditions, and different syngas (or pyrolysis oil) products. The gasification technology scale up work will couple gasification to synthesis gas conversion to demonstrate the production of fungible liquid transportation fuel at pilot scale operation. In addition, a detailed design case for biomass pyrolysis technology options is currently in progress, and will be used to inform R&D activities as well as cost and performance targets.

Investigating thermochemical conversion technologies together with downstream fuel synthesis identifies the challenges of integrating different feedstocks and processes. One immediate near-term goal is to demonstrate that the improved tar cracking and reforming catalysts have the potential to consolidate high temperature chemical transformations, thereby increasing thermodynamic efficiency as well as reducing the cost and risk of gasification-based process technology. Fundamental research is focused on developing process models that can predict the performance of advanced consolidated processes in an iterative manner for improved conversion by optimizing those parameters, such as residence time, particle size, and biomass deconstruction into pretreated/preconditioned fractions to maximize yields of highly selective thermal transformations.

A fundamental understanding of the factors controlling thermochemical conversion is needed to be able to develop new or improved technologies that increase the efficiency and/or reduce the cost. As feedstock prices increase due to supply and demand, decreased conversion costs will allow the industry to utilize higher priced feedstocks.

(dollars in thousands)

Work will be done in collaboration with competitively selected industrial partners. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
Biochemical Platform R&D	**32,845**	**39,156**	**32,131**

The Biochemical Platform R&D is focused on reducing the cost of converting lignocellulosic biomass to mixed, dilute sugars and further conversion to liquid fuels, like ethanol, to advance technologies needed for successful integrated biorefineries and support the $1.07 per gallon cellulosic ethanol cost goal for the Biofuels Initiative.

In Fiscal Year 2009, the Biochemical Platform R&D will make further improvements to feedstock interface, pretreatment and conditioning, enzymes and fermentation processes in addition to process integration in order to reduce sugar costs as the springboard to launching the next generation of cellulosic ethanol technology from a wide range of feedstocks. Core research addresses key technical barriers.

In Fiscal Year 2009, specific objectives include demonstrate alternative pretreatment technologies at bench-scale using advanced cellulase enzymes and integrated technologies that have the potential of achieving $0.12 per pound (in 2007 $) of sugars on the pathway to $0.073 per pound (in 2007 $) by 2012.

Current efforts and work planned for 2009 are focused into the following work breakdown areas:

Establishing the value of and requirements for feedstock assembly processes to feed bioconversion processes are important for the development of biorefineries. Activities will develop cost and quality specifications for feedstock assembly technologies that are compatible with biochemical conversion technologies. The key technical target is to improve feedstock yield potential through targeted logistics operations between the field or forest and the biorefinery.

Fiscal Year 2009 activities will be aimed at understanding and reducing sugar degradation kinetics. Work will take place to reduce sugar losses to less than 7 percent in laboratory equipment. Fiscal Year 2009 funding also supports projects from the Fiscal Year 2007 Biochemical solicitation to support the development of commercially-viable enzymes – a key component in the production of biofuels, including cellulosic ethanol.

Integration of biomass pretreatment, saccharification and fermentation steps can improve overall efficiency and reduce cost. In addition, the effect of feed and process variations throughout the process must be understood to ensure robust, efficient biorefineries. Fiscal Year 2009 work is focused on maintaining high conversion rates from the individual operations in an integrated processing configuration at high solids loadings. The integrated biorefinery pilot scale facility at NREL will be

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

used to validate the integration of the separate unit operations.

A fundamental understanding of the factors and causes underlying the recalcitrance of biomass to biological and chemical degradation is needed to make processing more specific and less costly. Work outlined in DOE's EERE and Office of Science joint research agenda entitle, "Breaking the Biological Barriers to Cellulosic Ethanol" (June 2006) will directly apply to this R&D area. These efforts will provide the basic science groundwork to develop applied and ultimately integrated process solutions for biomass conversion. Specifically, this work will produce advanced conversion processes and techniques for future biorefinery concepts. In Fiscal Year 2009, efforts will focus on understanding lignin re-deposition and other process effects on enzyme kinetics.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**1,770**	**1,406**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Platforms Research and Development	**49,306**	**67,282**	**53,400**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Thermochemical Platform R&D	
The decrease is due to a temporary shift in funding within the program to support the EPACT Section 932 integrated biorefinery demonstration projects and the 10% of commercial scale demonstration projects under the Utilization of Platform Outputs R&D subprogram. This funding level still supports existing and new project multi-year contractual agreements in Biochemical Platform linked to the AEI cost goal and supporting the EISA and the "Twenty in Ten" plan. This funding level includes the awards from solicitations initiated in Fiscal Year 2007 in the Thermochemical Platform R&D for syngas and pyrolysis oils to fuels activities.	-6,493

	FY 2009 vs. FY 2008 ($000)
Biochemical Platform R&D	
The decrease is due to a temporary shift in funding within the program to support the EPACT Section 932 integrated biorefinery demonstration projects and the 10% of commercial scale demonstration projects under the Utilization of Platform Outputs R&D subprogram. This funding level still supports existing and new project multi-year contractual agreements in Biochemical Platform linked to the AEI cost goal and supporting the EISA and the "Twenty in Ten" plan. This funding level includes the awards from solicitations initiated in Fiscal Year 2007 in the Biochemical Platform R&D for the development of improved cellulases with increased activities.	-7,025
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-364
Total Funding Change, Platforms Research and Development	**-13,882**

Utilization of Platform Outputs R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Utilization of Platform Outputs R&D			
Integration of Biorefinery Technologies	103,301	102,985	138,393
Products Development	33,945	9,899	15,677
SBIR/STTR	0	673	2,030
Total, Utilization of Platform Outputs R&D	137,246	113,557	156,100

Description

Utilization of Platform Outputs R&D consists of two sub-elements: Integration of Biorefinery Technologies and Products Development. Integration of Biorefinery Technologies enables the integration of enabling technologies developed under Platform R&D as well as Product Development. Program efforts focus on implementing the cost-shared commercial and 10 percent scale biorefinery projects authorized by EPACT 2005, Section 932(d). The projects are designed to integrate advanced technologies through public-private partnerships with the goal of producing cost-competitive fuels, chemicals and materials, and/or heat and power. Biofuels infrastructure is also included within the scope of Integration of Biorefinery Technologies. These activities will address challenges from fuels distribution to vehicle end use in order to achieve large scale market adaptation of biofuels from biorefineries. The Products Development sub-element is focused on the conversion of sugars from the biochemical platform into ethanol. It supports public/private partnerships focused on developing a commercially viable fermentation organism which can help reduce the cost of cellulosic ethanol production. The activities under Utilization of Platform Outputs R&D will ultimately contribute to all biorefinery pathways. Currently, the program's priority remains focused on enabling biorefineries to efficiently convert lignocellulosic biomass into ethanol and other biofuels.

Activities under Utilization of Platform Outputs support the achievement of the Biofuels Initiative's goal of cost competitive cellulosic ethanol by 2012 and "Twenty in Ten" plan. Success in Utilization of Platform Outputs activities would help validate biorefinery concepts and could help reduce technological and financial risks for future biorefineries by reducing technology integration barriers. These activities will also promote large-scale market adaptation and commercial acceptance of biofuels. As more technologies (for making biofuels, biopower, and bioproduct options) from a wider variety of feedstocks are demonstrated and validated, the risk-reward relationship will continue to improve. This will attract additional sources of financial capital at competitive rates and accelerate biorefinery commercialization and, thus, oil displacement.

An indicator of progress toward achieving the benefits includes:

- In Fiscal Year 2009, initiate construction of six commercial-scale biorefinery project (700 tons/day feedstock processed) selected in Fiscal Year 2007, including hard orders for all tangible equipment, vendor packages and structural steel.
- In Fiscal Year 2009, approve final engineering design of two additional commercial scale biorefineries (3 in total) selected in Fiscal Year 2007, including hard orders for all tangible equipment, vendor packages and structural steel.
- In Fiscal Year 2009, approve of preliminary engineering design package, market analysis and financial projections for at least five demonstration scale biorefineries (1-3 million gallons per year) selected in Fiscal Year 2008.

The Utilization of Platform Outputs R&D subprogram is an integral part of the Biomass Program's partnered strategic pathway of science to research to technologies to market interdependent approach using linkages and feedback among them to accelerate the benefits of technology development and adoption.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Integration of Biorefinery Technologies	**103,301**	**102,985**	**138,393**

The program will continue work with partners to demonstrate integrated biorefineries across various pathways (successful operation of three plants by 2012) and will also validate mature plant modeled cost of ethanol production of $1.33 - $1.85 per gallon in 2012 based on pioneer plant performance. In Fiscal Year 2009, funding for Integration of Biorefinery Technologies increases to continue the validation of the near-term biorefinery pathways that could ultimately allow the production of cost competitive cellulosic ethanol. The program will continue to support project multi-year contractual agreements from public-private partnerships initiated in Fiscal Year 2007 for biorefinery integration at a small commercial scale for the production of transportation fuels and co-products (such as materials and chemicals), as authorized by EPACT, Section 932. The program will also continue to support project multi-year contractual agreements from public-private partnerships initiated in Fiscal Year 2008 to validate biomass conversion technologies developed under Platform R&D and integrate them into biorefineries at approximately 10 percent of commercial scale.

Fiscal Year 2009 activities include completing standards development and testing of E15 and E20 distribution systems and vehicles. Additionally, a strategy for growing and maintaining E85 infrastructure on a regional basis will continue to be implemented.

With DOE support, the projects will result in technological risk reduction and economic validation, thereby enhancing the probability of success for the private sector's commercialization and replication. University and National Laboratory personnel will conduct research to support public-private

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

partnerships in overcoming barriers identified by these projects and continually improve the biorefineries effectiveness and efficiency.

Products Development	**33,945**	**9,899**	**15,677**

By 2009 the program will have implemented its shift in focus to support biorefinery integration activities. In FY 2009, the program will continue to support the five cost share projects selected under the FY 2007 solicitation aimed at developing fermentation organisms that have increased productivity, stability, robustness, and lower cost. Advances in the production of liquid fuels, primarily ethanol, but possibly butanol or other alcohols in the future, are focused on improving existing fermentation organisms. Fundamental research is focused on improving understanding of and developing advanced technologies to overcome the key rate limiting steps in the conversion of biomass to fermentable sugars. The goal of this effort is to accelerate the development of advanced micro-organisms capable of fermenting mixed sugars from cellulosic residues, thus increasing the ethanol output from future biorefineries. Additionally, this funding will be used to assess, prioritize, and initiate addressing R&D barriers for other biofuels options beyond cellulosic ethanol, such as biodiesel.

SBIR/STTR	**0**	**673**	**2,030**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Utilization of Platform Outputs R&D	**137,246**	**113,557**	**156,100**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Integration of Biorefinery Technologies	
The funding increases significantly in order to support multi-year contractual agreements for EPACT Section 932 integrated biorefinery demonstration projects and the 10% of commercial scale demonstration projects under Integrated Biorefinery sub-element initiated in Fiscal Year 2007. Biofuels infrastructure is also included within the scope of Integration of Biorefinery Technologies. These activities will address challenges from fuels distribution to vehicle end use in order to achieve large scale market adaptation of biofuels from biorefineries. The ramp up in funding also supports biofuels infrastructure activities in collaboration with other DOE program's such as Vehicle Technologies Program, Clean Cities, and FEMP along with other Federal	+35,408

	FY 2009 vs. FY 2008 ($000)
agencies (EPA, DOC-NIST, DOT, and DOD).	
Products Development	
The funding increase supports the five public-private partnership projects for fermentation organism (aka ethanologen) development selected for award in Fiscal Year 2007. Additionally, the funding level allows the program to assess, prioritize, and initiate addressing R&D barriers for other biofuels options beyond cellulosic ethanol.	+5,778
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+1,357
Total Funding Change, Utilization of Platform Outputs R&D	**+42,543**

Cellulosic Ethanol Reverse Auction

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Cellulosic Ethanol Reverse Auction	0	4,955	0
Total, Cellulosic Ethanol Reverse Auction	0	4,955	0

Description

Establish the framework for implementing a cellulosic ethanol reverse auction in accordance with Section 942 of the Energy Policy Act of 2005.

Potentially accelerate rate of introduction of cellulosic ethanol into the market place, in line with production incentives outlined in Section 942 of the Energy Policy Act of 2005.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Cellulosic Ethanol Reverse Auction	**0**	**4,955**	**0**

The Biomass Program will evaluate and develop a framework for an ethanol reverse auction in accordance with Section 942 of the Energy Policy Act of 2005.

Total, Cellulosic Ethanol Reverse Auction	**0**	**4,955**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Cellulosic Ethanol Reverse Auction	
No funds requested in 2009. The Program will have completed the framework for implementing Section 942 of EPACT.	-4,955
Total, Cellulosic Ethanol Reverse Auction	**-4,955**

Solar Energy

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation[a]	FY 2008 Original Appropriation	FY 2008 Adjustments[b]	FY 2008 Current Appropriation	FY 2009 Request
Solar Energy					
Photovoltaic Energy Systems	138,372	138,000	-1,256	136,744	137,120
Concentrating Solar Power	15,696	30,000	-273	29,727	19,000
Solar Heating and Cooling Systems	2,960	2,000	-18	1,982	0
Total, Solar Energy	157,028	170,000	-1,547	168,453	156,120

Public Law Authorizations:

P.L. 93-409, “Solar Heating and Cooling Demonstration Act” (1974)
P.L. 94-163, “Energy Policy and Conservation Act” (EPCA) (1975)
P.L. 94-385, “Energy Conservation and Production Act” (ECPA) (1976)
P.L. 95-91, “Department of Energy Organization Act” (1977)
P.L. 95-590, “Solar Photovoltaic Energy Research, Development and Demonstration Act” (1984)
P.L. 95-619, “National Energy Conservation Policy Act” (NECPA) (1978)
P.L. 96-294, “Energy Security Act” (1980)
P.L. 101-218, “Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989” (1989)
P.L. 101-575, “Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990” (1990)
P.L. 102-46, “Solar, Wind, Waste, and Geothermal Power Production Incentives Technical Amendments Act” (1991)
P.L. 102-486, “Energy Policy Act (EPACT)” (1992)
P.L. 109-58, “Energy Policy Act of 2005” (2005)
P.L. 110-140, “Energy Independence and Security Act of 2007”

Mission

The mission of the Solar Energy Technologies Program (“Solar Program”) is to conduct research, development, demonstration and deployment activities to accelerate widespread commercialization of clean solar energy technologies across America, diversifying the Nation’s electricity supply options, while increasing national security and improving the environment. Accomplishing the mission will benefit the supply side of the Department’s energy security equation accelerating the arrival and use of the new fuels and technologies that we need.

[a] Excludes amounts transferred to the Science appropriation for carrying out SBIR / STTR. All subsequent tables in this program also reflect this transfer.
[b] Reflects amounts rescinded by General Provision, Section 312, of the Omnibus Appropriations Act, 2008.

Through its research and development (R&D) activities, the Solar Program is developing solar energy technologies – photovoltaics (PV) and concentrating solar power (CSP) – that are reliable, affordable, and environmentally sound. Transforming the Nation's vast supply of direct solar energy into a widely available, affordable, low emission energy resource will increase energy security both by diversifying domestic energy supply options in both normal market conditions and emergency situations. Achievement of the program's goals could also yield economic benefits to consumers and the electric power industry, and provide environmental benefits by reducing carbon emissions. Greater use of solar energy will also reduce the growth of greenhouse gas emissions associated with long-term climate change.

The Solar America Initiative (SAI) funds efforts designed to achieve market competitiveness for solar electricity by 2015. The R&D effort focuses on technology pathways that have the greatest potential to lower costs and improve performance. Industry-led R&D partnerships, known as "Technology Pathway Partnerships (TPPs)," address the issues of cost, performance and reliability associated with each technology pathway. Members of the TPPs include industry, universities, laboratories, and other governmental entities broadening the base and increasing the likelihood of achieving the goals. Our modeling suggests that, in 2015, outcomes and benefits could include 4 GW of cumulative new capacity.

The Solar Program provides additional types of public benefits in the areas of reliability, security, and environment.[a] PV systems can either be integrated with the electricity grid or work independently as distributed systems, a flexibility which increases national energy security by providing a widely available and flexible source of power not dependent on our aging and vulnerable electricity grid system. CSP systems use dishes for smaller, decentralized systems, and dish arrays, parabolic troughs or power towers for larger, centralized power applications that meet the large output needs of utilities. CSP power plants can increase grid reliability with the inclusion of thermal storage to largely eliminate the intermittency of solar energy and by strategically placing them "downstream" of transmission congestion points.

Solar energy is particularly valuable in reducing the need for new generating and transmission capacity because its natural availability matches daily and seasonal electricity peaks. The ability to store solar energy is of particular interest to utilities because it allows them to use solar energy during their entire periods of peak demand. Solar energy promotes energy security during emergencies by providing power and hot water that is not dependent on fuel deliveries or overhead wires that are subject to disruption and which will not contribute to local air pollution during a protracted emergency. Solar energy displaces demand on the electricity grid most during the hottest, sunniest days of the year when demand for space cooling peaks reducing the potential for blackouts. If solar energy can displace conventional power plants, greenhouse gas emissions and criteria pollutant emissions can be significantly reduced.

The generation of electricity from solar energy contributes no CO_2 or other GHGs directly to the atmosphere. Increasing the contribution of solar generation to the Nation's energy portfolio will directly lower GHG intensity (GHGs emitted per unit of economic activity) in proportion to the amount of carbon-emitting energy sources displaced. Transitioning from today's reliance on fossil fuels to a global energy portfolio that includes significant renewable energy sources will require continued improvements

[a] Not reflected in the quantified benefits reported in the Expected Program Outcomes section.

in cost and performance of renewable technologies, including wind. This transition would also require shifts in the energy infrastructure to allow a more diverse mix of technologies to be delivered efficiently to consumers in forms they can readily use. Combinations of renewable and conventional technologies and systems—and, therefore, integration and interconnection issues—will grow in importance.

Today, solar energy systems are well established. Demand for these systems is growing in many parts of the world. Possible near-, mid-, and long-term scenarios for renewable energy are as follows:

- In the near term, as system costs continue to decrease, the number of grid-connected solar systems could increase quite rapidly, meeting local energy needs such as uninterruptible power, community power, or peak shaving.
- In the midterm, reductions in cost could encourage penetration by solar technologies into large-scale markets, first in distributed markets such as commercial buildings and communities, and later in utility-scale systems.
- In the long term, solar technologies could also provide electricity and heat for major sections of the country, and most residential and commercial buildings could generate their own energy on-site with grid-connected systems.

By 2030 the Solar Program will directly contribute to private sector development of more than 70 gigawatts to the grid and reduce carbon emissions by 40 million metric tons, and will essentially triple those contributions by mid century. The program's economic, environmental and security benefits that are quantified as expected program outcomes are described in more detail under the "Expected Program Outcomes" sections.

Program Deliverables and Interdependencies

The following expected program deliverables are expected as a result of the activities supported with the carbon strategy budget above:

Solar R&D will focus on Applied Research, Technology Acceptance, Technology Evaluation, Systems Development and Renewable Systems Interfaces:

- Improving cost effectiveness and reliability of PV systems and components through cost-shared work with Technology Pathway Partnerships and Incubator award winners on path to meeting SAI goals.
- Supporting next generation PV research through continued funding of competitively awarded grants to universities and industry to bridge the gap between basic and applied research.
- Completing work with 13 Solar America Cities in their effort to build sustainable solar infrastructures, while assisting a second round of cities in defining and launching their activities.
- Industry supported storage solutions, manufacturing approaches, and new system concepts for large-scale concentrating solar power plants,
- Parabolic trough R&D to improve solar field concentrator and receiver technologies,
- Evaluation of energy storage media and concepts,

- Increasing the annual system efficiency from 10.6 percent to 17.2 percent,
- Reducing the cost of reflectors by 55 percent, and
- Increasing the operating temperature from 390C to 500C.
- Dish system reliability improvements are being pursued (along with significant cost reductions) through advanced structure, azimuth drive, and optical element design as well as through next generation power conversion unit and receiver development. Work on the Stirling engine includes improvements in valves, seals, gas management, and controls.
- CSP: Technical Support and Technology Acceptance Activities that will help industry partnerships achieve the cost targets and enable CSP to become an intermediate and baseload power source, including the development of lower-cost trough system designs and manufacturing supply chains for 100-500MW power plants, and investigating thermal storage materials and systems.

Specific milestones for technology performance for these activities are included in the near following section entitled Contribution to GPRA Unit Program Goal.

Program Interdependencies include:

- Increasing resources with in the solar-buildings initiative focused on large-scale building commercialization, i.e., to accelerate deployment of higher-efficiency buildings incorporating PV technologies.
- Implementing a robust storage technology development effort, i.e., to enable large-scale installations of PV and other renewable technologies with low-cost storage.
- The capacity and availability of the existing electrical grid is a limiting factor to CSP market penetration. Transmission throughout the west is a problem. It is a series of independent grids that have been joined together. Most transmission lines are often operating at capacity. Many lines have bottlenecks that limit the amount of power that can be moved to load centers. New transmission is needed to enable renewable power plants to provide electricity throughout the West.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Solar Energy Program supports the following goal:

Strategic Theme 1, Energy Security

Strategic Goal 1.1 – Energy Diversity: Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs.

Solar energy can decrease natural gas demand and potentially help slow any growth in foreign supplies.

And concurrently supports:

Strategic Goal 1.2 – Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Goal 1.3 – Energy Infrastructure: Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

The Solar Energy Program has one GPRA Unit program goal which contributes to Strategic Goals 1.1, 1.2, and 1.3 in the "goal cascade":

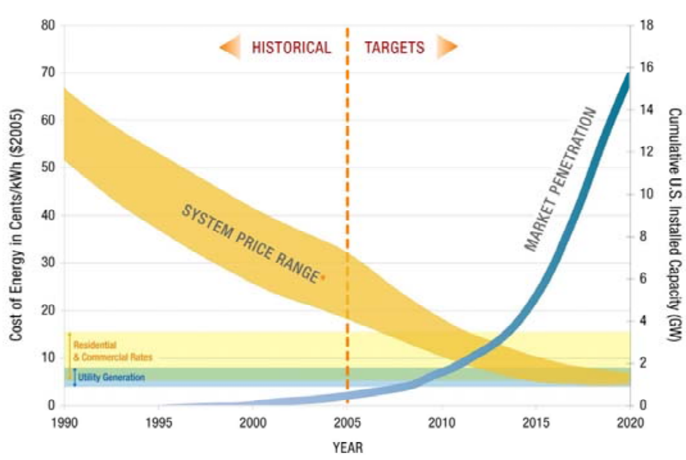
GPRA Unit Program Goal 1.1.03.00: Solar Energy - The Solar Program goal is to improve the performance and reduce the cost of solar energy systems to make solar power cost-competitive with conventional electricity sources by 2015, thereby accelerating large-scale usage across the Nation and making a significant contribution to a clean, reliable and flexible U.S. energy supply.

Contribution to GPRA Unit Program Goal 1.1.03.00 (Solar Energy)

The key Solar Program contributions to this goal are through increased production of electricity and diversification of energy supply. The Solar Program works to improve the performance of next-generation solar energy technologies which reduce system, manufacturing, and installation costs to levels competitive with conventional energy sources. When Federal solar energy research increased in the 1970s in response to oil price shocks, the cost of electricity from solar resources was about $2.00 per kilowatt-hour (kWh). Technological advances by the Solar Program over the last two decades have contributed to reducing solar electricity costs by more than 90 percent. Today, in areas with favorable conditions, solar electricity can be produced at costs as low as $0.12/kWh for CSP and as low as $0.18/kWh for PV applications.

The Solar Program goal of achieving cost-competitive solar electricity translates to a range of costs based on specific markets. For PV, the estimated cost ranges for market-specific cost-competitive electricity generation in 2015 are:

Historical/Projected PV Cost Curves and Market Penetration



- 5-7¢/kWh for centralized power markets,
- 6-8¢/kWh for commercial markets, and
- 8-10¢/kWh for residential markets.

The long-term goal (2020) for CSP systems is cost competitive (5-7¢/kWh) baseload power including 12-16 hours of thermal storage.

Key technology pathways to the goals include (detailed annual performance progress indicators are presented in their respective benefits sections):

- By 2010, reduce the 30-year user cost for PV electric energy to 10-18¢/kWh from 18-23¢/kWh in 2005.

- By 2010, reduce the cost of large-scale CSP power plants in the Southwest to 10-12¢/kWh from 12-14¢/kWh in 2004.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.1, Energy Diversity			
GPRA Unit Program Goal 1.1.03.00, Solar Energy			
Photovoltaic Energy Systems	138,372	136,744	137,120
Concentrating Solar Power	15,696	29,727	19,000
Solar Heating and Cooling Systems	2,960	1,982	0
Total, GPRA Unit Program Goal 1.1.03.00, Solar Energy	157,028	168,453	156,120
Total, Strategic Goal 1.1 (Solar Energy)	157,028	168,453	156,120

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.1.03.00 (Solar Energy)					
Photovoltaic Energy Systems					
Verify, with standard laboratory measurements, U.S.-made commercial production crystalline silicon PV modules with 12.5 percent conversion efficiency.	Verify, using standard laboratory measurements, a conversion efficiency of 13.5 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.95 per Watt. [MET]	Verify, using standard laboratory measurements, a conversion efficiency of 13.8 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.90 per Watt. [MET]	Verify, using standard laboratory measurements, a conversion efficiency of 14.5 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.80 per Watt. [MET]	Reduce producer manufacturing cost of silicon PV modules to $1.70 per Watt, roughly equivalent to a modeled levelized cost of energy of $0.14-$0.23/kWh.	Reduce producer manufacturing cost of silicon PV modules to $1.60 per Watt, roughly equivalent to a modeled levelized cost of energy $0.12-$0.20/kWh
Verify, with standard laboratory measurements, U.S.-made commercial production thin-film PV modules with 10 percent conversion efficiency. [MET]	Develop thin-film PV modules with an 11.0 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Develop thin-film PV modules with an 11.2 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Develop thin-film PV modules with an 11.8 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Complete R&D that will reduce the direct manufacturing cost of thin film PV modules to $1.60 per Watt, roughly equivalent to a modeled levelized cost of energy of $0.14-$0.23/kWh.	Modeled levelized cost of power for residential photovoltaic markets under ideal conditions in cents per kilowatt-hour (¢/kWh). [Baseline and targets under development.]
					Modeled levelized cost of power for commercial photovoltaics markets under ideal conditions in cents per kilowatt-hour (¢/kWh). [Baseline and targets under development.]
Concentrating Solar Power					
		Conduct advanced research on trough collectors and receivers that will lead to a reduction in the modeled cost of energy from CSP troughs to $0.12-$0.14/kWh. [MET]	Develop CSP trough collector and receiver technologies that enable a system conversion efficiency of 13.1%. The levelized cost of energy from such a system is expected to be in the range of $0.11-$0.13/kWh. [MET]	Modeled levelized cost of power from large-scale concentrating solar power (CSP) plants in the range of $0.11-$0.13/kWh from completed R&D.	Modeled levelized cost of power from large-scale concentrating solar power (CSP) plants in the range of $0.10-$0.12/kWh from completed R&D.
Solar Heating and Cooling Systems					

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Developed conceptual designs of a low-cost polymer solar water heater capable of operation in freezing climates. [MET]	Achieve 5.0 cents per kilowatt-hour modeled cost of energy from solar water heater capable of operating in non-freezing climates. [MET]				
Contributed proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [MET]	Contributed proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($19,342K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent... Baseline and targets under development.

Means and Strategies

The Solar Program will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Solar Program will implement the program using the following means:

- Perform research, development, demonstration and deployment activities in partnership with coalitions of industry members, universities, National Laboratories and/or States to reduce costs;
- Increase photovoltaic module and system efficiency, system reliability, and manufacturing capability and efficiency;
- Select technology pathways for accelerated development of improved manufacturing methods, materials use, defect control and throughput;
- Increase the efficiency and reliability of CSP systems;
- Develop low-cost thermal storage for CSP systems;
- Perform research and development on advanced, building-integrated solar heating and cooling systems, such as hybrid solar electric/thermal systems;
- Coordinate with the Buildings Technologies Program on the integration of solar technology into zero energy homes;
- Conduct technology acceptance activities to identify and address market barriers to solar technology usage, and promote market expansion opportunities;
- Conduct technology analysis and systems driven analysis to help identify research priorities; and
- Develop lower cost production processes for cells and modules.

The Solar Program uses the following strategies:

- The SAI features "Technology Pathway Partnerships," public-private, industry-led partnerships to achieve SAI goals. These private sector teams match taxpayer dollars one for one. Key solar technologies which have the greatest potential for cost competitiveness in this accelerated time frame are selected for development. Based on a stage-gate evaluation process, only the technology pathways with the greatest potential for achieving the 2015 goal will be continued;
- Work with cost-shared partnerships consisting of industry members, universities, National Laboratories, States and/or other governmental entities to solve scientific and technical barriers necessary to improve performance and reliability, while reducing cost in PV technology pathways;
- Use cost-sharing arrangements with industry and other partners to leverage Federal resources;

- Work with States, industry, and other entities to leverage Federal taxpayer resources, communicate technology advances and opportunities effectively, reduce barriers, and accelerate market penetration of technology applications; and
- Work with the Office of Science, the Building Technologies Program (EERE) and the Federal Energy Management Program on solar R&D and deployment opportunities. This includes work with other agencies such as the Defense Advanced Research Projects Agency (DARPA), Bureau of Land Management (BLM), etc.

These strategies will significantly reduce the cost of solar technologies, which will improve energy security by increasing the amount, availability and diversity of the domestic energy supply.

The following external factors could affect the Solar Program's ability to achieve its strategic goal:

- material costs and availability (e.g., silicon supply, etc.);
- labor costs;
- currency exchange rates;
- the price and availability of alternative technologies and conventional fuels;
- international R&D and deployment efforts;
- financial incentives and other policies;
- interest rates and inflation;
- state and local regulation;
- market participant withdrawal or entry;
- build community infrastructure; and
- utility barriers and pricing strategies.

In carrying out the mission, the Solar Program performs the following collaborative activities:

- research, development, demonstration and deployment activities, as well as information sharing, with DOE programs and other governmental entities to improve coordination and collaboration across Departmental organizational boundaries;
- work with solar energy and other industry experts outside of the Department to:
- ensure that the Solar Program's research directions and priorities address the needs of manufacturers, utilities, state agencies, consumers, and other stakeholders;
- ensure that program activities are within the realm of technical feasibility and properly aligned with market forces;
- develop technology roadmaps and peer reviews, versions of which have been completed within the last two years for each of the primary solar subprograms;
- ensure that adequate Federal land is made available for solar power plants; and
- ensure that adequate transmission is allocated for solar projects.

Validation and Verification

To validate and verify program performance, the Solar Program will conduct internal and external reviews and audits. The table below summarizes validation and verification activities.

Data Sources:	Annual Energy Review 2006 (EIA); Renewable Energy Annual 2006 (EIA); Annual Energy Outlook 2007 (EIA); Zero Energy Homes Roadmap (2002); Peer Review of the U.S. Department of Energy's Solar Buildings Technology Research Program (2001); National Research Council, Renewable Power Pathways: A Review of the Department of Energy's Renewable Energy Programs (2000). National Research Council, Critique of the Sargent and Lundy Draft Assessment of Cost and Performance Forecasts for Concentrating Solar Power (2002); Sargent and Lundy, Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts (2003); Peer Review of the DOE Photovoltaic Program (2003); Our Solar Power Future: The U.S. Photovoltaic Industry Roadmap for 2005; Beyond (2004); and Potential Impact of Zero Energy Homes (2006).
Baselines:	The Solar Program's 2003 baselines for system production cost reduction goals are: $0.19 – $0.24/kWh for PV electric energy (See the Solar Program Multi-Year Technical Plan) and; $0.12 - $0.14/kWh for electricity from CSP technologies (See the CSP Technology Transition Plan 2004). Documents can be found at: www.eere.doe.gov/solar/about.html.
Frequency:	Annual.
Evaluation:	In carrying out the program's mission, the Solar Program uses several forms of evaluation to assess progress and to promote program improvement. ▪ Technology validation and operational field measurement; ▪ Implementation of a consistent methodology across the program for analyzing levelized cost of energy (LCOE); ▪ Critical peer review of both the program and subprogram portfolios and activities by independent outside experts; ▪ Annual internal Technical Program Review of the Solar Program; ▪ A Technical Review Team specific to the SAI; ▪ Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate; ▪ Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); PMA (the President's Management Agenda -- annual Departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly); and PART (common government wide program/OMB reviews of management and results); and ▪ Annual review of methods, and re-computation of potential benefits for the

Government Performance and Results Act (GPRA).

Data Storage: EIA and other organizations, such as National Laboratories (including the National Renewable Energy Laboratory (NREL), Sandia National Laboratories (Sandia), store data on computer servers.

Verification: Peer reviews; National Laboratory system and component test data; trade association reviews; National Laboratory survey of PV manufacturing cost/capacity data from U.S. industry; EIA survey of solar manufacturers; literature reviews.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to access the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The Solar Program has incorporated feedback from OMB into the FY 2009 Budget Request and has taken or will take necessary steps to continue to improve performance.

The 2003 PART rated the Solar Program "moderately effective" - the second highest rating category- with the following scores: purpose (80 percent), planning (80 percent), management (100 percent), results and accountability (58 percent). The 2003 PART review and score, and subsequent follow-up activities by the Solar Program, provided suggestions that resulted in refined long-term and annual measures incorporated in this FY 2009 Budget Request. The PART review also recognized that the Solar Program has implemented a new "systems driven" approach to help prioritize activities in its portfolio by analyzing present and potential markets, technology trade-off studies, and research and development reviews, and recognized that the program had developed a Multi-Year Technical Plan to guide its research efforts. In addition, the PART review also recognized that Congressionally Directed activities reduce the program funding available for competitive solicitations and core National Laboratory research designed to support program goals. The Solar Program is attempting to adhere to the specific direction of congressional appropriation earmark language while increasing the contribution to program goals to the maximum extent possible.

The program is developing and using peer reviewed cost models to assess the levelized cost of energy and the installed cost for various applications. These tools will be used for technology "down-selects" and stage gate decisions.

The Department has responded to the PART recommendation of "Develop guidance that specifies a consistent framework for analyzing the costs and benefits of research and development investments, and use this information to guide budget decisions." The Department continues to work on the development and implementation of common assumptions, a consistent approach to incorporation of risk, and other issues. EERE continues to refine the methods its uses in support of this framework and Departmental processes.

Expected Program Outcomes

The program pursues its mission through an integrated portfolio of research, development, demonstration and deployment activities that improve the Nation's energy security, energy efficiency and productivity of our economy while minimizing environmental impacts. We expect the energy efficiency and renewable energy components of these energy savings to result in lower energy bills and reduced susceptibility to energy price fluctuations; reduced cost of controlling regulated pollutants; enhanced energy security as petroleum and natural gas dependence is reduced and domestic fuel supplies increase; and greater energy security and reliability from improvements in energy infrastructure.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices and systems commodities, differ from the baseline case assumed for this analysis (essentially the EIA business as usual outlook for components of the economy affecting energy use). These inputs included modeling competing technologies. Possible changes in public policy and disruptions in the energy system which may affect estimated benefits were not modeled. The external factors such as unexpected changes in competing technology costs, identified in the Means and Strategies section could also affect EERE's ability to achieve its strategic goals as could persistent directed funding. Projections of future benefits depend on assumptions relating to how the economy will evolve over time and how rapidly energy efficient technologies will be developed and adopted among other variables. The estimated benefits were predicated on the assumptions included in EIA's Annual Energy Outlook 2007 Reference Case projections as well as Departmental guidance for the Climate Strategy analysis.

EIA also provides projections under alternative economic assumptions ranging from 2.4 to 3.5 percent annual growth between 2004 and 2030. Across this range, total energy consumption may grow by anywhere from 22 to 47 percent between 2004 and 2030. EIA also offers a range of technology assumptions. Across these cases total energy consumption may grow by anywhere from 45 percent between 2004 and 2030 if technology does not improve at all to 26 percent if technology improves rapidly. Changing assumptions on important variables such as these would likely affect the estimated benefits in this budget.

Benefits estimates used as inputs were based on modeling of some of the possible program production technologies. While uncertainties are larger for longer term estimates, they provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Estimated benefits assume that individual technology plans and market assumptions occur. A summary of the methods, assumptions, and models used in developing these benefit estimates are provided at http://www1.eere.energy.gov/ba/pba.

The program portfolio includes a mix of efforts intended to produce short-, mid-, and long-term benefits. The size of these benefits depends not only on the success of the EERE program efforts funded in this budget request, but on how future energy markets and policies evolve. EERE estimates a sub-set of these benefits assuming a continuation of current policies and business-as-usual development of energy markets. These estimates do not include the underlying, basecase improvements in energy efficiency and renewable energy use that could be expected in the absence of continued funding of EERE's programs.

The EERE portfolio focuses on the three benefits that align with DOE's strategic goals:

- Environmental benefits
- Economic benefits, and
- Benefits associated with security and reliability.

FY 2009 GPRA Benefits Estimates for Solar Energy Program[a]

Mid-Term Benefits[b,c]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	ns	0.06	0.35	1.07
Energy expenditure savings (Billion 2003$)	1	2	8	8
Carbon emission reductions (MMTCE)	0	1	8	29
Natural gas savings (Quads)	ns	0.05	0.09	ns
Program specific electric capacity additions (GW)	1	5	30	67

Long-Term Benefits[d]	2030	2040	2050
Primary nonrenewable energy savings (Quads)	1.65	3.15	5.22
Energy system net cost savings (Billion 2003$)	3	6	10
Carbon emission reductions (MMTCE)	40	65	111
Natural gas savings (Quads)	0.18	1.40	2.06
Program specific electric capacity additions (GW)	73	159	264

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the program's technical targets are achieved and funding continues at levels consistent with assumptions in the FY 2009 Budget.
[b] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2007 Reference Case.
[c] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits.
[d] Long-term benefits were estimated utilizing the GPRA09 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Photovoltaic Energy Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Photovoltaic Energy Systems			
Applied Research	29,110	36,861	35,590
Systems Development	89,810	64,210	64,267
Technology Evaluation & Integration	0	21,503	21,570
Technology Acceptance	19,452	14,170	13,860
SBIR/STTR	0	0	1,833
Total, Photovoltaic Energy Systems	138,372	136,744	137,120

Description

Photovoltaic (PV) technologies utilize semi-conducting materials that directly convert sunlight into electricity. Modular by nature with no moving parts, they can be sized to almost every need and placed almost anywhere sunlight is available.

The basic building block of a photovoltaic system is the solar cell that converts sunlight into electricity. Solar cells are connected together to form modules, and the modules can be further connected together to form arrays. The modules and/or arrays are used to power electrical appliances, such as security lighting or highway signs, or feed electricity directly into the grid via inverters such as a roof-top system on a home. R&D efforts are focused on improving performance and reliability of systems and reducing manufacturing and installation costs.

Consistent with EPACT of 2005, Section 931, the Photovoltaic Energy Systems subprogram focuses on the development of highly-reliable PV systems with user lifetime energy costs competitive with electricity from conventional resources. The PV subprogram attempts to achieve this goal by: 1) increasing the sunlight-to-electricity conversion efficiency (performance) of cells, modules and systems; 2) reducing the manufacturing cost of cells, modules, balance of plant components, and overall systems; 3) reducing the installation, interconnection and certification costs for residential, commercial and utility systems, and 4) increasing system operating lifetime and reliability.

Photovoltaics are not sold as individual solar cells; the fundamental commercial unit is the photovoltaic module. Module size is typically one square meter with a power output ranging from roughly 150-300 Watts (W) roughly 2-4 times the energy needed for the typical incandescent light bulb (but 8-16 times a typical compact fluorescent light bulb). The module comprises 50-60 percent of the cost of an installed PV system and presents a significant opportunity for cost savings. Current crystalline silicon power modules produced in the U.S. are approximately 13.8 percent efficient and produce electricity at 17 to 22 cents/kWh[a]. Crystalline silicon is the most mature technology and comprises greater than 90 percent

[a] Data from 2006. Lifetime system user cost over 30 years in areas with a wide range of favorable conditions. Costs could be greater in certain areas depending upon climate and financing available.

of the market. New technologies have the potential for lower costs include thin films and high performance multi-junction cells for use in concentrating collectors.

To more rapidly lower costs and improve performance, the PV subprogram is accelerating its R&D activities under the Solar America Initiative (SAI) to focus on technology pathways that have the highest potential to reach cost competitiveness by 2015. New industry-led partnerships, known as "Technology Pathway Partnerships" (TPPs) are being funded to address the technical issues associated with each pathway. Milestones and metrics are used in a stage-gate process to monitor progress and downselects.

The SAI strategy to reach the program's 2015 cost-competitiveness goal is to promote and compete the best technology options. Following a stage gate evaluation process significant funding will be expended only on those technology pathways that have the most potential and can produce tangible results. This strategy is aimed to maximize public funding benefits while increasing the chance of achieving program goals.

PV activities are coordinated with the Office of Science (SC), Office of Electricity Delivery and Energy Reliability (OE), the Building Technologies Program and the Federal Energy Management Program (FEMP). The Photovoltaic Subprogram is working with the SC to coordinate the Department's basic research activities that are crucial to addressing fundamental technical problems associated with current technologies, as well as new 3rd and 4th generation technologies such as polymers, organics and nano-technologies. This coordination is documented in the DOE Solar Energy National Solar Action Plan, September 2007. Likewise, closely coordinated planning and research with the Building Technologies Program's zero energy buildings activities will lead to PV products that are easily integrated in new and existing building designs. The Solar Program is working with FEMP to seek Federal deployment opportunities for PV systems. Coordinating this research with other Federal offices both ensures the most efficient use of resources and the best opportunity for the Department to achieve its goals.

For FY 2009, the PV subprogram's priorities are:

- Align R&D activities to concentrate on the most promising technology pathways and market acceptance activities.
- Produce R&D results and meet all technical milestones commensurate with the second full year of industry-led multi-year 50-50 cost-shared contracts under competitive solicitations to reduce costs. The TPPs and Technology Acceptance activities will include teams with industrial, university, National Laboratory, and/or state agency partners.
- Work closely with the SC and the Building Technologies Program on the scientific, technical, and strategic issues that limit PV performance and application. Improved understanding of the scientific underpinnings of PV materials and devices, deposition and fabrication processes, and the optimal methods for fitting PVs to buildings—ultimately providing a key component of the zero energy buildings—will help the Solar Program achieve its goals.

- Advance module and system manufacturing technologies to achieve higher performance and lower-cost products with faster throughput.
- Continue systems reliability research to increase the lifetime of thin-film modules and the mean time to failure of DC-to-AC current inverters for low-cost, grid-tied distributed PV systems.

Increasing module efficiency is a critical component to lowered system production costs (per Watt) and successful entry of PV systems into energy markets. Although a main focus of SAI is on reducing system costs and improving manufacturing processes through industry-led consortia, module efficiency levels remain an important component of lowering the cost of energy from PV systems.

U.S.-Produced PV Module Efficiency Targets and Actuals

(Conversion Efficiency (%))

	Historic				Planned					
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Efficiency										
Target	12.5	13.0	13.5	13.8	14.5	15.5	16.0	16.5	17.0	20.0
Actual	12.5	13.0	13.5	13.8	-	-	-	-	-	-

The Solar Program uses the following PV module manufacturing cost data and projections presented below as helpful indicators of progress toward achieving program benefits:

Historic and Projected Solar Energy Costs

	Historic				Planned					
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Manufacturing Cost PV Modules ($/Watt)										
Target	2.10	1.95	1.95[a]	1.90	1.80[b]	1.70	1.60	1.50	1.40	1.00
Actual[c]	2.10	1.95	1.92	1.90	1.80	-	-	-	-	-

[a] PV cost targets were adjusted for 2005 and outward due to verification processes. No technical targets were changed but the target verification process caused the stated targets to slip one year due to availability of market data.
[b] Outyear cost targets have been modified based on recent increases in material costs (e.g., silicon).
[c] "Actual" cost data represents the lowest costs reported by a major U.S. module manufacturer during an annual manufacturing survey.

	Historic				Planned					
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Cost of Power from PV Modules ($/kWh) [a]										
Target	0.19-0.24	0.18-0.23	0.18-0.23	0.17-0.23	0.16-0.27	0.14-0.23	0.12-0.20	0.10-0.18	0.09-0.16	0.05-0.10
Actual	0.19-0.24	0.18-0.23	0.18-0.23	0.17-0.23	0.16-0.23	-	-	-	-	-

To implement the budget and performance integration portion of the President's Management Agenda, the Solar Program participated in the Administration's R&D Investment Criteria (R&DIC) evaluation process, the OMB Program Assessment Rating Tool (PART) process, and an internal multi-year program planning (MYP) process. These exercises guided program budget planning, management decisions, and performance goals and targets.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Applied Research	**29,110**	**36,861**	**35,590**

Applied Research is essential to the advancement of photovoltaic technology to meet the Solar Program's goal of making solar electricity cost-competitive by 2015. The activity's main emphasis is on cross-cutting research focused on semiconductor material, device and processing issues that benefit multiple companies and/or technologies. Applied Research supports the SAI through laboratory and university research that addresses the needs of the industry-led partnerships. Key to this support are the research activities in the Process Development Integration Laboratory (PDIL) within the Science and Technology Facility (S&TF) at NREL. The research conducted in these laboratories is designed to shorten the time lag between laboratory bench results and the introduction of commercial product. In the PDIL, laboratory researchers work side-by-side with industry researchers to improve larger-scale processing of thin films and crystalline silicon. The Solar Program is also working with the SC to help coordinate and accomplish SC's basic and EERE's applied solar research needs.

[a] Cost of power is expressed in ranges due to the diversity of PV module applications. The low end of costs reflect commercial applications under good conditions, such as advantageous financing terms and sunny locations, while the higher end of the range is more common in residential applications. Costs could be impacted by changing key factors, such as interest rates, labor costs, raw material costs, Federal, State and local incentives, global deployment efforts, and geography of installation. The Solar Program has a better sample of data across U.S. installations and has used it to calibrate our cost analysis tool. This has resulted in higher cost estimates for residential PV installations.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

In the Applied Research area there are three main research areas in FY 2009: Electronic Materials, and Devices, Measurements and Characterization, and University and Exploratory Research.

Electronic Materials and Devices (EMD) is a core laboratory research activity that is cross-cutting and supportive of all technologies. EMD carries out research in semiconductor materials, device properties, and fabrication processes to improve the efficiency, stability, and cost of photovoltaic solar energy conversion. This research supports technology in near, mid- and long-term time frames. EMD includes collaborative assistance to industry in solving current problems, exploration of specific techniques and processes to develop improvements that industry needs, and creating new, next-generation technologies with lower costs to open larger markets for PV. Most of these research activities will be conducted in the Science and Technology Facility S&TF in support of the TPPs.

Measurements and Characterization provides test, measurement, and analysis support and research for all PV material technologies, and involves collaborations with internal research groups, external research partners in university and industry laboratories, and PV manufacturers. The activities encompass three critical areas essential to continued understanding and improvement of photovoltaic materials, devices and device/module reliability, including: i) measurement and characterization support; ii) collaborative research with program partners, and iii) diagnostic development and technology transfer. This project assists stakeholders through the test and analysis of thousands of materials and device samples annually, helping them to understand and direct work on their research and commercial product development.

University and Exploratory Research includes work on cutting-edge next generation R&D, which currently includes technologies such as plasmonics, organic cells, and multiple exiton generation (MEG). The core activity is the Future Generation PV R&D work begun in FY 2008 through a competitive solicitation that resulted in awards to universities and industry members. R&D on non-traditional PV technologies is essential to ensure innovation and support the development and expansion of advanced PV options. This work helps bridge the gap between basic science and technology development.

Systems Development	**89,810**	**64,210**	**64,267**

The Systems Development activity works primarily through cost-shared contracts with industry to advance the development of PV systems and components. This activity has three primary projects, the TPPs, the PV Incubator Project, and University Process and Product Development.

The industry-led TPPs are executing projects segmented into three manageable three-year phases, with new funding opportunities released at the completion of each phase – for both continuing industry-led teams and new applicants. These phases will progressively reduce the cost of commercially-available PV systems and components, and will ultimately yield commercial products and production processes that achieve the SAI cost and capacity targets for 2015.

Funding for R&D projects during the first of these phases was offered through a Funding Opportunity Announcement (FOA) that was issued in FY 2007. In FY 2009, the second year of the first phase, the partnerships will focus on development, testing, demonstration, validation, and interconnection of

new PV components, systems, and manufacturing equipment. Results in FY 2009 will help inform the issuance of a FOA for second phase projects planned for FY 2010.
In phase one, TPPs are developing new PV solutions for the residential, commercial, and utility market sectors of grid-tied electric power. These are described as follows:

- Residential Rooftop Market: Typically mounted on rooftops and range in size from under 1kW to 10kW, most commonly in the 3 – 4 kW range. These systems are connected to the grid on the retail (customer) side of the utility meter. These systems can be retrofitted onto existing homes or integrated into new construction through building-integrated PV (BIPV) designs.
- Commercial Rooftop Market: Typically mounted on the large flat roofs of commercial, institutional, and industrial buildings, ranging in size from less than 10kW to 500kW and connected on the retail side of the utility meter. Retrofits and BIPV are possible applications in this market as well.
- Utility Market: Large-scale (multi-megawatt) systems that displace conventional utility generated intermediate load electricity (e.g. natural gas CCT plants) on a wholesale basis. Typical utility PV systems are ground-mounted and range in size from 1MW to10MW, although much larger systems are possible. Designs include both fixed and tracking configurations.

The TPPs are developing systems which have the greatest potential for cost-competitiveness by 2015. Examples of promising PV technologies include crystalline silicon modules and systems and thin film modules and systems. SAI partnerships are also developing and testing balance-of-system component designs that address emerging requirements for modularity, interface standardization, reliability, and decreased installation cost.

The PV Incubator project launched in FY 2008 has enabled start-up PV companies to work with the national laboratories to make module prototypes and pilot manufacturing processes. During FY 2009, performers will continue joint research with the laboratories in order to deliver new module prototypes and demonstrate pilot production by 2010. This will reduce risk in capital investments for manufacturing capacity expansion and allowing private capital markets to fund the build-out of manufacturing capacity based on these projects starting in 2011.

The University Process and Product Development Project was initiated in FY 2008 to recognize the essential expertise that universities hold and so create competitively awarded university-led process and product development projects in support of the SAI. Universities hold a fundamental understanding of materials and device physics, as well as experience with laboratory-scale processes and prototype production. This experience uniquely positions universities to leverage their knowledge in assisting the transition of PV technology from laboratory to marketplace and to offer guidance to industry on how to move forward efficiently. Additionally, market-oriented research offers students exposure to the growing PV-related commercialization efforts and supplies industry with a stream of qualified scientists. These projects will develop market applicable technologies directly related to the goals of the SAI. Within this activity, funding is also included to recapitalize (i.e. replaces existing equipment essential for ongoing R&D that is at or near lifetime end) at the Solar

Energy Research Facility (SERF) and completes post-construction outfitting of the new Science and Technology Facility S&TF.

Technology Evaluation & Integration	**0**	**21,503**	**21,570**

Technology Evaluation & Integration (TEI) activities focus on evaluation of technical advances throughout the Solar Program using independent testing and analysis, including the evaluation of ongoing system-level progress of the TPPs. TEI activities also include the development of models that predict system performance and cost based on industry data, and data taken from systems operating throughout the country. Also included are detailed analysis of industry's technology, manufacturing capability, and business plans. Many of these technical evaluation activities will be used to conduct the necessary stage-gate reviews and periodic downselects critical to the success of the SAI. TEI also features activities that promote the integration of solar systems into end use locations and the electricity grid.

TEI contains four primary activities: Systems Analysis, Systems Test and Evaluation, Component Test and Evaluation and Solar Integration. In FY 2009, solicitations will be issued for new systems testing hardware; module accelerated aging test standards development; and CSP and PV systems analysis software, which fall within several of the below activities.

System Analysis activities will continue benchmarking, modeling and analysis for the systems driven approach. Also included are market, value and policy analysis necessary to support the SAI.

Systems Test and Evaluation activities will focus on the critical need to test and evaluate all the deliverables developed under the TPPs. The information will be used to determine if the Partnerships are meeting their milestones and goals on time. This independent testing activity will provide the data necessary to conduct stage-gate reviews and periodic downselects as the SAI proceeds through its series of competitive phases. The Reliability R&D activity also includes laboratory R&D to help reduce the cost of installed systems and improve their reliability. The laboratory R&D emphasizes four technical objectives: 1) reducing life-cycle costs; 2) improving reliability of systems; 3) increasing and assuring the performance of fielded systems; and 4) removing barriers to the use of the technology.

In FY 2009, performance evaluation of thin-film systems will continue to be conducted in the field by the Regional Experiment Stations (RESs) to compare against benchmark data in both hot, humid climates representative of the southeastern U.S. and hot, dry climates representative of the southwestern U.S. Accelerated lifetime testing in the laboratory will be conducted in parallel of the field testing. Any failures found in the field or in the laboratory will be analyzed to determine the degradation mechanisms. Work at the RESs will also continue to improve the reliability of distributed grid-tied systems, especially in the buildings sector.

Under the Component, Test and Evaluation activity, researchers work in partnership with universities, industry and the National Laboratories to improve the efficiency of cell materials and devices by investigating their fundamental properties and operating mechanisms. This teamed research approach identifies efficiency-limiting defects in cell materials and analyzes their electrical and optical properties. In FY 2009, the Component Test and Evaluation activity will focus its efforts on supporting the new TPPs. Researchers will work with the partnerships to improve the understanding of materials, impurities and defects and their impact on device performance and reliability.

Also included in Component Test and Evaluation is Module Packaging where researchers work to solve reliability issues such as degradation mechanisms and intrinsic instabilities of pre-commercial thin film modules, and to improve packaging for 30-year outdoor lifetime. Inverter and Balance of System (BOS) development focuses on the critical need to improve the reliability of the inverter and other BOS components. Emphasis is placed on reducing life-cycle costs by increasing mean-time-between-failure (MTBF) of inverters and battery charge controllers, by developing higher performance technologies through advanced solutions to thermal management and surge protection, and by optimizing designs to achieve “plug and play” ability. In FY 2009 the second year of Advanced Inverters and Energy Management 3-year contracts with industry will be continued to design, test and produce advanced inverters and energy management systems with improved reliability, enhanced value and reduced cost. In addition, necessary analysis and communication activities will be conducted to help ensure performance measures and goals are attained.

The Solar Integration activity is a new effort to be initiated in 2009. This activity will include R&D on control systems to manage the grid interactions of distributed installations in residential communities, commercial office/retail parks and electric distribution systems. In addition, R&D will be conducted to help advance low-cost storage technologies for distributed renewable installations, primarily, distributed PV. Field testing of distributed energy storage and controls working synergistically with building-based PV installations and other onsite renewable systems will be initiated, with the goal of assessing the actual value to the utility and customer through data gathered from utility and customer accounting systems. A lab-based testbed will be developed and operated to conduct evaluations of new distributed PV technologies under various grid system designs and architectures that can not be readily tested in the field. The Solar Program will work closely with the Building Technologies Program to maximize the impact of this work to both programs. This effort does not duplicate grid integration work being done by the OE. The Solar Program will regularly review activities with OE to ensure adequate coordination and minimize the risk of duplication.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Technology Acceptance	**19,452**	**14,170**	**13,860**

All of the work under Technology Acceptance is focused on achieving solar energy technology cost competitiveness by minimizing market barriers to solar commercialization and promoting opportunities for solar technology market penetration.

The first area of work involves codes and standards. The Solar Program will continue to fund the Solar America Board of Codes and Standards ("Solar ABCs" formerly called Solar Codes and Standards Working Group) and the State and Regional Code Proceedings Team each in the third year of funding. Areas of work include providing assistance on interconnection standards, building codes and net metering regulations; and developing and promoting national module performance rating systems. DOE will work closely with many stakeholders in this area, including state and local governments, the solar manufacturing community, non-profits, and others.

Secondly, the program will continue to fund activities supporting the training and certification of solar installers and code officials, and working to create a sufficiently large and qualified workforce that can install PV systems in sufficient quantities to meet the goals of the SAI. FY 2009 efforts include the buildout of the workforce development and education and training effort launched in FY 2008.

In the third area, technical partnerships and demonstrations, the program focuses on providing technical assistance (but not hardware purchases) to large-scale, high-visibility installations, such as new building communities, big box retailer installations, and utility-scale solar. Two activities entering their second will be the Solar America Cities activity and Solar America Showcases. Both activities involve partnerships between DOE and stakeholders to leverage the advanced solar efforts occurring throughout the U.S. on a local level. The Solar America Cities activity features assistance to U.S. cities that have committed to solar, while the Solar America Showcases effort provides technical assistance to companies, States, and other entities for large-scale, high-visibility solar projects. FY 2009 funds will be used to support previously selected Solar America Cities under multi-year awards some selected during the FY 2007 for whom work commenced in FY 2008, and the others selected during FY 2008 for whom work commences in FY 2009. Cities will be encouraged to share best practices through the use of interactive tools and discussion opportunities funded by DOE. In addition, in response to EPACT Sec 931, funding will support a Government Solar Installation Program that will employ third-party financing to capitalize more than 3 gigawatts (GW) of solar installations on Federal sites by 2012. Through these funds, the Solar Program will work with FEMP to provide administrative services to Federal agencies that will enter into power purchase agreements with private third-party project developers, based on a standard offer contract such as that developed by DOE.

The fourth area of Technology Acceptance features technical outreach and communications activities. Efforts include the Technical Outreach activities to States, cities, builders, and utilities. The purpose of these activities is to provide technical information on solar technologies and related topics (interconnection) to target audiences as needed.

In FY 2009, the Solar Decathlon activity has been shifted to the Building Technologies Program

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

because this activity is more aligned with the mission of the Zero Energy Buildings effort within that program.

SBIR/STTR	**0**	**0**	**1,833**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Photovoltaic Energy Systems	**138,372**	**136,744**	**137,120**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Applied Research	
This decrease reflects an anticipated 10% decrease in Future Generation PV R&D requirements due to planned down-selects among several industry and/or university contracts.	-1,271
Systems Development	
No significant changes.	+57
Technology Evaluation	
No significant changes.	+67
Technology Acceptance	
The funding decrease reflects two offsetting changes: an increase in funding for the Government Solar Installation Program (GSIP) and the transfer of the Solar Decathlon activity to the Buildings Program ($3.4 million). The GSIP Program is being established in response to EPACT Sec 931, and will employ third-party financing to capitalize more than 3 GW of solar installations on Federal sites by 2012. Through these funds, the Solar Program will work with FEMP to provide administrative services to Federal agencies that will enter into power purchase agreements with private third-party project developers, based on a standard offer contract such as one developed by DOE.	-310
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of	+1,833

	FY 2009 vs. FY 2008 ($000)
program activities.	
Total Funding Change, Photovoltaic Energy Systems	**+376**

Concentrating Solar Power

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Concentrating Solar Power	15,696	26,929	18,733
SBIR/STTR	0	2,798	267
Total, Concentrating Solar Power	15,696	29,727	19,000

Description

Consistent with Sections 931 and 934, EPACT of 2005, the Solar Program will develop concentrating solar technologies that address market barriers for generating electricity and fuels. Concentrating solar power (CSP) systems utilize the heat generated by concentrating and absorbing the sun's energy to produce electric power. The concentrated sunlight produces thermal energy to run heat engines or steam turbines for generating power. These plants can also store the sun's energy so it can be used when the sun is not shining, enabling it to displace significant quantities of carbon dioxide. Although CSP plants can be configured in all sizes, they are most cost effective when they produce greater than 100 MW. Their size plus economical energy storage make CSP systems strong candidates for centralized power applications by utilities.

The Solar Program is working with industry on the development of CSP technology, which in the years leading up to FY 2008 included work on only troughs and dish-engine systems. In FY 2008, the subprogram also began looking at some new concepts developed by industry (e.g. linear Fresnel, distributed power tower) which may play a more prominent role in FY 2009 and beyond. In addition to working with industry, the Solar Program is working with key stakeholders (e.g., Southwestern States, utilities, and the Western Governors' Association) to inform them of the potential economic, environmental, and energy benefits of CSP. These activities have led to better performing technology and helped foster an increased interest in the technology. This interest is illustrated in the planning of a 1 MW dish system in California and the completion of a 1 MW trough plant in Arizona in 2006, as well as a 64 MW trough plant completed in Nevada in 2007. All three were funded with private sector investments. These projects have been followed by CSP industry responses to solicitations for renewable energy from most of the major utilities in the southwest. Several projects have been initiated in California that, if built, could become the largest solar power plants in the world.

The program's goal for CSP is for it to be competitive in the intermediate power market by 2015 and in the baseload power market by 2020. Unlike baseload power generators, which are designed to operate on a nearly continuous basis and supply most of a utility's electricity, intermediate power generators supply some of electricity some of the time. Intermediate power generation is either somewhat less efficient, uses more expensive fuels than baseload generators, or is not able to operate nearly 24 hours per day. As such, its cost is about 5-7¢/kWh whereas baseload power is about 3-5¢/kWh. Solar power plants without storage can operate only about 25 percent of the time. This puts them in the market with other technologies providing intermediate power. By providing intermediate power, CSP would augment a U.S. power market that now receives nearly 70 percent of its energy from coal and natural gas.

The CSP subprogram contributes to the overall program goal by developing energy supply technologies that are reliable, affordable, and environmentally sound. Expanding the national electricity generation fuel portfolio will increase energy security by diversifying domestic energy supply options for use both in normal and emergency situations. In addition, CSP plants can be placed so as to relieve transmission congestion problems in the West.

The subprogram has benefited from several rigorous technology reviews which have established CSP as one of the most attractive renewable energy options in the U.S. Southwest, with a cost target of 9-11¢/kWh by 2012 and the possibility of eventually achieving 3.5-6.2¢/kWh.[a] Utilities have indicated CSP will become a serious option for them when its cost is below 10¢/kWh.

The CSP performance metric focuses on system efficiency, which is defined as the annual solar-to-electricity conversion efficiency of the entire CSP system. This measure reflects the technical progress in certain activities funded by the Solar Program, allows for simple verification and validation of results, and minimizes the potential for target achievement disruption or overstatement caused by market factors beyond the program's control.[b] Of equal importance to the public is the cost of energy, as the cost of energy is seen in the consumers' bills and the producers' cost in a competitive market. Therefore, the program uses cost as its metric for accountability in the PART process.

Similar to the relationship between conversion efficiency of PV modules and PV electricity cost, CSP system efficiency correlates strongly with the cost of CSP produced electricity. As with PV efficiency measures, CSP system efficiency measures are by no means the exclusive factor affecting cost, but provide a valuable method of tracking technical progress. The Solar Program will continue to track cost data, as cost measures are significant indicators of market trends and assist the program in responding to a changing marketplace. Therefore, the program is using a combination of targets for its work that emphasizes technical accomplishments, but maintains a strong connection to modeled, or projected, cost of energy from CSP.

U.S.-Produced Parabolic Trough System Efficiency Targets and Actuals

	Historic				Planned					
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Annual Solar-to-Electric Conversion Efficiency (%)										
Target	n/a	n/a	n/a	11.9	13.1	14.0	14.1	14.2	14.4	14.6
Actual	11.1	11.9	11.9	11.9	14.0	-	-	-	-	-

[a] R. Charles, et al., "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts," Sargent & Lundy Consulting Group, SL-5641, May 2003.
[b] Market factors outside the program's control that could affect the achievement of cost goals include, but are not limited to, raw material costs, labor costs, currency exchange rates, interest rates, inflation, foreign competition, state and local regulations, and market participant withdrawals or entries.

The Solar Program uses the below historical cost data and projections as indicators of progress toward achieving program benefits.

CSP Solar Energy Cost Targets and Actuals[a]

	Historic				Planned					
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Levelized Electricity Cost from CSP										
Target	0.12-0.14	0.12-0.14	0.12-0.14	0.12-0.14	0.11-0.13	0.11-0.13	0.10-0.12	0.10-0.12	0.10-0.12	0.09-0.11
Actual	0.12-0.14	0.12-0.14	0.12-0.14	0.12-0.14	0.12-0.15-	-	-	-	-	-

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Concentrating Solar Power	**15,696**	**26,929**	**18,733**

One focus of the CSP subprogram is to achieve the cost competiveness of intermediate power by 2015. A solicitation issued in FY 2007 resulted in 12 industry contract awards focused on establishing a U.S. manufacturing capability of low cost trough components and the technical feasibility of low cost thermal storage. In FY 2008, the Solar Program funded Phase I of these contracts. In FY 2009, the more promising contracts will move into Phase II...

The Solar Program will also work with various entities that can help CSP gain market penetration:

- **State Governments** – provide CSP information (e.g. impact of state incentives on cost of power, job impact of CSP projects, resource assessment)
- **Utilities** – assist in technical evaluation of proposals, provide resource assessment
- **Western Governors' Association** – assist in the WGA's Clean and Diversified Energy Initiative as well as other regional renewable activities (e.g. transmission, renewable energy credits)
- **Bureau of Land Management/Department of Defense** – assist in technical evaluation of CSP applications for projects on Federal lands, assist in evaluating the environmental impact of CSP plants on Federal land set aside for CSP projects. The Federal Government owns large tracts of land in the West that are suitable for CSP power plants (e.g. land that has intense solar insolation and is flat).
- **DOE Office of Electricity** – the lack of access to electrical transmission will be a major inhibitor to the increased use of CSP. The program will provide resource information and analyses that

[a] In this table, years indicate the years in which field verification of modeled cost occurs.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

recommend optimum routes for new transmission lines that enable CSP power to be moved from arid areas of the Southwest to major population centers throughout the western U.S.

- **Project Developers** – develop a better method of accurately predicting the solar resource from satellite data, establishing a standard system of collecting data at specific sites, and disseminating resource information to project developers.
- **Stakeholders -** CSP information will be provided to other stakeholders as opportunities arise.

The CSP subprogram will also continue R&D efforts in the areas of dish/engine technology and parabolic troughs, new R&D efforts in the areas of linear Fresnel technology and distributed power towers will be initiated. Dish/engine R&D will provide technical assistance to industry in developing its 1 MW project in California. Efforts will focus on engineering solutions to reliability issues related to the Stirling engine (e.g., valves, seals and controls) while gaining valuable experience on the operation of multiple dishes in a power plant configuration. Researchers will also work with industry to improve the manufacturability of dish systems in preparation for upcoming projects. Parabolic trough R&D will continue to improve efficiency and effectiveness of trough components, such as thermal receivers and solar collector.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**2,798**	**267**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Concentrating Solar Power	**15,696**	**29,727**	**19,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Concentrating Solar Power This decrease in funding reflects the anticipated down-selection of CSP industry contracts in the second full year of the CSP storage and trough component solicitation.	-8,196

	FY 2009 vs. FY 2008 ($000)
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-2,531
Total Funding Change, Concentrating Solar Power	**-10,727**

Solar Heating and Cooling Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Solar Heating and Cooling Systems	2,960	1,954	0
SBIR/STTR	0	28	0
Total, Solar Heating and Cooling Systems	2,960	1,982	0

Description

Consistent with Section 931, EPACT of 2005, DOE develops solar hot water and space heating/cooling technologies. This activity has been managed by the Solar Technologies Program, but with increasing collaboration with the Buildings Technologies Program during the last two years. The collaboration is focused on developing a zero energy home whose cost is within the means of most Americans. To accomplish this in the most efficient manner possible, all aspects of a home (e.g. walls, windows, insolation, HVAC, PV, solar water heating, solar space heating/cooling) have to be designed and analyzed as a whole system. Beginning in FY 2009, the Solar Program will transfer the activity to the Building Technologies Program. The Solar Program will continue to promote the Solar Heating and Cooling technologies along with the growing suite of market-ready solar technologies as part of its market transformation efforts will provide technical assistance to the Building Technologies Program as needed. PV R&D related to buildings will also remain solely the responsibility of the Solar Program.

The objectives of this activity are to develop solar technology that can provide the thermal energy needed for a zero energy building and to coordinate with the Buildings Technologies Program the integration of solar technologies (thermal and electric) into a zero energy home. Benefits specific to this activity would be associated with energy savings due to solar technology that provides water heating, space cooling, and space heating.

The SHC subprogram contributes to the overall Solar Program goal by developing energy supply technologies that are reliable, affordable, and environmentally sound. Using solar energy to provide heat increases our national security by reducing our reliance on imported fossil fuel, diversifying our energy portfolio for both normal and emergency situations, and alleviating pressure on both the natural gas supply and the aging electricity grid.

The market for solar water heaters is booming in countries such as China, Israel, Germany, and Austria. In China for example, solar water heaters contribute nearly 20 percent of the water heating market and has been growing by 27 percent per year. In Austria solar water heaters contribute nearly 14 percent of the water heating market. In Germany, it’s 4 percent and the market growth throughout Europe is 14 percent per year. In the United States, on the other hand, solar water heaters contribute less than 0.1 percent of the water heating market even with the solar tax credit established by EPACT 2005. Water heaters are the second largest consumer of energy in a home behind space heating. Each solar water heater produces as much energy as is used by the family car. There are thus considerable energy and environmental benefits to be accrued by their wider use. In order to increase the solar water heating market, the Solar Program will continue to provide technical information to States, cities, and Federal agencies showing them the benefits of solar water heaters. This will include States such as California which has an aggressive program promoting the technology.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Solar Heating and Cooling Systems	**2,960**	**1,954**	**0**

The Solar Heating and Cooling Systems subprogram expects to complete the development of hybrid solar lighting and solar water heating for nonfreezing locations by the end of FY 2008. Those technologies were sufficiently developed to enable their transfer to industry for commercialization. The conclusion of these activities facilitates the transition to the Building Technologies Program in FY 2009.

SBIR/STTR	**0**	**28**	**0**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Solar Heating and Cooling Systems	**2,960**	**1,982**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Solar Heating and Cooling Systems	
Decrease represents planed completion of all solar water heating for non-freezing climates and hybrid solar lighting tasks by the end of FY 2008. In FY 2009, the Solar Heating and Cooling Systems will be closed out within the Solar Program and transferred with new tasks focusing on zero energy buildings within Building Technologies.	-1,954
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-28
Total Funding Change, Solar Heating and Cooling Systems	**-1,982**

Wind Energy

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation[a]	FY 2008 Original Appropriation	FY 2008 Adjustments[b]	FY 2008 Current Appropriation	FY 2009 Request
Wind Energy					
Technology Viability	30,589	27,200	-248	26,952	31,000
Technology Application	18,070	22,800	-207	22,593	21,500
Total, Wind Energy	48,659	50,000	-455	49,545	52,500

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act (EPCA)" (1975)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)
P.L. 102-486, "Energy Policy Act (EPACT)" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Wind Energy Program is to lead the Nation's research, development, and deployment efforts to improve wind energy generation technology, enhance domestic economic benefit from development, and to address barriers to the use of wind energy in coordination with stakeholders, resulting in greater energy security and a cleaner and more diversified electricity supply.

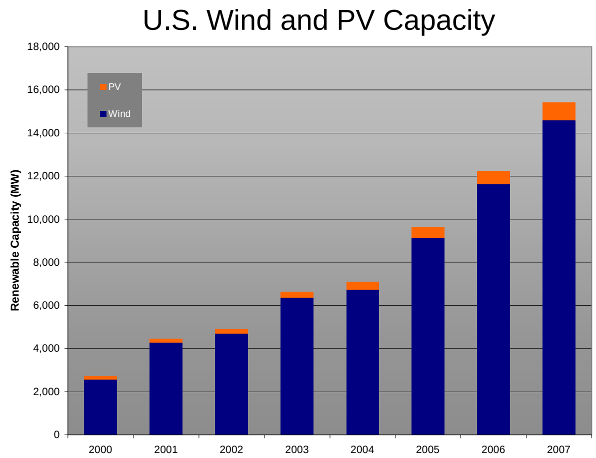
Accomplishing the mission will benefit the supply side of the Department's energy security equation accelerating the arrival and use of the new fuels and technologies that we need.

The Wind Energy Program's mission and activities contribute directly to EERE's and DOE's mission of improving national, energy and economic security and address the call set forth by the President's National Energy Policy, the Advanced Energy Initiative and the Energy Policy Act of 2005 for increasing the diversity of our Nation's energy resources.

The program is concentrating on improving cost, performance and reliability of large scale land-based technology; facilitating wind energy's rapid market expansion by anticipating and addressing potential barriers to integrating wind into the electric transmission system; siting, permitting, environmental issues; and investigating wind energy's application to other areas -- from offshore wind technology to distributed and community-owned wind projects. New opportunities will be explored in water treatment, transport and hydrogen production applications to help contribute to transportation fuel supplies.

[a] Excludes amounts transferred to the Science appropriation for carrying out SBIR / STTR. All subsequent tables in this program also reflect this transfer.
[b] Reflects amounts rescinded by General Provision, Section 312, of the Omnibus Appropriations Act, 2008.

Since 2000, wind energy has demonstrated significant expansion and promise as an affordable energy supply, increasing from about 2.5 GW to about 15 GW by the end of 2007. Dramatic growth has occurred on an annual percentage basis. The Wind Program is helping to facilitate wind's rapid rise by addressing key market, institutional and technology areas of concern. This will result in increasing and diversifying the domestic energy supply, offering the United States a clean, domestic technology that will help mitigate greenhouse gas emissions on a large scale, while strengthening the Nation's infrastructure posture by reducing economic effects of fuel price or supply disruptions through increased system reliability. In addition, expanding the affordability and applications for wind offers an increasingly attractive investment for addressing growth in electricity demand and significant economic development potential, in particular for rural areas.



Today, grid-connected wind energy systems are well established. Demand for these systems is growing in some parts of the world. Markets are growing for small, high-value or remote applications of wind energy. Achieving the Department's climate strategic goals is dependent upon the budgets and accelerated use of the proposed technology pathways to enable these possible near-, mid-, and long-term scenarios for wind energy as follows:

- In the near term, as interconnection issues are resolved, the number of grid-connected renewable systems could increase quite rapidly, meeting local energy needs such as uninterruptible power, community power, or peak shaving. Wind energy may expand most rapidly among grid-connected applications. The use of utility-scale wind technology is likely to continue to expand on land and is targeted to become competitive in select offshore locations between 5 and 50 nautical miles from shore and in water depths 30 meters or less. Small wind turbines are on the verge of operating cost-effectively in most of the rural areas of the United States, and more than 15 million homes have the potential to generate electricity with small wind turbines. With a further maturing of the market, costs will be lowered to compete directly with retail rates for homeowners, farmers, small businesses, and community-based projects.
- In the midterm, offshore wind energy could begin to expand significantly. Technology development may focus on turbine-support structures suitable for deeper water depths, and reducing turbine system and balance of plant costs to offset increased distance from shore, decreased accessibility, and more stringent environmental conditions. Land-based use of wind turbines is also likely to expand for large and small turbines as the costs for these systems continue to decrease. Small turbines may be used to harness wind to provide pumping for farm irrigation -- helping to alleviate water-availability problems -- and provide a viable source of clean and renewable hydrogen production.
- In the long term, wind energy could be the lowest-cost option for electricity generation in favorable wind areas for grid power, and offshore systems could become prevalent in many countries by achieving a commercially viable cost by using floating platforms technologies.

The Wind Energy Program budget could directly contribute nearly 0.4 gigatons of carbon (GtC) mitigation by 2030, and as much as five gigatons by 2050. Consumer and power industry savings in 2030 could be over $35 billion and nearly $150 million by mid century. The program's economic, environmental and security benefits that are quantified as expected program outcomes are described in more detail under the "Expected Program Outcomes" sections.

Program Deliverables and Interdependencies

- Increasing the viability of wind energy – developing new cost-effective technology and increasing the operability and reliability of all large wind technology; developing cost-effective distributed, small-scale wind technology; and performing research that supports these technology viability activities.
- Increasing the application of wind energy – helping facilitate the installation of wind systems by supporting research and outreach in power grid integration, transmission, technology acceptance, systems engineering, and analytical support.
- Expand deployment outreach to officials, markets and the public through multi-sector training programs to overcome real and perceived barriers to wind energy use in the United States.
- Develop distributed and community wind technologies to expand market size.
- Increase R&D in large turbine technology to more quickly enable development of the next generation turbine and transitional offshore technologies to achieve much larger penetrations of wind energy use.
- Provide expanded systems integration knowledge and electrical system technical outreach.
- Support resource assessment and analytical capabilities to remove integration barriers.

Keeping wind energy cost competitive through focus on four areas:

- Expanding the Nation's transmission infrastructure without placing the full burden of this expansion on wind project developers.
- Reducing the generator cost of energy from high wind resource sites through operation, reliability and performance enhancement to pay higher transmission costs for delivery.
- Furthering the development of distributed wind technologies to allow communities, rural businesses, and residents to take advantage of local wind resources.
- Making lower wind resource locations or offshore sites cost-competitive to circumvent the need for expanded transmission.

Interdependencies include:

- outputs from academia, manufacturers, developers, and National Laboratories (e.g., the Offshore Wind Collaborative, a joint Federal/state/industry/academia collaboration to address barriers to U.S. offshore wind development);
- American Wind Energy Association (AWEA), DOE and NREL Wind Plan;
- utility industry transmission and distribution interconnection policy and R&D issues;
- Office of Electricity Delivery and Energy Reliability (OE) on transmission-related issues;
- Federal, state, and regional oversight bodies on policies concerning wind energy interconnection;

- Federal Aviation Administration (FAA) and the Department of Defense on radar and other military issues affected by wind turbines;
- Interior's Minerals Management Service on regulations for offshore wind energy;
- industry and R&D directions for the production of hydrogen for energy use, and for other non-energy uses; and
- cooperative research and development with the International Energy Agency (IEA).

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Wind Energy Program supports the following goal:

Strategic Theme 1, Energy Security

Strategic Goal 1.1, Energy Diversity: Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs.

And concurrently supports:

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Goal 1.3, Energy Infrastructure: Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

The Wind Energy Program has one GPRA Unit Program goal which contributes to Strategic Goals 1.1, 1.2, and 1.3 in the "goal cascade":

GPRA Unit Program Goal 1.1.04.00: Wind Energy - The goal of the Wind Program is to enable wind to compete with conventional fuel throughout the Nation, creating a clean renewable energy option. The Department accomplishes this through technology research and development, collaborative efforts, technical support and outreach to overcome barriers in energy cost, energy market and infrastructure rules and energy sector acceptance.

Contribution to GPRA Unit Program Goal 1.1.04.00 (Wind Energy)

The Wind Energy Program's key contribution to Strategic Theme 1, Energy Security, is through supply growth and diversification of energy resources. Key technology pathways that contribute to achievement of these benefits include (annual performance indicators are provided in the individual technology benefits narrative):

- Low Wind Speed Technology:[a]

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[a] Annual targets using Cost of Energy are tracked to a fixed technology baseline that reflects a set of standard financial and technology assumptions for each technology (Land-based and Offshore wind technologies). Cost of energy targets differ from actual market conditions, as baseline technology assumptions do not include such factors as the impact of the on and off nature of the Production Tax Credit that leads to turbine demand spikes; changing financial variables; fluctuating commodity prices and currency exchange rates; and changes in expected equipment life.

- By 2012, complete research that will achieve modeled cost of energy from large wind systems in class 4 winds to $0.036/kWh for land-based systems (from a baseline of $0.055/kWh in 2002);
- By 2014, complete research that will achieve modeled cost of energy from large wind systems in Class 6 winds to $0.070/kWh for shallow water (depths up to 30 meters) offshore systems (from a baseline of $0.095 in FY 2005); and

- Distributed Wind Technology (DWT): By 2015, expand by five-fold the number of distributed wind turbines deployed in the U.S. market from a 2007 baseline (2,400 units).
- Technology Application: By 2010, facilitate the installation of at least 100 MW in at least 30 States, from a baseline of 8 States in 2002; and by 2018, facilitate the installation of at least 1000 MW in at least 15 States, from an estimated baseline of 3 states in 2008.

Funding by Strategic and GPRA Unit Program Goal

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Strategic Goal 1.1, Energy Diversity			
GPRA Unit Program Goal 1.1.04.00, Wind Energy			
Technology Viability	30,589	26,952	31,000
Technology Application	18,070	22,593	21,500
Total, GPRA Unit Program Goal 1.1.04.00, Wind Energy	48,659	49,545	52,500
Total, Strategic Goal 1.1 (Wind Energy)	48,659	49,545	52,500

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.1.04.00 (Wind Energy)					
Technology Viability/Low Wind Speed Technology					
Complete testing of prototypes of first advanced low wind speed technology components, and complete detailed design under first public-private partnership project for full system low wind speed turbine development. [MET]	Complete fabrication and begin testing advanced variable speed power converter. Test first advanced blade, incorporating improved materials and manufacturing techniques. Field test the first full-scale Low Wind Speed Technology prototype turbine. This contributes to the Annual LWST COE Target: 4.3 cents per kWh in Class 4 winds. [MET]	Annual COE Target: 4.2 cents per kWh in onshore Class 4 winds; 9.3 cents per kWh for offshore systems in Class 6 winds. [MET]	Annual COE target: 4.1 cents per kWh in onshore Class 4 winds; 9.25 cents per kWh for shallow water offshore systems in Class 6 winds; [MET]	4.0 cents per kWh modeled cost of wind power in land-based Class 4 wind speed areas (i.e., 13 mph annual average wind speed at 33 feet above ground). 9.2 cents per kWh modeled cost of wind power in Class 6 wind speed areas (i.e., 15 mph annual average wind speed at 33 feet above ground) for shallow offshore systems.	3.9 cents per kWh modeled cost of wind power in land-based Class 4 wind speed areas (i.e., 13 mph annual average wind speed at 33 feet above ground). 9.15 cents per kWh modeled cost of wind power in Class 6 wind speed areas (i.e., 15 mph annual average wind speed at 33 feet above ground) for shallow offshore systems.
Technology Viability/Distributed Wind Technology (DWT)					
	Complete prototype testing of 1.8 kW Small Wind Turbine, finishing the International Electrotechnical Commission suite of tests for acoustics, power, durability, and safety. This contributes to the Annual DWT COE Target: 12-18 cents per kWh in Class 3 winds. [MET]	COE Target: 11-16 cents per kWh in Class 3 winds. [MET]	COE Target: 10-15 cents per kWh in Class 3 winds. [Met] New effort: Distributed Wind (DW): 2400 units of distributed wind turbines in market. [baseline] [MET]	500 new units of distributed wind turbines deployed in market.	600 new units of distributed wind turbines deployed in market.
Technology Application					
	32 States with over 20 MW installed; 15 States with over 100 MW installed. [PARTIALLY MET]	19 States with over 100 MW wind installed. [PARTIALLY MET]	20 States with over 100 MW wind installed. [PARTIALLY MET]	22 States with at least 100 megawatts (MW) of wind power capacity installed.	27 States with at least 100 megawatts (MW) of wind power capacity installed, and 4 States with over 1,000 MW wind power capacity installed.

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [MET]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($18,371K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.

Means and Strategies

The Wind Energy Program will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Wind Energy Program will be implemented through the following means:

- In Low Wind Speed Technology (LWST), the program is increasingly using Cooperative Research and Development Agreements (CRADAs) for large wind system technology. CRADAs allow collaborative development activities, closely supported by laboratory-based research and testing, to assist private organizations in expanding the applicability of wind technology into new, more effective and efficient generators. Laboratory-based Supporting Research and Testing (SR&T) works to advance technologies that have shown potential to reduce the cost or improve the performance and reliability of large utility-scale and distributed wind systems. Activities under this area also address more basic technology assessments, identifying the underpinnings of new applications for wind technology, such as offshore applications and wind/hydrogen technology development. These efforts also improve the basic understanding of wind phenomena such as advanced blade aerodynamics and upper air resource assessment and modeling. Due to the different financial and technical strengths of wind industry companies, the use of collaborative partnerships will vary depending on specific needs and desired results. Some projects whose results will be made publicly available will require higher Federal cost share while other technology development will rely on strong industry support. Through the collaboration with governmental and industry partners, combined with laboratory-based research, the program will assess the market for a U.S. based offshore wind industry in preparation for a program review planned for FY 2009.
- Under the Distributed Wind Technology activity, the program began a new effort in FY 2008 to reinvigorate distributed and community-owned wind technology to meet the growing demand for local power generation. This market encompasses systems that connect to the lower voltage distribution grid, either directly or on the consumer side of the electric meter, including: 1) small turbines for residential and small business applications; 2) mid-sized turbines for farms, ranches, and small industry; and 3) locally owned community projects using larger turbines tied to distribution lines. The development of turbines in this market segment that can provide power at lower costs and with attractive payback would allow average Americans, farmers, and businesses to take an active role in the Nation's drive for energy independence.
- The Systems Integration key activity will expand on all areas to address the technical barriers to integrating increasing amounts of wind energy into our Nation's generation mix. The program will develop a more complete and readily accessible data set of wind resource potential throughout the country. To aid the electricity planning community, the program will provide the capability for state of the art representations of renewable energy development potential in support of the evolution of the Nation's electric system. In support of power system operations, this activity will acquire information on actual system performance characteristics, develop system models for integrated resource planning activities, and develop methods for enhancing integration and identifying ancillary service costs related to renewable energy.

- Dedicated outreach efforts will be funded through the Technology Acceptance key activity. Laboratory and contract staff supply information on a range of wind energy technologies and related issues to national, state, and local stakeholders, decision makers, and potential customers and investors so that there is a transparent exchange of credible information. A new effort in FY 2009 will expand this to regional relationships, as regional decision makers are increasingly looking to regional approaches to energy resource and planning. This is especially true in the electricity market where national policy has developed Regional Transmission Organizations. Electricity generators no longer serve loads in a single State, but rather serve interconnected markets that cross multiple political boundaries. Open and clear dialogue is necessary for making informed and long-lasting energy and environmental decisions.

The Wind Energy Program will implement the following strategies:

- The Wind Energy Program will provide leadership to the wind industry and focus priorities on removing the barriers to the use of wind energy technology. Additionally, the state of progress in advanced wind energy technology research and development projects and the financial strength of an emerging utility market for wind turbine systems are decreasing the level of government support needed for technology development in large scale, land-based wind turbine systems in favor of targeted research on components and others issues affecting technology reliability.

The following external factors could affect the Wind Energy Program's ability to achieve its strategic goal:

- the availability of conventional energy supplies;
- the cost of competing technologies;
- the ability of the industry to learn quickly as wind installation demand increases;
- fluctuating material costs (i.e., steel, copper, fiberglass, and concrete) and currency exchange rates;
- state and international efforts to support wind energy;
- Federal, state and regional regulatory actions affecting land-based and offshore wind installations;
- continuation of Federal tax incentives;
- implementation of other policies at the national level, including Federal efforts to reduce carbon and criteria pollutant emissions; and
- availability of wind and power data from wind energy installations

In carrying out the program's mission, the Wind Energy Program collaborates in several important activities, including:

- program activities depend upon outputs from academia, manufacturers, developers, and National Laboratories (e.g., the Offshore Wind Collaborative, a joint Federal/state/industry/academia collaboration to address barriers to U.S. offshore wind development);
- research plans and priorities, as set forth in the Wind Vision Plan being prepared cooperatively by the American Wind Energy Association (AWEA), DOE and NREL;
- with the utility industry on transmission and distribution interconnection policy and R&D issues;
- Office of Electricity Delivery and Energy Reliability (OE) on transmission-related issues;
- Federal, state, and regional oversight bodies on policies concerning wind energy interconnection;

- Federal Aviation Administration (FAA) and the Department of Defense on radar and other military issues affected by wind turbines;
- Interior's Minerals Management Service on regulations for offshore wind energy;
- industry and R&D directions for the production of hydrogen for energy use, and for other non-energy uses;
- cooperative research and development with the International Energy Agency (IEA); and
- peer review of the Wind Energy Program's overall strategies and its activities by academia, industry representatives, National Laboratories, and independent experts.

Validation and Verification

To validate and verify program performance, the Wind Energy Program will conduct internal and external reviews and audits. The table below summarizes validation and verification activities.

Data Sources:	"20 percent Wind Energy Initiative: A Collaboration between USDOE, AWEA, NREL and Black and Veatch," expected Spring 2008. "Musial, W.D.; Butterfield, S.; Laxson, A.; Heimiller, D.; Ram, B – *"Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers,"* November 2007, Golden, Colorado, National Renewable Energy Laboratory. NREL/TP-500-40745. "*Distributed Wind Market Applications,*" Trudy Forsyth and Ian Baring-Gould, NREL Technical Report TP-500-39851, November 2007. "Low Wind Speed Technologies Annual Turbine Technology Update (ATTU): Process for Land-Based Utility-based Technology," NREL Report #TP-50037505, June 2005. "Assessment of Potential Improvements in Large-Scale Low Wind Speed Technology," J. Cohen, Proceedings of Global Wind Power 2004, Chicago, Illinois, March 28-31, 2004, published by American Wind Energy Association. "Low Wind Speed Turbine Technology Characterization," Migliore and Cohen, presented at Wind Power 2003; "Wind Energy Technology Characterization, 1997," published by EPRI. "Low Wind Speed Turbine Technology Benefits," internal analysis for the FY 2002 request, peer reviewed by A.D. Little. FY 2001, FY 2002, FY 2003, FY 2004, FY 2005 and FY 2006 Wind Energy Program Peer Reviews. American Wind Energy Association (AWEA)/Global Energy Concepts Wind Plant Database, reviewed by EIA, contain proprietary data. Various published and unpublished data on wind projects economics. AWEA Small Wind Turbine Industry Roadmap.
Baselines:	Low Wind Speed Technology: $0.055/kWh in FY 2002 for land-based applications in Class 4 winds; $0.095/kWh in FY 2005 for shallow water offshore applications in Class 6 winds. Distributed Wind Technology: 2400 turbines deployed in distributed wind applications in 2007**.** Technology Application: Eight States in 2002 with at least 100 MW wind installed, and 3 states in FY 2008 with at least 1000 MW installed.
Frequency:	Annual.
Data Storage:	Web, paper publications and on-line storage.

Evaluation: In carrying out the program's mission, the Wind Energy Program uses several forms of evaluation to assess progress and to promote program improvement.

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the Wind Energy Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); PMA (the President's Management Agenda -- annual departmental and program-based goals whose milestones are planned, reported and reviewed quarterly); and PART (common Government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Verification: Activities and accomplishments will be verified by monthly reports from contractors/National Laboratories, including NREL, and from lead program field elements. Determining the cost of energy (COE) for Low Wind Speed Technology goals will be derived from the impact of improvements in individual components and subsystems based on comparisons against a baseline turbine composite with a well-understood cost of energy. Progress in the process of developing a detailed methodology to assess the removal of barriers to Distributed Wind Technology as a means of assessing progress towards the program goal. Determining the number of States with over 100 MW and 1000 MW of wind for the Technology Application goal will come from U.S. wind capacity statistics regularly collected by the National Renewable Energy Laboratory through subcontract. Reporting will be done on a quarterly basis to DOE from NREL.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities consistently.

The 2003 PART found that the program has a clear purpose, strong planning and management. OMB gave the program fairly high scores (80 percent), (80 percent), and (88 percent) respectively, in Purpose, Planning, and Management. A lower score (67 percent) in Results/Accountability is being addressed by developing better performance measures. The PART findings acknowledged the role of the program in commercial success of high wind speed technologies and encourages greater focus on low wind speed technologies, as reflected in the budget priorities. The program has also focused on improved performance of outreach activities (along with measures to assess performance), which is described in the technology acceptance activity section.

The 2002 PART review of the Wind Energy Program contained a recommendation to continue emphasis on wind technology development for low wind speed areas; Low Wind Speed Technologies continue to be a part of the Wind Energy Program's budget. Another PART recommendation suggested the development of practical, but meaningful annual performance measures; the Wind Energy Program has developed annual performance targets for its three PART goals and Budget technology pathways (see the "Contribution to Program Goals" section), covering about 90 percent of its budget request. The Wind Energy Program is also attempting to adhere to the specific direction of Congressional appropriation language while increasing the contribution to program goals to the extent possible. These improvements in accountability were reflected in the Wind Energy Program's significantly improved 2003 score in the results/accountability area, resulting in a modest overall score improvement, and a "moderately effective" rating, the second highest rating possible.

The Department has responded to the PART recommendation of "Develop guidance that specifies a consistent framework for analyzing the costs and benefits of research and development investments, and use this information to guide budget decisions." The Department continues to work on the development and implementation of common assumptions, a consistent approach to incorporation of risk, and other issues. EERE continues to refine the methods its uses in support of this framework and Departmental processes.

Expected Program Outcomes

The Wind Energy Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources. Estimates of the security, economic and environmental benefits from 2008 through 2050 that would result from realization of the program's goals are shown in the table below.

EERE's Wind Energy Program Goal Case reflects the increasing penetration of wind over time, as the program's goals are met. Not included are policy or regulatory mechanisms, or other incentives not already in existence, that might be expected to support or accelerate the achievement of the program goals. The expected benefits reflect solely the achievement of the program's goals. The program does not currently estimate the mid- and long-term benefits of distributed wind activities or explicitly estimate the impact of barrier removal or market acceleration activities included under the Technology Application portion of the program. Activities will be undertaken in FY 2008 to allow assessment of these program elements explicitly through the GPRA process, beginning with the FY 2010 budget request.

The goals are modeled in contrast to the "baseline" case, in which no DOE R&D exists. The baseline case is identical to those used for all DOE applied energy R&D programs.[a] Further, across EERE, and across all of DOE's applied energy R&D programs, the expected outcome benefits are being calculated using the same fundamental methodology. Finally, the metrics by which expected outcome benefits are

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[a] The starting point for the baseline case is the Energy Information Administration's "reference case," as published in the AEO 2006. Program analysts from across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO's technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

Primary Benefits Metrics for FY09 Request – NEMS and MARKAL

	Metric[1]	Model	Year 2015	Year 2020	Year 2030	Year 2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	0.3	2.0	N/A
		MARKAL	ns	ns	ns	3.1
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	58	355	N/A
		MARKAL	28	107	593	4726
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	862	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	1	26	N/A
		MARKAL	ns	ns	43	121
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	4	10	N/A
		MARKAL	ns	2	14	27
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	20	N/A
		MARKAL	ns	ns	6	18

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

measured are identical for all of DOE's applied energy R&D programs.[a] This standardization of methods and metrics has been undertaken as part of the Department's efforts to respond to OMB's request to make all programs' outcomes comparable.

The difference between the baseline case and the program goal case results in economic, environmental and security benefits. For example, achievement of program goals results in a reduction in cumulative net consumer expenditures of $26 billion by 2030. Savings to the electric power industry are expected to be $10 billion by 2030 and as much as three times that by 2050. Finally, the program would also generate in carbon emissions reductions of 50 million metrics tons by 2030 and nearly five gigatons by 2050. The results are generated by modeling the program goals within two energy-economy models: NEMS for benefits through 2030, and MARKAL for benefits through 2050.[b] The full list of modeled benefits appears below.

Program Indicators

	2010	2020	2030	2040	2050
Additional Billion kWh Generated	3	185	213	579	852
Additional GW Installed	.7	46	52	130	177

[a] The set of expected outcome metrics being used this year differs in substantial ways to that of previous years. In addition to the standardization across DOE's applied energy R&D programs, the list is expanded and more comprehensive than in past years. Further, the list maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

[b] Final documentation on the analysis and modeling, including all of the methodologies and underlying assumptions, is expected to be completed and posted on the web by March 31, 2007. Past GPRA modeling and analysis documentation can be found at http://www1.eere.energy.gov/ba/pba.

Technology Viability

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Technology Viability			
Low Wind Speed Technology (LWST - Large Systems)	11,607	5,801	2,700
Distributed Wind Technology (DWT - Small Systems)	750	3,814	3,500
Supporting Research and Testing (SR&T)	18,232	16,804	24,207
SBIR/STTR	0	533	593
Total, Technology Viability	30,589	26,952	31,000

Description

Technology Viability activities are aimed at advancing wind turbine components and systems, through targeted research and development projects using public/private partnerships and Cooperative Research and Development Agreements (CRADAs), and through research and testing efforts that bring specialized technical expertise, comprehensive design and analysis tools, and unique testing facilities to bear upon problems that industry encounters in bringing new wind technology to the marketplace.

Technology Viability key activities focus on research, development and testing for improving the performance, cost effectiveness and reliability of large and distributed wind energy systems, which are primary barriers to wind energy competing to serve the Nation's energy needs. Achieving the Wind Energy Program's goals will help wind energy expand more widely and rapidly in energy markets. The focus of the Low Wind Speed activity is to improve the cost and performance of land-based and offshore wind turbines. If the DOE FY 2009 go/no-go decision leads to developing offshore wind technology, the U.S. coastal waters appear to show promise for longer-term growth, and would act as a hedge against transmission bottlenecks that may limit land-based wind development in eastern regions. The goal for Distributed Wind Technology is to expand the market for distributed wind technologies five-fold from where it existed in 2007, the baseline year.

The following table provides expected annual indicators of progress for the Large Turbine Technology and Distributed Wind activities:

(fiscal year)

	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Low Wind Speed Technology – Land-based (Modeled cost of energy in Class 4 in cents/kWh)															
Target	5.5	5	4.6	4.3	4.2	4.1	4	3.9	3.8	3.7	3.6				
Actual	5.5	5	4.4	4.3	3.9	3.8									
Low Wind Speed Technology –Shallow Offshore Wind Systems (Modeled cost of energy in Class 6 in cents/kWh)															
Target				9.5	9.3	9.25	9.2	9.15	9.1	8.9	8.3	7.6	7.0		

(fiscal year)

	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Actual				9.5	9.3	9.25									
Distributed Wind Technology – (Class 3 in cents/kWh for historical program activity)															
Target	17-22	14-20	13-19	12-18	11-16	10-15									
Actual	17-22	14-20	13-19	12-18	11-11.5	9.9-10.7									
Distributed Wind Technology: new distributed wind turbines deployed in market (new effort since FY 2008)															
Target							500	600	800	1,000	1,200	1,400	1,700	2,200	
Actual															

The Wind Energy Program has developed a methodology for measuring and tracking program performance. Levelized cost of energy (COE), in constant dollars, is the primary performance indicator for the Low Wind Speed Technology effort – for land-based and offshore wind technology. Achieving the planned COE target will be possible through the technology improvement opportunities being addressed by the large turbine R&D portfolio. Cost of energy estimates for full-scale prototypes are based on industry experience in maturation of technologies and manufacturing processes. Determining the COE impact of improvements in individual components and subsystems are based on comparisons against a baseline turbine composite with a well-understood cost of energy. Using a peer reviewed process, the impact of technology improvements is assessed each year. Forecasts of COE impact are based on progress of existing subcontracts, and results of research efforts at the time of the assessment, thereby allowing a clear picture of the impact of improvements against the overall goals and objectives.

The program will also assess the number of distributed wind turbines deployed each year. While deployment levels are impacted by many outside factors (Federal tax incentives, state renewable portfolio standards, and other factors listed under "Means and Strategies" above), the program believes that this metric can be used to quantify the program's success in the removal of technology, market, and implementation barriers for distributed wind technologies.

The Wind Energy Program continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Low Wind Speed Technology (LWST - Large Systems)	**11,607**	**5,801**	**2,700**

The Low Wind Speed Technology project supports public/private partnerships, Cooperative Research and Development Agreements, and specific National Laboratory research, analysis, and testing for large wind system technology pathways (turbines over 100 kilowatts) to achieve the following goals:

- $0.036/kWh for land-based systems in Class 4 winds by 2012; and
- $0.07/kWh for shallow water offshore systems in Class 6 winds by 2014;

For land-based systems, public/private partnerships and CRADAs catalyze industry adoption of technology developments and emerging innovation, in collaboration with National Laboratory expertise. A series of three low wind speed technology competitive solicitations were conducted to promote land-based wind technology development. Phase I (FY 2002) and Phase II (FY 2004) were cost-shared industry partnerships and concentrated on three technical areas: 1) conceptual design studies, 2) component development and testing; and 3) full turbine prototype development and testing. Phase III was a CRADA solicitation for industry partnerships to address component improvements to existing large wind turbine designs. Phase III was awarded in FY 2008.

Through FY 2009, the program will apply limited resources to offshore wind technology research to analyze the potential of offshore wind energy development. Activities will obtain and evaluate the information needed to allow a programmatic go/no-go decision in FY09/FY10 regarding future offshore wind technology development. In addition, the Wind Energy Program will participate in a limited manner to explore initial deployment issues for offshore wind turbines in the United States, including assessing environmental conditions and working with the Interior Department's Minerals Management Service (MMS) to develop offshore regulatory policy in accordance with the Energy Policy Act of 2005 (EPACT 2005) Section 321, *Alternate Energy-Related Uses on the Outer Continental Shelf.* These activities will allow the program to determine whether there are any significant market and governmental constraints to offshore wind technologies. Following the go/no-go decision, a government role may be defined. If DOE investments are made they would be phased solicitations to facilitate development of offshore technology and build on the success of the program's partnering strategy. Through FY 2009, offshore activities will be conducted in three functional areas to provide information required for the go/no-go decision: technology assessment, deployment and outreach, and international collaboration and standards.

FY 2009 activities will focus on: 1) make programmatic decision for continued investment in offshore wind technology development; and 2) support development of turbine technology aimed at reducing Operations and Maintenance costs and expanding reliability of existing systems

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Distributed Wind Technology	**750**	**3,814**	**3,500**

The program has identified a significant potential market for mid-to-large turbines installed on the distribution side of the meter in low wind speed areas. This encompasses distributed applications, such as farming, ranching, and community wind, which are generally served by older generation technology. Manufacturers focused on this market tend to be small and undercapitalized companies that do not have the means to individually invest in high rates of R&D needed to affect the cost and performance improvements necessary for commercial success.

Supporting research and testing is an integral part of the DWT effort. It includes a variety of supporting activities. Design review and analysis activities assist project partners on technical, market and cost challenges. Basic research activities are conducted to evaluate turbine aero acoustics, new materials for blades, and innovative power electronics components such as inverters and controllers. Some of the turbine products developed as a result of the partnerships require field testing at the National Wind Technology Center, which include loads, power performance, acoustic emission, power quality, and duration testing. A 225kW dynamometer facility is maintained for testing a wide range of drive train components for small distributed wind turbines.

FY 2009 activities will include: 1) continued independent, laboratory field testing of distributed turbines that began in FY 2008; 2) initiation of a partnership project to develop a mid-scale turbine prototype; and 3) continuation of efforts to evaluate technologies for small-scale turbines.

Supporting Research and Testing (SR&T)	**18,232**	**16,804**	**24,207**

In support of achieving cost of energy goals, the National Renewable Energy Laboratory and Sandia National Laboratory provide targeted research and testing to improve the reliability, efficiency, and performance of wind turbines. Activities are continuously coordinated with industry and other research institutions to facilitate technology transfer and transition of designs and component improvements into full systems. Large turbine projects are periodically reviewed against analytically established performance measures to provide the basis for funding and planning adjustments needed to optimize the portfolio for success.

Through the National Laboratories, specialized technical expertise, comprehensive design and analysis tools, and the unique testing facilities are brought to bear on problems that industry is or will encounter in bringing new turbine technology to the marketplace. This technical support is essential to the public/private partnerships and collaboratives and engages the capabilities of the National Labs, universities and other technical support available in private industry.

Advanced Rotor Development - A wind turbine’s blades control the energy capture and almost all the loads, and are therefore a primary target of research efforts. The challenge is to create the scientific knowledge base and engineering tools to enable designers to achieve optimum performance at the lowest possible cost by using new materials, advanced control techniques, improved manufacturing processes, and enhanced design tools. Rotor development work will assist the industry in meeting its cost goals by increasing rotors’ swept areas to enable use in previously uneconomic wind regimes.

Advanced rotor development will be done in blade development, aerodynamic code development and validation, aeroacoustics research and testing, and systems and controls.

Site Specific Design - Future wind energy installations will be in areas of significantly different wind resource potential and terrain roughness. The benefits of designing large installations (100 MW or more) for specific site conditions are substantial. The nature of atmospheric loading at increasing heights will be assessed and documented. Blade designs, including aerodynamic geometry, controls, and structural details, must be tuned to the energy capture requirements and durability suitable for low-energy lightly-loaded sites. Site specific design covers the development of systematic methods for specifying site energy, load conditions, and turbine inflow characterization.

Generator, Drivetrain, and Power Electronics - The generator, gearbox, and power converter represent roughly 25 percent of the installed capital cost of a modern wind turbine. The drivetrain is becoming a primary factor in machine design because its weight and size affect other wind turbine configuration and erection factors, such as tower size and crane rating. Variable-speed wind turbine designs are dependent on the efficiency and mode of operation of the power converter that changes variable-frequency AC from the generator to fixed-frequency AC conditioned for injection into the electrical grid. Conversion efficiency is a critical factor. Future designs of generators and power converters must be specialized and tailored for wind turbines because most of the time wind turbines operate at less than rated power. Permanent magnet generators that allow lighter generator rotor designs and have lower losses will play a role, as will power converters and generators that allow variable-speed operation and have higher efficiencies below rated power. Reliability will be an issue because the generator and power converter are key points of system failure. Public/private partnerships to explore areas that will contribute to improvements in converter and generator designs, focusing on generator and converter architecture, controls, and reliability will be examined. As the Wind Energy Program develops new technology through industry collaboration, it will also provide oversight and technical support. Design review and analysis provides a means by which NREL and SNL can provide specialized expertise for industry-led activities. It also supports the proposal or CRADA evaluation process. This support and oversight will assist industry, protect the taxpayer's investment in these partnerships, and enhance their chance of success.

The National Wind Technology Center has unique facilities developed to provide the testing capabilities needed to achieve large turbine cost goals. Testing is conducted on full-scale turbine systems installed in the field and on turbine components and subsystems. Component testing utilizes the NWTC's specialized blade and dynamometer test facilities. These tests support certification and technology characterization. Field testing of turbine loads, power performance, power quality, and acoustic emissions are conducted in accordance with standards developed under the International Electrotechnical Commission (IEC) and the American Association of Laboratory Accreditation.

As described above, computer modeling and dynamic simulations are important elements of DOE's support of industry turbine development. Validating and improving these models is difficult because the models cannot always simulate true inflow, turbine response, or control performance. To fill this gap, extensive and detailed field and laboratory testing is necessary. The data are used to optimize turbine configurations and COE, e.g. by improving control algorithms and simulation codes from which

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		

the turbines were designed. Three primary types of testing are conducted through the DOE program, structural testing, dynamometer testing, and field testing.

Capital equipment expenditures of approximately $2,500,000 are planned at the National Renewable Energy Laboratory for FY 2009 to support testing at NWTC, as well as for the large wind turbine blade test facility collaboration with industry. Performance is measured for R&D activities using analytically-established targets linking contributions from each activity to meeting program goals. Outputs of this activity include periodic design reviews and results of tests at industry and laboratory locations.

In FY 2009, the program expects to achieve the following major milestones under the this key activity: 1) installation of utility scale turbine at the National Wind Technology Center for field testing of control logic enhancements; and 2) perform detailed testing and analysis of drive trains and blades performance and reliability using National Wind Technology Center testing facilities.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**533**	**593**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Technology Viability	**30,589**	**26,952**	**31,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Low Wind Speed Technology (LWST - Large Systems)	
The reduction is due to the shift to a CRADA process rather than a large public/private partnership process to develop improved components for utility scale turbines, and to a reduction in funding for offshore wind technology assessment.	-3,101
Distributed Wind Technology	
The decrease is due to the completion of the distributed wind market assessment in FY 2008, and the winding down of a technical evaluation of a mid-scale turbine prototype in FY 2009.	-314

Supporting Research and Testing (SR&T)

The increase supports additional public-private Cooperative Research and Development Agreements (CRADAs) for promoting wind energy technology advances and improvements. CRADAs are the primary mechanism by which the program promotes wind energy technology development. The increase also funds capital equipment expenditures to support improved testing at the NWTC, as well as for the large wind turbine blade test facility collaboration with industry.	+7,403

SBIR/STTR

Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+60
Total Funding Change, Technology Viability	**+4,048**

Technology Application

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Technology Application			
Systems Integration	12,426	15,707	14,480
Technology Acceptance	5,644	6,864	7,000
SBIR/STTR	0	22	20
Total, Technology Application	18,070	22,593	21,500

Description

The Technology Application subprogram addresses opportunities and barriers other than turbine cost of energy concerning use of wind energy systems. The efforts managed in this area of the program help to prepare and accelerate the market interest in broad application of wind technologies.

Through one of its key activities, Technology Acceptance, Technology Application focuses on resolving institutional issues, providing state and regional energy sector outreach, and investigating and mitigating social, environmental and wildlife issues associated with wind energy development. The second key activity, Systems Integration, focuses on anticipating and overcoming operational issues associated with interconnecting greater amounts of wind energy and other renewables on the electricity system.

Technology Application helps the program achieve its mission by focusing on the cost barriers other than generator technology that enhance or impede wind energy use in the United States. Helping stakeholders and officials within States understand wind energy technologies and how wind can be integrated into their state energy systems will in turn reduce institutional and regulatory barriers, helping wind to contribute in a competitive wholesale electric market.

The following table provides expected annual indicators of progress for Technology Application:

(fiscal year)

	00	01	02	03	04	05	06	07	08	09	10
Technology Application - # of States with over 100 MW installed											
Target			--	10	12	16	19	20	22	27	30
Actual	4	7	8	10	12	15	16	16			

(fiscal year)

	08	09	10	11	12	13	14	15	16	17	18
Technology Application - # of States with over 100 MW installed											
Target	22	27	30								
Actual											
Technology Application - # of States with over 1000 MW wind installed											
Target		4	5	6	7	8	9	10	12	13	15
Actual	3 (expected baseline)										

Technology Acceptance is used as a way to measure the success of the Wind Energy Program's outreach activities. Since each State is a unique regulatory, policy and economic entity, reaching 100 MW installed capacity threshold has been used an important indicator that wind is being accepted as a large-scale generating option by the state's utilities, regulators and investors. As the scale of penetration increases, a 1000 MW state goal has been added. Activities conducted under Technology Acceptance and Systems Integration will together contribute to the new 1000 MW state goal, as large scale integration studies are necessary and complementary to outreach activities in order to enable such large penetration of wind energy in States and regions.

The Wind Energy Program continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Systems Integration	**12,426**	**15,707**	**14,480**

Systems Integration focuses on addressing the technical barriers to interconnecting large amounts of wind energy into the Nation's electric grid and supporting operational evaluations. Program efforts in this activity for FY 2009 will continue following the FY 2008 expansion of the technical information needed by the electric power industry to make informed decisions about wind energy. Coordination with DOE's Office of Electricity Delivery and Energy Reliability (OE) will continue on grid interconnection related to wind energy.

The Renewable Resource Characterization task will continue meso-scale modeling of the wind resource in areas around the country with high levels of potential. This will lead to improvement in the understanding and analysis of the wind characteristics in areas where wind energy projects are established or are being planned. The data collected through this activity will be used to develop and validate high-resolution wind resource maps in cooperation with the wind industry. As part of this, meteorological towers in key locations will be installed to obtain actual time series wind data. In addition, time synchronized load data will be obtained to determine generation/load coincidence.

(dollars in thousands)

The Operations & Analysis Support task will continue developing system models of wind energy generation, which are needed by the electric utility industry to conduct operational analysis. This activity will also incorporate data from the industry to study the dynamic interaction between wind generators and the rest of the electric system

The Renewable Interconnection Planning Support task will develop models and methods to assist transmission planners with long-term integrated resource planning tasks and will utilize data provided from other activities within this program.

The Wind Energy Systems Simulation & Applications Analysis task will focus on building the stakeholder consortium, gathering existing data regarding renewable systems integration and analyzing future industry needs with the purpose of creating a centralized source of technical information on wind energy interconnection.

	FY 2007	FY 2008	FY 2009
Technology Acceptance	**5,644**	**6,864**	**7,000**

Technology Acceptance focuses on outreach activities to overcome market and regulatory barriers at the national, state, and local levels that are essential to making progress towards significant increases in wind use. Within Technology Acceptance, Wind Powering America ($6,500,000 in FY 2009; $5,500,000 in FY 2008) is aimed at facilitating the deployment of wind technology to increase the use of wind energy in the United States; bringing economic and environmental benefits to the country; and stimulating a sustainable tribal and rural-based energy sectors. Activities are conducted in partnership with utility generators, equipment manufacturers, project financiers and developers, public and private officials, regulators, industrial and public sector consumers, other Federal and state agencies, and citizen stakeholder groups to provide technical support, guidance, and information on national, regional, state, and local efforts to explore and develop their wind energy resources, both on land and offshore. Technology Acceptance also supports cooperative activities with utility-based and other key stakeholder organizations to expand access to wind resource data and to provide information on technical and institutional barriers to development.

There will be an increased emphasis beginning in FY 2009 on efforts to assess and mitigate effects of wind turbines on Federal mission areas and the environment. These efforts include working with all stakeholders to address the following specific barriers: direct and indirect Federal mission area and wildlife impacts of wind technology and projects lack of government consensus on regulatory or process requirements necessary to protect Federal mission areas and wildlife from impacts; lack of tools for industry to assess and mitigate Federal mission area and wildlife impacts from wind; and public perception that the environmental risks associated with wind power outweigh its environmental and other benefits. Many of these efforts will be applicable to local and regional siting and permitting proceedings.

FY 2009 will also focus on enhancing the program's new regional wind support effort that was started in FY 2007. Since many benefits and challenges associated with wind energy are not limited by state

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

borders, developing regional collaborations allows many organizations to more effectively address common issues. Additional support will continue to be provided for development of regional wind institutes; existing and emerging state wind working groups; tribal wind technical assistance on wind resources and project planning, in coordination with financial assistance provided through OWIP's Tribal Energy Program; partnership activities with national agriculture-sector organizations; collaboration with public power organizations; community and rural schools projects by expanding activity over regions of the country with similar issues. Distributed wind system support activities such as working with state regulators, small wind stakeholders, and the agricultural sector on market acceptance issues specific to distributed wind technologies, will also continue. In addition, the program will continue to assess and mitigate effects of wind turbines on the environment. These efforts will address barriers by funding collaborative research activities; working with the Department of Interior to revise siting guidelines; supporting mitigation research; and producing technical and outreach materials on ways to develop wind in an environmentally sensitive manner. FY 2009 performance target for this activity: 27 States with over 100 MW; 4 States with over 1000 MW wind installed.

SBIR/STTR	**0**	**22**	**20**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Technology Application	**18,070**	**22,593**	**21,500**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Technology Acceptance	
There is no significant change in the activities undertaken under this activity, which focuses on outreach activities to overcome market and regulatory barriers at the national, state and local levels that are essential to making progress towards substantial increases in wind-generated electricity. FY 2009 activities will increasingly focus on assessing and mitigating the effects of wind turbines on Federal mission areas and the environment. Also, FY 2009 will continue the regional wind support effort begun in FY 2007 to develop regional collaborations that allows many organizations to more effectively address common issues.	+136
Systems Integration	

	FY 2009 vs. FY 2008 ($000)
The decrease is due to the completion of the first set of nationwide meso-scale wind resource modeling.	-1,227
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-2
Total Funding Change, Technology Application	**-1,093**

Geothermal Technology

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation[a]	FY 2008 Original Appropriation	FY 2008 Adjustments[b]	FY 2008 Current Appropriation	FY 2009 Request
Geothermal Technology					
Enhanced Geothermal Systems	2,000	20,000	-182	19,818	30,000
Oil & Gas Well Co-production and Resource Assessment	3,000	0	0	0	0
Total, Geothermal Technology	5,000	20,000	-182	19,818	30,000

Public Law Authorizations:

P.L. 93-410, "Geothermal Energy Research, Development, and Demonstration Act of 1976" (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act of 1978" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990" (1990)
P.L. 102-486, "Energy Policy Act of 1992" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the new Geothermal Technology Program is to conduct research and development on Enhanced Geothermal Systems (EGS) to advance the technology as an economically competitive contributor to the U.S. energy supply.

Accomplishing the mission will benefit the supply side of the Department's energy security equation accelerating the arrival and use of the new fuels and technologies that we need.

The Geothermal Technologies Program's mission and activities directly support DOE's mission to promote scientific and technological innovation in support of advancing the national, economic and energy security of the United States. A DOE sponsored analysis published in January 2007 by an MIT-led panel shows the potential for Enhanced or Engineered Geothermal Systems (EGS) to contribute 100,000 MWe to the U.S. energy supply. Ultimately, commercial EGS could provide baseload, indigenous power and contribute to the security and diversity of U. S. energy supplies.

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[a] Excludes amounts transferred to the Science appropriation for carrying out SBIR / STTR. All subsequent tables in this program also reflect this transfer.
[b] Reflects amounts rescinded by General Provision, Section 312, of the Omnibus Appropriations Act, 2008.

When implemented, EGS will avoid greenhouse gas (GHG) emissions. The Geothermal Technology Program will promote the use of EGS and associated reductions in GHG emissions.

Typical EGS power plants will use more advanced closed loop conversion systems that will not add CO_2, NO_x, or other greenhouse gases to the atmosphere.   New commercial EGS reservoirs could provide baseload, indigenous power and contribute to the long-term diversity of U. S. energy resources.

Expected program outcomes will include creation of a commercial-scale geothermal reservoir and power plant capable of producing 5 MWe for 7 years by 2015. This showcase plant should foster rapid growth in the use of geothermal energy in the outyears as predicted by the MIT study.

Today, grid-connected geothermal hydrothermal systems are well established. In the midterm, early geothermal plants using engineered geothermal systems technology could come online, greatly extending access to geothermal resources. In the long term, geothermal systems could be a major source of base-load electricity for large regions.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for energy, nuclear, science, environment, and management) plus 16 Strategic Goals, four priorities, and nine operating principles. The Geothermal Technology Program directly supports the following goal:

Strategic Theme 1, Energy Security

Strategic Goal 1.1, Energy Diversity: Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs.

And concurrently supports:

Strategic Goal 1.2 – Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Theme 3, Scientific Discovery and Innovation

Strategic Goal 3.3, Research Integration: Integrate basic and applied research to accelerate innovation and to create transformational solutions for energy and other U.S. needs.

The Geothermal Technology Program has one GPRA Unit Program Goal which contributes to Strategic Goal 1.1.

GPRA Unit Program Goal 1.1.05.00: Geothermal Technology - the Geothermal Technology Program goal is to improve EGS technologies that will enable the private sector to commercialize EGS after 2020.

The Geothermal Technology Program (GTP) will conduct cost-shared technology research, development, and validation on Enhanced Geothermal Systems. A more detailed program plan will be developed during Fiscal Year 2008

Funding by Strategic and GPRA Unit Program Goal

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Strategic Goal 1.1 Energy Diversity			
GPRA Unit Program Goal 1.1.05.00, Geothermal Technology	5,000	19,818	30,000
Total, Strategic Goals 1.1 (Geothermal Technology)	5,000	19,818	30,000

Annual Performance Results and Targets[a]

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.1.05.00 (Geothermal Technology)					
Enhanced Geothermal Systems					
Create an Enhanced Geothermal System (EGS) with an industry partner and test associated technology needed to operate and monitor the system. [NOT MET]	Field test a fully integrated Diagnostics-While-Drilling (DWD) advanced drilling system in a high-temperature geothermal well, verifying control of drilling operations in real time, thereby reducing costs. If successful, DWD will reduce drilling costs by one half of the total cost reduction target for drilling. [MET]	Develop an Electronic Repository which makes digitized copies of all Geothermal Technology Program Research Development and Deployment Technical Reports available via the internet, while demonstrating reduction in cost of power for flash systems to 4.9 cents/kWh from 5.3 cents/kWh in 2005 and reducing cost of binary to 8.2 cents/kWh from 8.5 in 2005 based on modeled analysis. [MET]	Complete an interim report on EGS technology evaluation, and report on completion of program activities and projects funded in FY 2006. [MET]	Conclude EGS technology evaluation and publish a new Geothermal Program Plan.	TBD [1]
Contribute proportionately to EERE=s corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funds]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($21,644K) until the target is met. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]		

[a] A Program ture Plan for the new GTP will be developed in collaboration with stakeholders. This plan will outline the Annual Performance Targets.

Means and Strategies

A more detailed program plan will be developed for the Geothermal Technology Program during Fiscal Year 2008. The GTP has adopted a three-fold strategy to achieve its goal using a cost-shared approach: (1) conduct research on EGS-related technologies that have the greatest impacts on EGS reservoir creation, operation, and management using a test site; (2) develop EGS reservoirs at existing geothermal fields; (3) provide improvements in EGS supporting technologies determined to have the broadest applicability and greatest impact on cost.

Validation and Verification

To validate and verify program performance, the GTP will conduct internal and external reviews and audits with the assistance of experts from a variety of stakeholder organizations. The table below summarizes validation and verification activities.

Data Sources:	"The Future of Geothermal Energy" , Massachusetts Institute of Technology; 2006; Enhanced Geothermal Systems Technology Evaluation Workshops (June- October, 2007).
Baselines:	The GTP is in the process of developing a baseline of technology performance for Enhanced Geothermal Systems.
Evaluation:	The GTP will establish a process for conducting external reviews of program performance.Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); PMA (the President's Management Agenda -- annual Departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly); and PART (common government wide program/OMB reviews of management and results).
Frequency:	Annual
Data Storage:	A web based public data center.
Verification:	Long-term flow test at field sites.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The original Geothermal Technologies Program underwent a PART review in 2003. The results of the PART analysis acknowledged the role of the program in cost reduction and subsequent growth of competitive power production from expanded geothermal resources and highlighted the need to focus on Enhanced Geothermal Systems. The GTP is planning to implement a new organization structure solely focused on EGS during fiscal year 2008.

Expected Program Outcomes

In January 2007, an MIT led panel presented analysis that showed a potential contribution of 100,000 MWe to the U.S. energy supply by Enhanced or Engineered Geothermal Systems. The Program will develop an integrated portfolio of cost-shared technologies that will avoid GHG emissions, criteria pollutants and provide a ubiquitious baseload source of domestic power. The Geothermal Technology Program is directed in FY 2009 toward EGS R&D activities. Expected program outcomes will include creation of a commercial-scale geothermal reservoir and power plant capable of producing 5 MWe for 7 years by 2015. This showcase plant should foster rapid growth in the use of geothermal energy in the outyears as predicted by the MIT study.

Basic and Applied R&D Coordination

The Geothermal Technology Program will coordinate with the Department's Office of Science and Office of Fossil Energy on reservoir stimulation and carbon sequestration for EGS.

Enhanced Geothermal Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Enhanced Geothermal Systems			
Enhanced Geothermal Systems	2,000	19,264	29,160
SBIR/STTR	0	554	840
Total, Enhanced Geothermal Systems	2,000	19,818	30,000

Description

Natural geothermal systems depend on three factors to produce energy: heat, water, and permeability. Heat is present virtually everywhere at depth; water and permeability are less abundant. Enhanced Geothermal Systems (EGS) are engineered reservoirs created to produce energy from geothermal resources deficient in economical amounts of water and/or permeability.

EGS generally involves drilling wells into hot rock, fracturing the rock between the wells, and circulating a fluid through the fractured rock to extract the in situ heat. This means of "heat mining" mimics naturally-occurring, conventional hydrothermal reservoirs but includes several advantages not common to conventional reservoirs: (1) siting flexibility - hot rock is omnipresent in the earth, and EGS can be located close to load centers or distant from environmentally sensitive areas; (2) sizing flexibility - EGS can be created in distinct units and sized to fit the need or expanded to meet increased needs; (3) controlled operation - as engineered reservoirs, EGS can be managed with regard to heat extraction rates and production of dissolved minerals over time. While pilot EGS reservoirs of limited size have been designed, built and tested for a short period in various countries, many technical hurdles remain in reservoir creation, operation, and management. Program activities will focus on R&D needed to reduce barriers and address these hurdles.

The program will promote the advancement of the EGS through an integrated portfolio of cost-shared research. One approach to overcoming the hurdles is to focus initially on controlling the amount and period over which geothermal heat can be extracted. The strategy involves working with cost-sharing partners at existing geothermal fields to develop, test, and perfect the tools needed to fracture hot, impermeable rock. Some novel or cutting-edge technologies, may be too risky for tests in commercial wells. Consequently, a test site will be employed for verification of innovative EGS technology. This site will allow DOE to control site operations and scheduling, an ability not available at commercial fields. Ultimately, EGS reservoir experiments will take place in sufficient numbers and geologic environments to demonstrate the general applicability of the technology. A detailed program plan will be developed during Fiscal Year 2008.

Initially, priority will be given to reservoir technology R&D, including the development of modeling tools necessary for simulating long term circulation tests. The program will conduct continuous systems analysis to determine technical, environmental, and economic effectiveness. Based on the results, the

GTP will update the R&D portfolio. Periodic technology evaluations will be performed calling on experts from geothermal and allied industries such as the petroleum service sectors.

The GTP will continue to work with BLM and other Federal agencies as necessary.

EGS R&D is expected to provide technological tools and information that will enable business decisions by the private sector to create commercial-scale EGS reservoirs. Recent carbon avoidance analysis performed by NREL shows EGS has the potential to substantially reduce carbon emissions.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Enhanced Geothermal Systems	**2,000**	**19,264**	**29,160**

In FY 2008, a program plan will be developed that outlines the goals and specific activities of this new effort. The GTP plans to issue solicitations and select industry cost-shared projects based in part on the results of a technology evaluation initiated in 2007. During FY 2009, the program will continue implementation of solicitations issued in FY 2008 and will support additional reservoir R&D in the areas of reservoir stimulation, fracture mapping, and fluid circulation. The program also will conduct an independent peer review and issue a second round of solicitations, as necessary. Analysis of candidate sites for technology verification will begin. Priority EGS research and technology development will continue at various research institutions which will have been selected via a competitive process.

SBIR/STTR	**0**	**554**	**840**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Enhanced Geothermal Systems	**2,000**	**19,818**	**30,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Enhanced Geothermal Systems	
The additional funds will enable a second round of solicitations for cost-shared EGS reservoir development and testing, adding at least two new sites in different geologic and geographic settings. Increasing the number and variety of sites will provide needed data on EGS technology under a broad range of conditions. This increase also funds expanded R&D site analysis and an independent peer review.	+9,896
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+286
Total Funding Change, Enhanced Geothermal Systems	**+10,182**

Oil & Gas Well Co-production and Resource Assessment

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Oil & Gas Well Co-production and Resource Assessment	3,000	0	0
Total, Oil & Gas Well Co-production and Resource Assessment	3,000	0	0

Description

In the past, this activity focused on practical demonstration of power production from geothermal brines produced from oil & gas wells. The focus involved the field verification of new technology, deployment of that technology, and its transfer to commercial applications.

There are no funds requested or benefits associated with this subprogram in FY 2009.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Oil & Gas Well Co-production and Resource Assessment	**3,000**	**0**	**0**
No new projects will be undertaken in 2009 and any existing projects supported through prior year funds will be completed in an orderly fashion.			
Total, Oil & Gas Well Co-production and Resource Assessment	**3,000**	**0**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Oil & Gas Well Co-production and Resource Assessment	
No change.	0
Total Funding Change, Oil & Gas Well Co-production and Resource Assessment	**0**

Water Power

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments[a]	FY 2008 Appropriation	FY 2009 Request
Water Power	0	10,000	-91	9,909	3,000
Total, Water Power	0	10,000	-91	9,909	3,000

Public Law Authorizations:

P.L. 109-58, "Energy Policy Act of 2005" (2005) Title IX, Sec. 931
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Water Power Program is to explore, test and develop (as appropriate) innovative and effective technologies capable of harnessing hydrokinetic (i.e., energy from the motion of fluids) energy resources, including ocean wave and current (ocean and tidal) energy.

If the initial resource assessment proves that there is ample opportunity for cost-effective water power technologies in U.S. waters, the use of such technologies would provide another clean and affordable domestic energy source for the United States.

To assess technologies, the Water Power Program must work in conjunction with industry to gain insight about actual data of working water power devices. It is necessary to have demonstrations of technology to close the loop between theoretical and actual performance.

Accomplishing the mission will benefit the supply side of the Department's energy security equation accelerating the arrival and use of the new fuels and technologies that we need.

The Water Power Program's mission and activities will contribute directly to EERE's and DOE's mission of improving national, energy and economic security through the scientific and technological advancement of reliable, clean, and affordable energy. Specific program goals and estimates of benefits are under development.

The program is initially concentrating on (1) resource assessments in order to identify the prime domestic resource areas and based on these results, (2) technology characterizations of the various water power energy conversion technologies, with the goal of determining cost, performance and reliability characteristics, and (3) industry partnerships to take advantage of early industry demonstration projects to assess the "actual" performance and cost of real projects in the ocean.

Pending the outcomes of the program's thorough resource assessment, the Water Power Program will help to facilitate the advancement of hydrokinetic technologies as a key regional renewable energy resource. Work will be done collaboratively through cost-shared R&D. Development of the vast ocean

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[a] Reflects amounts rescinded by General Provision, Section 312, of the Omnibus Appropriations Act, 2008.

and river energy resources could serve to increase and diversify the domestic energy supply, thus offering the United States another clean, domestic energy source that will help mitigate utility sector greenhouse gas emissions, and support our Nation's energy independence and national security.

Intrinsic benefits associated with this technology include:

- No carbon or other air pollution emissions
- No foreign fuel supply dependency
- Domestic economic development opportunity
- Power plant sites are typically close to load centers
- Predictable energy with possibility for base-load contributions

Interdependencies

- A Water Power Program will allow the U.S. to leverage international collaboration and eventual domestic investments.
- Because some other countries are ahead of the U.S. in water power development, international collaboration will also allow us to learn from others, and avoid duplication of effort.
- There already exist some strong capabilities within the DOE National Laboratories under the former Hydropower Program. This emerging new DOE program can benefit from some of this experience and expertise.
- Finally, tangible development of this technology area will enhance our capability to maintain and even expand domestic manufacturing, thus strengthening the green technology sector of our economy.

Expected Program Outcomes

Given the long coastlines and tidal impoundment of the United States, water power technologies offer a possible significant regional energy source for the United States, free of greenhouse gas emissions and close to many load centers. Completion of resource assessment and technology characterization activities will provide estimated energy production potential for water power technologies in the U.S.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Ocean Power Program supports the following goals:

Strategic Theme 1, Energy Security

Strategic Goal 1.1, Energy Diversity: increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs.

And concurrently supports:

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Goal 1.3, Energy Infrastructure: Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

The Water Power Program has one GPRA Unit Program goal which contributes to Strategic Goals 1.1 and 1.2 in the "goal cascade."

GPRA Unit Program Goal 1.1.08.00: The Water Power Program's goal is under development, however the initial focus is to evaluate whether water power energy systems have the potential of becoming cost-competitive with conventional electricity sources.

Contribution to GPRA Unit Program Goal 1.1.08.00 (Water Power)

The Water Power Program's key contribution to these goals is through research and development that promotes supply growth and diversification of U.S. clean energy sources. The following are the key pathways for this new program:

- Resource Assessment: By 2010, the program will complete a comprehensive resource assessment of water power in the United States, including wave, current (ocean and tidal), ocean thermal and conventional hydropower resources.
- Technology Characterizations: Characterizations of individual water power technologies if appropriate.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.1, Energy Diversity			
GPRA Unit Program Goal 1.1.08.00, Water Power			
Water Power	0	9,909	3,000
Total, GPRA Unit Program Goal 1.1.08.00, Water Power	0	9,909	3,000
Total, Strategic Goal 1.1 (Water Power)	0	9,909	3,000

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.1.08.00 (Water Power)					
n/a					
	n/a	n/a	n/a	n/a	Performance measures are under development.

Means and Strategies

The Water Power Program will accomplish its mission by assessing the prospect of hydrokinetic technologies in the United States and based on those results, establish research and development efforts to advance hydrokinetic energy generation technologies, develop new and innovative conversion technologies, identify key resource locations, and address barriers to the use of water power energy in coordination with stakeholders, resulting in greater energy security and a cleaner and more diversified electricity supply.

The Water Power Program will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Water Power Program will be implemented through the following means:

- Based on analysis, and in collaboration with the U.S. and international industry, further develop existing systems as well as new and innovative water power conversion technologies.
- Resource assessments in order to identify the prime domestic resource areas and relative energy available in coastal regions.
- Technology characterizations of the various water power conversion technologies, with the goal of determining cost, performance and reliability characteristics.
- Industry partnerships in order to best position U.S. industry to take advantage of our findings and develop market products.

The Program will implement the following strategies:

- Evaluate existing technologies and work with industry to develop a strategic plan to assess and advance the most promising hydrokinetic technologies.

These strategies will serve to consolidate the needs of the emerging water power industry, and enable prioritization of RDD&D requirements and quantification of the potential barriers of this emerging industry. Ultimately, this could result in significant cost savings, reductions in greenhouse gas emissions and fuel imports.

The following external factors could affect the Water Power Program's ability to accomplish its mission:

- the availability of conventional energy supplies;
- the cost of competing technologies;
- the ability of the domestic industry to quickly adapt to market place and technology changes;
- state and international efforts to support water power technologies;
- the state of internationally recognized standards and certification;
- Federal, state and regional regulatory actions affecting water power technologies;
- application of state or Federal tax or other incentives; and
- implementation of other policies at the national level, including Federal efforts to reduce carbon and criteria pollutants.

In carrying out the program's mission, the Water Power Program expects to perform the following collaborative activities:

- develop strategic research plans and priorities with input from key program partners such as leading industry associations and National Laboratories;
- support the Interior Department's Minerals Management Services in the development of rules regulating ocean energy technologies in Federal waters, in accordance with EPACT provisions;
- work with other Federal and state agencies on environmental and other regulatory activities deemed necessary;
- engage in cooperative research and development with the International Energy Agency on ocean energy technologies;
- collaborate with universities, laboratories, developers, non-governmental organizations and others in the public and private sectors on issues and barriers;
- support international certification of standards for water power technologies; and
- seek regular peer reviews of the overall strategies and activities by academia, industry representatives, National Laboratories, and independent experts.

Validation and Verification

To validate and verify program performance, the Water Power Program will conduct internal and external independent peer reviews and audits. The initial resource assessments and technology characterizations will help to set the baseline for further development of technology goals and annual targets.

Water Power

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Water Power			
Water Power	0	9,909	3,000
Total, Water Power	0	9,909	3,000

Description

This multi-year effort will conduct resource assessments, technology characterizations, resource assessments, and industry partnerships to facilitate the understanding of water power technologies to provide information that will help industry in its decision-making. Specifically, these activities would include ocean energy and run-of-river resource assessments and validations, while conducting assessment and modeling of today's technologies, leading to decisions about specific R&D directions. Assuming the decision is to pursue R&D, activities would then focus on the development, design, deployment and enhanced marine survivability in accordance with international certification efforts; prototype development through industry partnerships; and field testing of deployed prototypes. Funding would also be used to provide core/critical staff, consolidate knowledge, showcase existing technology, and develop a strategic plan. This activity would directly support DOE program goals to increase energy diversity and improve energy infrastructure. Water Power technologies are not currently a DOE tracked activity.

Detailed Justification

Water Power

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Water Power	**0**	**9,909**	**3,000**

Following initiation of activities in FY 2008, FY 2009 activities will include: 1) continuing a comprehensive resource assessment of water power in the United States, including wave and current (ocean and tidal) resources; 2) continuing technology characterizations, with expected completion by the end of FY 2010; and 3) launching a limited Cooperative Research and Development Agreement (CRADA) to assess performance and cost and to help advance water power technology development and demonstration.

	FY 2007	FY 2008	FY 2009
Total, Water Power	**0**	**9,909**	**3,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Funds provided by Congress in FY 2008 to conduct resource and technology assessments are sufficient to carry out these activities well into FY 2009. The $3 million request for FY 2009 will be sufficient to continue critical activities during the remainder of the fiscal year.	-6,909
Total Funding Change, Water Power	**-6,909**

Vehicle Technologies

Funding Profile by Subprogram

	(dollars in thousands)				
	FY 2007 Current Appropriation[a]	FY 2008 Original Appropriation	FY 2008 Adjustments[b]	FY 2008 Current Appropriation	FY 2009 Request
Vehicle Technologies					
Hybrid Electric Systems	0	95,000	-865	94,135	103,361
Vehicle Systems	13,006	0	0	0	0
Hybrid and Electric Propulsion	59,240	0	0	0	0
Advanced Combustion Engine R&D	48,346	45,000	-410	44,591	33,600
Materials Technology	29,044	40,000	-364	39,636	36,903
Fuels Technology	18,413	18,000	-164	17,836	16,122
Technology Integration	0	17,000	-154	16,845	31,100[c]
Innovative Concepts	500	0	0	0	0
Technology Introduction	15,031	0	0	0	0
Total, Vehicle Technologies	183,580	215,000	-1,957	213,043	221,086

Public Law Authorizations:

P.L. 95-91, "U.S. Department of Energy Organization Act" (1977)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Vehicle Technologies Program is to develop more energy-efficient and environmentally friendly highway transportation technologies (for both cars and trucks) that meet or exceed performance expectations and environmental requirements and that will enable America to use significantly less petroleum and reduce greenhouse gas emissions. Accomplishing the mission will benefit the demand sides of the Department's energy security equation, enabling more productive use of the energy we consume.

The Vehicle Technologies (VT) Program mission and activities contribute directly to EERE's and DOE's mission of improving National Energy and Economic Security by addressing the President's Advanced Energy Initiative that supports the National Energy Policy call for reducing dependence on oil imports and modernizing conservation technologies and practices. President Bush observed that "We need to get on a path away from the fossil fuel economy. If we want to be less dependent on foreign

[a] Excludes amounts transferred to the Science appropriation for carrying out SBIR / STTR. All subsequent tables in this program also reflect this transfer.
[b] Reflects amounts rescinded by General Provision, Section 312, of the Omnibus Appropriations Act, 2008.
[c] Includes activities previously funded in the Hydrogen Program (Technology Validation, Safety and Codes and Standards, and Education).

sources of energy, we must develop new ways to power automobiles."[a] In fact, highway vehicles alone account for 55 percent of total U.S. oil use ─ more than all U.S. domestic oil production. Cost-competitive, more energy-efficient and fuel diverse vehicles will enable U.S. citizens and businesses to accomplish their daily tasks while reducing their consumption of gasoline and diesel fuels, thus reducing demand for petroleum, lowering carbon emissions, and decreasing energy expenditures. As the President also noted, "America is on the verge of technological breakthroughs that will enable us to live our lives less dependent on oil. And these technologies will help us be better stewards of the environment, and they will help us to confront the serious challenge of global climate change."[b]

The Vehicle Technologies Program pursues its mission through integrated activities designed to improve the energy efficiency of highway vehicles and the productivity of our economy. .

Achievement of the program's goals is expected to displace 2 million barrels per day (mbpd) of imported oil in 2030 and 6 mbpd in 2050, based on modeling the program's goals within energy-economy models. This displacement will yield other energy security, environmental and economic benefits.

In the near term, advanced highway vehicle technologies, such as electric-fuel-engine hybrids ("hybrid-electric" vehicles) and clean diesel engines, could improve vehicle efficiency and, hence, lower CO_2 emissions. Other reductions might result from modal shifts (e.g., from cars to light rail) or higher load factors, improved overall system-level efficiency, or reduced transportation demand. Improved intermodal connections could allow for better mode-shifting and improved efficiency in freight transportation.

In the near to mid-term, transportation energy use can be reduced through improved vehicle efficiency, clean diesel engines, hybrid propulsion, and the use of hydrogenated low-sulfur gasoline. Other fuels, such as ethanol, natural gas, electricity with storage, and biodiesel, can also provide attractive means for reducing energy use. These efficiency gains and fuel alternatives also provide other benefits, such as improving urban and regional air quality and enhancing energy security.

By 2030 the Vehicle Technologies Program technologies could directly contribute a cumulative reduction of at least 4 billion bbls of oil, 1.5 gigatons of carbon and consumer savings of nearly $250 billion. By mid century the benefits will increase by as much as tenfold. The program's economic, environmental and security benefits that are quantified as expected program outcomes are described in more detail under the "Expected Program Outcomes" sections.

Program Deliverables and Interdependencies

- Four technology pathways each of which when completed can improve vehicle efficiency (noted in parenthesis), thus lowering oil use and greenhouse gas emissions:
  - Advance hybrid electric vehicle component efficiency (up to 50 percent),
  - Improve Plug-in hybrid electric vehicle components (up to 300 percent),

[a] Remarks by President George W. Bush on Energy Efficiency, National Small Business Conference, Washington, D.C., April 27, 2005.
[b] Ibid.

- Advance combustion engines and enabling fuels (up to 50 percent and displacement of oil by non-petroleum fuels), and
- Vehicle lightweighting (up to 30 percent).

These improvements also can be combined to create integrated advanced technology vehicles capable of between 200 and 400 percent increased fuel economy per vehicle for passenger vehicles and 80 percent for commercial vehicles.

- Deployment activities will engage industry in development and testing of prototype/pre-prototype vehicles to identify technology flaws to be eliminated prior to technology introduction and technology development opportunities that lead to further cost reductions and/or performance improvements.
- Ethanol distribution infrastructure. Successful deployment of alternative fuel vehicles depends on adequate infrastructure for large-scale distribution of ethanol and ethanol blends. Currently, ethanol cannot be transported though the pipelines that carry petroleum products. Ethanol must be distributed by tanker truck or rail that limits the number of gallons that can be transported.
- Hydrogen distribution infrastructure. Successful deployment of fuel cell vehicles using hydrogen depends on adequate infrastructure for hydrogen distribution.
- Electricity grid capacity. Successful deployment of PHEVs depends on adequate grid capacity during peak hours. Lack of this capacity will reduce the introduction rate of PHEVs that have limited range and require recharging during the day. Limited availability of adequate electric outlets at many residences could also be a barrier to deployment.

Interdependencies include the following and are detailed in the Collaboration and Partnership section:

- **FreedomCAR and Fuel Partnership.** The program participates in the FreedomCAR and Fuel Partnership along with the Hydrogen Technology Program (HT), the U.S. Council for Automotive Research (USCAR) and five energy companies to support the Partnership's goals. The FreedomCAR and Fuel partners have identified eight specific technology goals for 2010 and 2015 to guide government and industry R&D efforts and to measure their progress. This request fully supports FreedomCAR goals for both hybrid and internal combustion power-train systems and light-weight materials.
- **21st Century Truck Partnership.** The 21st Century Truck Partnership (21CTP) is a cooperative effort between the commercial vehicle (truck and bus) industry and major Federal agencies to develop technologies that will make our Nation's commercial vehicles more efficient, clean, and safe and to:
  - increase engine efficiency;
  - reduce fatalities through advanced safety systems;
  - reduce parasitic and idling losses; and
  - validate and demonstrate these technologies.

- **DOE R&D Pathway Integration.** Vehicle Technologies participates in an effort to integrate and harmonize R&D pathways across DOE's energy research programs. VT's principal counterparts are the Biomass and Biorefinery Systems R&D, Building Technologies, and Hydrogen Technology programs within EERE, and the Basic Energy Sciences Program within the Office of Science.
- The program is also collaborating with the Environmental Protection Agency (EPA) to promote deployment.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Vehicle Technologies Program supports the following goals:

Strategic Theme 1, Energy Security

Strategic Goal 1.1, Energy Diversity: Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs.

And concurrently supports:

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Goal 1.4, Energy Productivity: Cost effectively improves the energy efficiency of the U.S. economy.

GPRA Unit Program Goal 1.1.02.00: Vehicle Technologies - The Vehicle Technologies Program goal is developing technologies that enable cars and trucks to become highly efficient, through improved power technologies and cleaner domestic fuels, while remaining cost- and performance-competitive. Manufacturers and consumers can then use these technologies to help the Nation reduce both petroleum use and greenhouse gas emissions.

By contributing to Strategic Goal 1.4 through the program goal, the Program also will make substantial contributions to achieving Strategic Goal 1.1 of creating energy diversity through increasing the use of biofuels and electricity for highway transportation; and Strategic Goal 1.2 by improving the quality of the environment through substantial reduction in the use of oil through higher efficiencies and oil displacement.

Contribution to GPRA Unit Program Goal 1.1.02.00 (Vehicle Technologies)

The key program contribution to Strategic Theme 1, Energy Security, is the direct reduction of petroleum use. The VT Program supports an R&D portfolio focused on developing technologies that can enable dramatic improvements in the energy efficiency of passenger vehicles (e.g., cars, light trucks, and SUV's) and commercial vehicles (heavy trucks, buses, etc.). In addition, the program R&D will focus on reducing the cost and overcoming technical barriers to volume manufacturing of advanced vehicle technologies.

The program's goals presented below demonstrate key technology pathways that contribute to achievement of reduced oil use.

- Hybrid Electric Systems subprogram (Power Electronics and Electric Motor R&D):

  - As an intermediate goal, by 2010, develop an integrated electric propulsion system that costs no more than $19/kW peak and can deliver at least 55 kW of power for 18 seconds and 30 kW of continuous power with an inlet coolant temperature of 90°C ($1,045 per system compared to the cost of $1,925 in 2004 with an inlet coolant temperature of 70°C). Additionally, the propulsion system will have an operational lifetime of 15 years.

  - By 2015, meet the same life and performance requirements at a cost of $12/kW with an inlet coolant temperature of 105°C.

- Hybrid Electric Systems subprogram (Energy Storage):

  - Reduce the production cost of a high power 25 kW battery for use in passenger vehicles from $3,000 in 1998 to $500 by 2010, enabling cost competitive market entry of hybrid vehicles; and

  - Reduce the production cost of a high energy and high power battery from $1,000 per kWh in 2006 to $300 per kWh by 2014, enabling cost competitive market entry of plug-in hybrid electric vehicles (PHEVs).

- Hybrid Electric Systems subprogram (Technology Validation): verify under, real world conditions, hydrogen fuel cell vehicle performance and 2,000 hour durability by 2009, and hydrogen infrastructure technologies with a cost of $3.00 per gge in 2009.

- Advanced Combustion R&D subprogram and Fuels Technology subprogram: Improve the efficiency of internal combustion engines from 30 percent (2002 baseline) to 45 percent by 2010 for passenger vehicles and from 40 percent (2002 baseline) to 55 percent by 2013 for commercial vehicle applications while utilizing an advanced fuel formulation that incorporates a non-petroleum based blending agent to reduce petroleum dependence and enhance combustion efficiency.

- By 2010, develop material and manufacturing technologies which, if implemented in high volume, could cost-effectively reduce the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to 2002 vehicles.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.1, Energy Diversity			
GPRA Unit Program Goal 1.1.02.00,			
Vehicle Technologies			
Hybrid Electric Systems	0	94,135	103,361

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Vehicle Systems	13,006	0	0
Hybrid and Electric Propulsion	59,240	0	0
Advanced Combustion Engine R&D	48,346	44,591	33,600
Materials Technology	29,044	39,636	36,903
Fuels Technology	18,413	17,836	16,122
Technology Integration	0	16,845	31,100
Innovative Concepts	500	0	0
Technology Introduction	15,031	0	0
Total, Strategic Goal 1.1 (Vehicle Technologies)	183,580	213,043	221,086

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.1.02.00 (Vehicle Technologies)					
Hybrid Electric Systems/Advanced Power Electronics and Electric Motors R&D					
			Demonstrate in the laboratory a motor with a specific power of 1.0 kW/kg, power density of 3.0 kW/liter, projected cost of $9/kW peak, and efficiency of 90 percent. [MET]	Reduce the projected cost (modeled) of a combined inverter/motor to $22/kW peak for a specific power of 1.0 kW/kg, a power density of 2.0 kW/liter, and an inlet coolant temperature of 90^{o} C.	Reduce the projected cost (modeled) of a combined inverter/motor to $19/kW peak for a specific power of 1.0 kW/kg, a power density of 2.2 kW/liter~~,~~ and an inlet coolant temperature of 90^{o} C.
Hybrid Electric Systems /Energy Storage R&D					
Reduce high-power 25 kW light vehicle estimated lithium ion battery cost to $1,000 per battery system. [MET]	Reduce high-power, 25 kW, light vehicle, lithium ion battery cost to $900 per battery system. [MET]	Reduce the projected cost at high volume of a high power, 25 kW, light vehicle, lithium ion battery to $750 per battery system. [MET]	Reduce high power, 25 kW, passenger vehicle, lithium ion battery cost to $700 per battery system for conventional hybrid vehicles. [MET]	Reduce modeled production cost of high-power, 25 kW passenger vehicle lithium-ion battery to $625. (Storage batteries are a key cost and performance component for hybrid vehicles, which offer improved fuel economy.)	Reduce modeled production cost of high-power, 25 kW passenger vehicle lithium-ion battery to $550. (Storage batteries are a key cost and performance component for hybrid vehicles, which offer improved fuel economy.)
Hybrid Electric Systems/Technology Validation					
Identify and complete feasibility and system design of an isothermal compressor to be incorporated in hydrogen refueling stations to produce hydrogen at $3.00/gge by 2009. [MET]	Complete validation of an energy station that can produce 5,000 psi hydrogen from natural gas for $3.60 per gallon of gasoline equivalent (including co-production of electricity) untaxed at the station with mature equipment production volumes (e.g., 100 units/year). [MET]	Complete installation and 1,000 hours of testing of a refueling station; determine system performance, fuel quality and availability; and demonstrate the ability to produce 5,000 psi hydrogen from natural gas for a projected cost of $3.00 per gallon of gasoline equivalent, untaxed at the station, assuming commercial deployment with large equipment production volumes (e.g., 100 units/year) by 2009. [MET]	Validate achievement of a refueling time of 5 minutes or less for 5 kg of hydrogen at 5,000 psi through the use of advanced sensor, control, and interface technologies. [MET]	Fuel Cell vehicle(s) demonstrate the ability to achieve 250 mile range without impacting cargo or passenger compartments leading to greater adoption of fuel cell vehicles. Technology Validation shows 103-190 mile range under real world operating conditions	Verify under real world conditions hydrogen infrastructure technologies with a cost of $3.00 per gge.
Industry contracts are awarded and initial vehicles delivered that support the 1,000 hour durability target. [MET]	Fuel Cell demonstration vehicles' durability can be projected to 1,000 hours based on voltage measurements. [PARTIALLY MET]	Operate fuel cell vehicle fleets to determine if 1,000 hour vehicle fuel cell durability, using fuel cell degradation data, was achieved by industry. [MET]			

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Advanced Combustion Engine R&D; Fuels Technology					
Complete Light Truck activity with 35 percent fuel efficiency improvement over a gasoline powered light truck and Tier 2 emissions levels (0.07g/mile NO_x). Demonstrate 45 percent thermal efficiency for heavy-duty commercial vehicle diesel engines while meeting EPA 2007 emission standards (1.2g/hp-hr NO_x). [MET]	Light vehicle combustion engines will reach 39 percent brake thermal efficiency and commercial heavy-duty vehicle combustion engines will be greater than 45 percent efficient while meeting EPA 2007 emission standards (1.2 g/hp-hr NO_x). [MET]	Achieve 41 percent brake thermal efficiency for light vehicle combustion engines and 50 percent brake thermal efficiency, while meeting EPA 2010 emission standards (0.2 g/hp-hr NOx), for heavy vehicle combustion engines. [MET]	In the laboratory, demonstrate passenger vehicle combustion engines with a 42 percent brake thermal efficiency. [MET]	Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 43 percent. (Engine efficiency improvements can improve vehicle fuel economy.)	Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 44 percent. (Engine efficiency improvements can improve vehicle fuel economy.)
				Complete progress review of heavy-duty engine research and down-select from 4 to 2 the number of cooperative agreements for continued R&D, based on the best prospects of achieving the 2013 goal of 55 percent engine efficiency.	Internal Combustion laboratory demonstrated engine efficiency for heavy-duty vehicles of 51 percent while meeting EPA 2010 emission standards (0.2 g/hp-hr NOx). Engine efficiency improvements can improve vehicle fuel economy.)
Materials Technology/Lightweight Materials Technology					
Complete R&D on technologies which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $5/pound. [MET]	Complete R&D on technologies, which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $4.50/pound. [MET]	Complete R&D on technologies, which, if implemented in high volume, could reduce the projected (i.e., modeled) bulk cost of automotive-grade carbon fiber to less than $3.00/pound. [NOT MET]	Reduce the modeled weight of a mid-sized passenger vehicle body and chassis components by 10 percent relative to baseline. [MET]	Reduce the modeled weight of a passenger vehicle body and chassis system by 25 percent relative to the 2002 baseline.	Reduce the modeled weight of a passenger vehicle body and chassis system by 40 percent relative to 2002 baseline.
Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (2005) until the target range is met. [MET]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2006) until the target range is met. [PARTIALLY MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs at less than 12 percent of total program costs.	Maintain administrative costs at less than 12 percent of total program costs.

Means and Strategies

The Vehicle Technologies Program will use various means and strategies to achieve its GPRA Unit program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the program's ability to achieve its goals. Collaboration with industry partners and other DOE programs will be integral to the planned investments, and the means and strategies used to address external factors.

Means:

Vehicle Technologies uses five basic means of accomplishing the program's goals: support of R&D, deployment efforts, coordination of R&D through government-industry partnerships, market analyses to inform strategic planning, and external and peer reviews of the program's direction and progress.

- The primary barriers and opportunities for improved vehicle efficiency are technological. Therefore the program uses the majority of its funds to support research and development (R&D) of technologies that have the potential to achieve significant improvements in vehicle fuel efficiency or significant displacement of petroleum-based fuels with clean, cost-competitive alternative fuels that can be produced domestically. Research performed by National Laboratories and universities is generally not cost-shared, but virtually all R&D performed by private industry is cost-shared, with the private share ranging from 20 percent to more than 50 percent. Most of the program's university and industry R&D is competitively awarded.
- Market deployment and adoption of new technologies face numerous non-technological barriers. To address these barriers, the program funds and facilitates demonstration and deployment efforts in the Technology Integration subprogram. Those efforts recently have focused on the use of alternative-fuel vehicles, but increasingly the deployment efforts will broaden to include plug-in hybrid electric vehicles (PHEVs) and other advanced technologies. Industry adoption of new technologies is also advanced through the program's university-oriented activities that create graduate education opportunities working with new technologies and encourage undergraduate engineering students to gain experience with hybrid systems technology and advanced combustion engines.
- The program makes extensive use of government/industry consortia to coordinate R&D goals and plans between DOE and our industry partners. Virtually all of the program's R&D is coordinated using technology roadmaps developed in either the FreedomCAR and Fuel Partnership or the 21st Century Truck Partnership. The partnerships not only address what research needs to be performed, but serve as a forum for discussion of which activities industry will undertake on their own and which may be appropriate for DOE funding.
- Both the R&D and deployment activities fund market and economic analyses as needed to properly inform the program's technology strategies and multi-year plans.
- The program's goals, activities, and progress are reviewed by our industry partners in the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership by industry and academic experts, through technical and programmatic reviews, and by the National Academies of Science through a formal biennial Peer Review process.

Strategies:

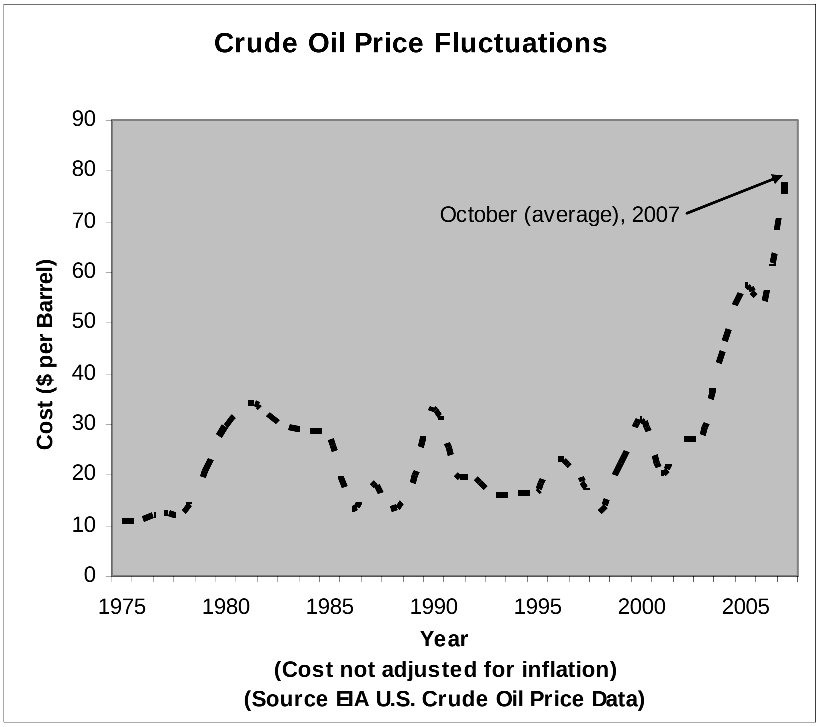
There are four fundamental ways in which vehicle efficiency can be improved and petroleum use can be displaced: more efficient combustion engines, hybrid-electric vehicle systems, reduced vehicle weight, and use of alternative fuels. The Vehicle Technologies Program is addressing all four approaches:

- Improved combustion technologies and optimized fuels can provide near- and mid-term fuel-efficiency gains in both passenger and commercial vehicles.
- Improved hybrid-electric systems and components can provide significant improvements in fuel economy even beyond the current generation of hybrids, and technologies optimized for plug-in hybrids will allow displacement of petroleum by electricity in passenger vehicles in the mid- and long-term.
- The efficiency of all vehicles – both passenger and commercial – can be improved by the development of lightweight materials to reduce vehicle weight and improve fuel economy. The VT Program supports R&D on both lightweight structural materials and also high-performance materials for energy storage and power-train components.
- Petroleum can be displaced by the use of alternative fuels. The development of alternative fuel production technologies is the responsibility of other DOE programs and Federal agencies (such as DOE's Hydrogen and Biomass programs and the Department of Agriculture), but the Vehicle Technologies Program has the lead in facilitating deployment and encouraging adoption of alternative fuels through partnerships with state and local governments, universities, industry, and other organizations. Beginning in FY 2009, these responsibilities include validation and learning demonstrations of hydrogen fuel-cell vehicles and hydrogen filling stations as well. The program's deployment activities will also expand to promote the adoption of advanced petroleum-displacement technologies such as plug-in hybrid-electric vehicles.

If successful, these strategies would result in significant cost savings and a significant reduction in the consumption of gasoline and diesel fuels, cost-effectively reducing America's demand for petroleum, lowering carbon emissions, and decreasing energy expenditures.

The following external factors could affect the ability of the Vehicle Technologies Program to achieve its strategic goal:

- The interest that consumers place on new vehicle fuel economy can be very dependent on the price of gasoline. But because gasoline prices have historically gone up and down, they have not provided a consistent signal. (See "Crude Price Fluctuations" figure.)



Manufacturers and consumers generally have not expected prices to remain high, but this may change. As a result of previous low consumer motivation for high fuel economy vehicles, manufacturers have been reluctant to assume the risk required for the production and distribution of advanced energy-efficient vehicle technologies; and

- Energy savings, oil savings, carbon emission reductions, and energy expenditure savings are estimated using an Energy Information Agency (EIA) reference case that has assumed low future oil prices. The "Annual Energy Outlook 2006" from EIA increased the forecasted price of oil, but it still remains well below CY 2005 prices. The goals and benefits could be affected if changes in energy policy encourage consumers to purchase more efficient vehicles than is currently projected.

Collaboration and Partnerships

Collaboration and partnerships with industry and with other Federal programs have been key features of the Vehicle Technologies Program. The principal current collaborations are:

- **FreedomCAR and Fuel Partnership.** The program participates in the FreedomCAR and Fuel Partnership along with the Hydrogen Technology Program (HT), the U.S. Council for Automotive Research (USCAR) and five energy companies to support the Partnership's goals. The USCAR member companies are Ford Motor Company, General Motors Corporation and Chrysler LLC. The energy partners are BP America, Chevron Corporation, ConocoPhillips, Exxon Mobil Corporation, and Shell Hydrogen LLC. The Partnership is focused on precompetitive high-risk research necessary to provide a full range of affordable energy-efficient cars and passenger trucks, and their fueling infrastructure. The primary focus is on hybrid-electric vehicle technologies, supporting R&D on combustion-engine and plug-in electric hybrids for the nearer term and fuel-cell hybrids for the long term. Within this Partnership, the Vehicle Technologies Program is responsible for the combustion engine and fuels R&D and for hybrid vehicle systems technologies such as batteries, power electronics and for lightweight materials and system analysis. Beginning in FY 2009 it is also responsible for the learning demonstrations of fuel cell vehicles and hydrogen dispensing facilities. The Hydrogen Technology Program is responsible for developing fuel-cell technology that could be used in hybrid vehicles along with hydrogen production and fueling infrastructure technologies that would support such vehicles.

FreedomCAR Funding

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Approp.	FY 2009 Request
Vehicle Technologies Portion	109,774	127,358	157,656
Hydrogen Portion	81,804	80,461	79,300
Total, FreedomCAR Funding	191,578	207,819	236,956

The FreedomCAR and Fuel partners have identified eight specific technology goals for 2010 and 2015 to guide government and industry R&D efforts and to measure their progress. This request fully supports FreedomCAR goals for both hybrid and internal combustion power-train systems and light-weight materials.

FreedomCAR and Fuel Partnership Coordinated Technology Goals

Vehicle Technologies has responsibility for these goals:

- Electric Propulsion Systems with a 15-year life capable of delivering at least 55 kW for 18 seconds and 30 kW continuous at a system cost of $12/kW peak;
- Internal Combustion Engine Power train Systems costing $30/kW, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards;
- Electric Drive train Energy Storage with 15-year life at 300 Wh per vehicle and with discharge power of 25 kW for 18 seconds and $20/kW;
- Material and Manufacturing Technologies for high volume production vehicles which enable/support the simultaneous attainment of: 50 percent reduction in the weight of vehicle structure and subsystems, affordability, and increased use of recyclable/renewable materials; and
- Internal Combustion Engine Power train Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards *(shared responsibility with Hydrogen Technology).*
- Internal Combustion Engine Power train Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards *(shared responsibility with Hydrogen Technology)*
- Demonstrate hydrogen refueling and develop commercial codes and standards and diverse renewable and non-renewable energy sources. (Beginning in FY 2009 the demonstrations and codes and standards activities will be funded in the Vehicle Technologies Program.) Achieve a cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $2.00-3.00 per gallon gasoline equivalent produced and delivered to the consumer independent of pathway by 2015 *(shared responsibility with Hydrogen Technology).*

Hydrogen Technology has responsibility for these goals:

- 60 percent peak energy-efficient, durable fuel cell power systems (including hydrogen storage) that achieve a 325 W/kg power density and 220 Wh/L operating on hydrogen. Cost targets are $45/kW by 2010 and $30/kW by 2015; and
- On-board Hydrogen Storage Systems demonstrating specific energy of 2.0 kWh/kg (6 weight percent hydrogen), and energy density of 1.5 kWh/L at a cost of $4/kWh by 2010 and specific energy of 3.0 kWh/kg (9 weight percent hydrogen), 2.7 kWh/L, and $2.00/kWh by 2015.

- **21st Century Truck Partnership.** The 21st Century Truck Partnership (21CTP) is a cooperative effort between the commercial vehicle (truck and bus) industry and major Federal agencies to develop technologies that will make our Nation's commercial vehicles more efficient, clean, and safe. Federal agency participants in the Partnership are the Departments of Energy, Defense (represented by the U.S. Army), Transportation, and the Environmental Protection Agency. Industry partners are Allison Transmission, BAE Systems, Caterpillar, Cummins, Detroit Diesel, Eaton Corporation, Freightliner, Honeywell International, International Truck and Engine, Mack Trucks, NovaBUS, Oshkosh Truck, PACCAR, and Volvo Trucks North America. The 21CTP effort centers on research and development to:

- increase engine efficiency;
- improve performance of hybrid powertrains;
- reduce fatalities through advanced safety systems;
- reduce parasitic and idling losses; and
- validate and demonstrate these technologies.

21st Century Truck Funding

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Approp.	FY 2009 Request
21st Century Truck Funding	42,021	29,792	25,195

- **DOE R&D Pathway Integration.** Vehicle Technologies participates in an effort to integrate and harmonize R&D pathways across DOE's energy research programs. VT's principal counterparts are the Biomass and Biorefinery Systems R&D, Building Technologies, and Hydrogen Technology programs within EERE, and the Basic Energy Sciences Program within the Office of Science.
- The program is also collaborating with the Environmental Protection Agency (EPA) to promote deployment of two specific technologies, as discussed in EPA's strategic plan: (1) DOE's Technology Integration activity will leverage its Clean Cities partnerships to work with EPA's SmartWay Transport Partnership to promote the installation of more biodiesel and E85 ethanol refueling stations around the country; and (2) the program will also cooperate with EPA to promote the adoption of idling-reduction technologies and practices for trucks and buses.

Validation and Verification

To validate and verify program performance, the Vehicle Technologies Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the Department's Inspector General, and the National Academy of Sciences. The Vehicle Technologies Program also uses several program performance management methods to validate and verify its performance during the course of the program on an annual and ongoing basis, including: management standards; incorporation of goals; measurement and reporting from program contracts; peer reviewed roadmaps and activities; performance modeling and estimation; prototype testing; site visits; and annual program reviews.

Data Sources: Program Reviews, Peer Reviews, Laboratory Tests, On-Road Tests, and Peer-Reviewed Model Baselines.

Baseline: Cost of hybrid batteries in 1998 ($3,000 projected for volume production of a high power 25 kW battery), combustion efficiency in 2002 (30 percent for passenger vehicles and 40 percent for commercial vehicles), 2002 passenger vehicle weight (3450 pounds as the nominal weight for a mid-sized car), cost of plug-in hybrid high energy battery in 2006 ($1,000/kWh), and integrated electric propulsion system cost in 1998 ($1,900). (Note: cost values are not adjusted for inflation.)

Frequency: Biennial Peer reviews will be conducted in alternate years for the FreedomCAR and Fuel Partnership and for the 21st Century Truck Partnership.

Data Storage: EE Corporate Planning System

Evaluation: In carrying out the program's mission, the VT Program uses several forms of evaluation to assess progress and to promote program improvement. These are conducted at both the program and the activity levels. The types of evaluations are:

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the VT Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based on Joule (the DOE quarterly performance progress review of budget targets), PMA (the President's Management Agenda ─ annual departmental and Program Secretarial Officer (PSO) based goals whose milestones are planned, reported and reviewed quarterly), and PART (common government wide program/OMB reviews of management and results);
- Annual review of methods, and computation of the potential benefits for the Government Performance and Results Act (GPRA); and
- Biennial reviews of both the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership by an independent third party, such as the National Academy of Sciences/National Academy of Engineering, to evaluate progress and program direction. The reviews include evaluation of progress toward achieving the Partnership's technical goals and direction. Based on this evaluation, resource availability, and other factors, the FreedomCAR and Fuel partners and the 21CT partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate.

Verification: Run and document vehicle simulation tests, conduct bench tests, run laboratory tests on the engine and vehicle dynamometers, run wind tunnel tests, and conduct on-road and track tests to evaluate the technology. Conduct fleet tests and undertake target performance review.

Program Assessment Rating Tool (PART)

PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The Department has implemented this tool to evaluate selected programs in conjunction with OMB. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The VT Program continues to incorporate feedback from OMB's PART comments into the FY 2009 Budget Request and is taking the necessary steps to continue to improve performance.

The Vehicle Technologies Program received its last OMB PART review in 2004. The 2004 PART review included ratings of 80 percent for program purpose, 90 percent for planning, 100 percent for management and 75 percent for program results and accountability with an overall rating of "moderately effective," the second-highest overall rating possible (total weighted score of 83 percent). The PART recommended that the program add a peer review to include the 21st Century Truck Partnership, including an assessment of the appropriateness of Federal support in each program area, which was completed in FY 2007.

The Department has responded to the PART recommendation of "Develop guidance that specifies a consistent framework for analyzing the costs and benefits of research and development investments, and use this information to guide budget decisions." The Department continues to work on the development and implementation of common assumptions, a consistent approach to incorporation of risk, and other issues. EERE continues to refine the methods its uses in support of this framework and Departmental processes."

Another PART recommendation was added in FY 2006. Based on a peer review by the National Academies, the review panel recommended that the program "Set priorities and identify decision points to focus resources on solving the most critical problems to commercialization of technologies that can reduce petroleum consumption." The program has been addressing this recommendation, as reflected in the budget shifts within FY 2008 and FY 2009 requests. For example, the National Academies recommended placing greater emphasis on battery R&D. The program continues do this, particularly in conjunction with the President's Advanced Energy Initiative and the Twenty in Ten Initiative where funding for high energy battery research (suitable for plug-in hybrid vehicles) has been emphasized.

Expected Program Outcomes

Estimates of the security, economic and environmental benefits from 2009 through 2050 that would result from realization of the program's goals are shown in the table below. These benefits are achieved by targeted Federal investments in technology research and development in partnership with auto manufacturers, commercial vehicle manufacturers, equipment suppliers, fuel and energy companies, other Federal agencies, state government agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits for the American taxpayer.

The table reflects the increasing penetration of the program's technologies over time, as the program's goals are met. Not included are any policy or regulatory mechanisms, or other incentives not already in existence, that might be expected to support or accelerate the achievement of the program goals. The expected benefits reflect solely the achievement of the program's goals.

The goals are modeled in contrast to the "baseline" case, in which no DOE R&D exists. The baseline case is identical to those used for all DOE applied energy R&D programs.[a] Further, across EERE, and across all of DOE's applied energy R&D programs, the expected outcome benefits are being calculated using the same fundamental methodology. Finally, the metrics by which expected outcome benefits are measured are identical for all of DOE's applied energy R&D programs.[b] This standardization of methods and metrics has been undertaken as part of the Department's efforts to respond to OMB's request to make all programs' outcomes comparable.

The difference between the baseline case and the program goal case results in economic, environmental and security benefits. For example, achievement of program goals results in a reduction in cumulative net consumer expenditures of almost $20 billion dollars by 2030 and approaches $2 trillion by 2050. Finally, the program would also result in carbon emissions reductions of 1.5 gigatons by 2030 and 20 gigatons by 2050. The results are generated by modeling the program goals within two energy-economy models: NEMS-GPRA09 for benefits through 2030, and MARKAL-GPRA09 for benefits through 2050.[c] The full list of modeled benefits appears below.

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[a] The starting point for the baseline case is the Energy Information Administration's "reference case," as published in the AEO 2007. Program analysts from across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO's technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

[b] The set of expected outcome metrics being used this year differs in substantial ways to that of most years. In addition to the standardization across DOE's applied energy R&D programs, the list is expanded and more comprehensive than in past years. Further, the list maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

[c] Documentation on the analysis and modeling can be found at http://www1.eere.energy.gov/ba/pba.

Primary Benefits Metrics for FY09 Request – NEMS and MARKAL

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	0.1	0.6	4.2	N/A
		MARKAL	0.2	1.1	8.5	47.1
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	6.5
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	7%
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	38	212	1565	N/A
		MARKAL	173	705	3920	20209
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	6	40	246	N/A
		MARKAL	38	113	505	1739
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	6	-5
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	30	100	300	N/A
		MARKAL	53	114	442	970

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

The model used to estimate these benefits increases the market share of advanced-technology vehicles over time as their projected incremental cost relative to conventional vehicles declines and as their efficiency relative to conventional vehicles increases. The energy savings (in the long-term benefits) are the net savings to the vehicle users, including both the value of fuel saved and the incremental expenditures they made to purchase their advanced vehicles. Carbon emission reductions are based on the amount of carbon that the petroleum products saved would have released if they had been used.

Basic and Applied R&D Coordination

The Vehicle Technologies Program pursues a broad technology portfolio aimed at reducing petroleum consumption. The program works closely with the Office of Science and other applied R&D offices such as the Office of Electricity Delivery and Energy Reliability. Specific examples of basic and applied R&D coordination are provided below.

The Energy Storage activity coordinates with other DOE programs doing relevant work in advanced battery technologies in order to maximize the return on DOE's technology investments in this area. Close cooperation with the Office of Basic Energy Sciences provides valuable technical and programmatic support. The activity also coordinates with the Energy Storage Program in the Office of Electricity Delivery and Energy Reliability on the development of batteries and components that might serve both transportation and stationary applications.

In coordination with the Office of Basic Energy Sciences, and the Office of Electricity Delivery and Energy Reliability, the VT energy storage activity will participate in integrated activities to support development of nanoscale materials and architectures for electrical energy storage. Nanomaterials can exhibit superior performance over conventional battery materials in terms of high pulse discharge and recharge power and improved performance at low temperatures. However, the behavior of these materials is not well understood and is thought to be more than just a length-scale effect. New diagnostic tools and techniques could be required to investigate these materials.

The Advanced Combustion R&D Program collaborates with the Office of Science through its combustion research and modeling activities which are conducted at Office of Science facilities at Sandia National Laboratory /Combustion Research Facility and the Argonne Laboratory/Advanced Photon Source. Although Vehicle Technologies pays for the salaries of the researchers the bulk of the equipment and the facilities are owned and operated by the Office of Science. Work conducted at these facilities is fully integrated into the Office of Science activities and cost sharing is obtained through the free use of the equipment and facilities.

Hybrid Electric Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Hybrid Electric Systems			
Vehicle and Systems Simulation and Testing	0	28,201	21,126
Technology Validation	0	0	14,789
Energy Storage R&D	0	48,236	49,457
Advanced Power Electronics and Electric Motors R&D	0	15,462	15,604
SBIR/STTR	0	2,236	2,385
Total, Hybrid Electric Systems	0	94,135	103,361

Description

This subprogram unites all of the program's efforts directly relating to the planning and modeling, development, and evaluation of advanced hybrid, electric, and plug-in hybrid drive systems. Starting in FY 2009 it also includes the Technology Validation ("Learning Demonstration") activity that was previously funded in the Hydrogen Technology Program. Those demonstration and validation activities are being incorporated within the Vehicles Technology Program to take advantage of synergisms between comparable efforts in advanced technology vehicle testing and validation within the two programs. The Technology Validation activity is now included in the Hybrid Electric Systems subprogram.

The Hybrid Electric Systems subprogram funds R&D on advanced vehicle technologies for both passenger and commercial vehicles that could achieve significant improvements in fuel economy without sacrificing safety, the environment, performance, or affordability. Primary emphasis is given to R&D on those technologies that support development of advanced hybrid electric and plug-in hybrid electric vehicles. The subprogram also conducts simulation studies, component evaluations, and testing to establish needs, goals, and component/vehicle performance validation. This subprogram's funding contributes to the 21st Century Truck Partnership and the FreedomCAR and Fuel Partnership, and the President's Advanced Energy Initiative.

The subprogram focuses its work on the two basic building-blocks of hybrid vehicles, plus a collection of activities that tie the R&D efforts together and evaluate their progress.

- Energy Storage R&D addresses the first building block of a hybrid-electric vehicle: electricity storage. The needs of "regular" hybrid vehicles and plug-in hybrids are similar, but not identical: plug-in hybrids need to be able to store considerably more total energy in their batteries. Developing batteries that are rugged, long-lasting, affordable, lighter, hold a substantial charge, and work in all climates and seasons is still a major R&D challenge.

- Advanced Power Electronics and Electric Motors R&D addresses the second building block, which is the collection of all the electric and electronic devices that tie the power stored in the battery to the vehicle's drivetrain: power control circuits, charging circuits, electric motors, logic to synchronize the power from the battery and motors with the main vehicle engine, and other related components. The power electronics for a plug-in hybrid will be considerably more complex than for a regular hybrid to accommodate additional charging modes and more complex driving modes.

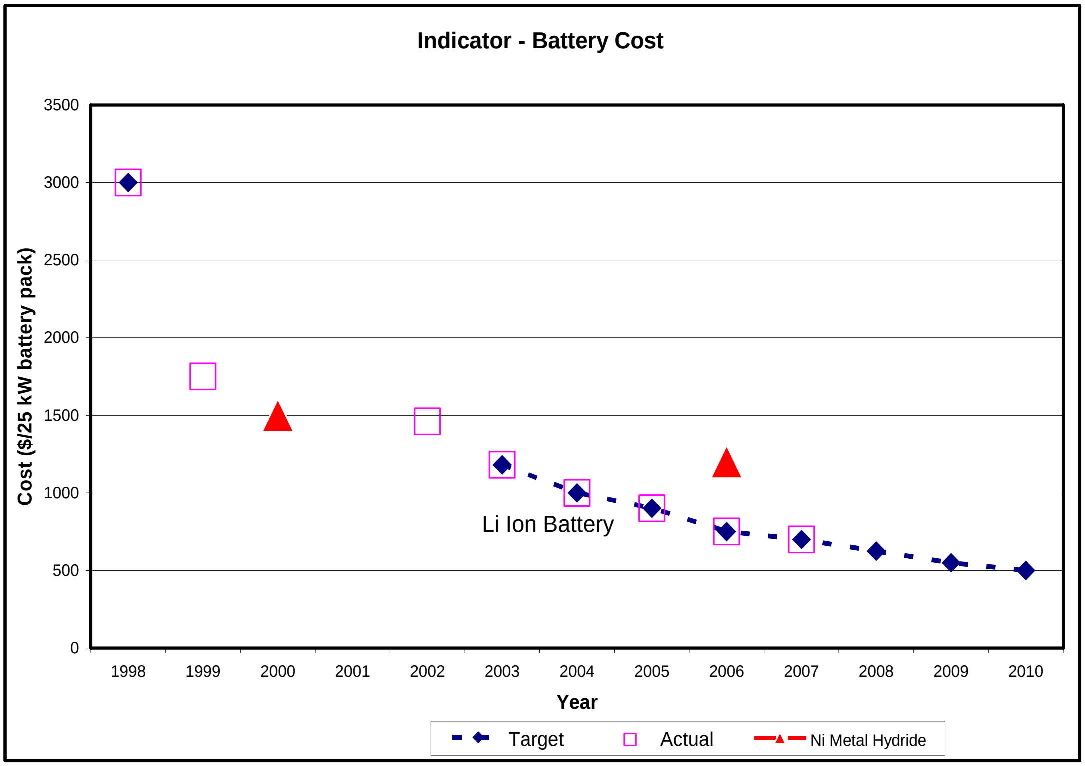
- Vehicle and Systems Simulation and Testing and the Technology Validation activities (moved from the Hydrogen Technology Program starting in FY 2009) tie all of the hardware R&D together. System-level simulations help specify the necessary performance characteristics of the hardware and predict the overall vehicle performance for a given configuration. Both simulation and testing activities can be used to evaluate the development and progress of individual components, and predict how well they will integrate with other components being developed. Tests and simulations also evaluate how well the program is approaching its whole-vehicle goals, and provide the technical inputs to models of future economic benefits.

  The Technology Validation activity includes the validation of both fuel cell technology and hydrogen infrastructure through the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project. The project is both a "Learning Demonstration" to manage the hydrogen and fuel cell component and materials research and a validation of the technology under real-world operating conditions against time-phased performance-based targets. The project is 50/50 cost-shared between the government and industry, including automobile manufacturers, energy companies, suppliers, universities, and state governments. Extensive data will be collected on vehicles operating on-road and during dynamometer testing. Validation of the hydrogen infrastructure includes verification of hydrogen production cost and fueling time while gaining experience in the safe operation of stations.

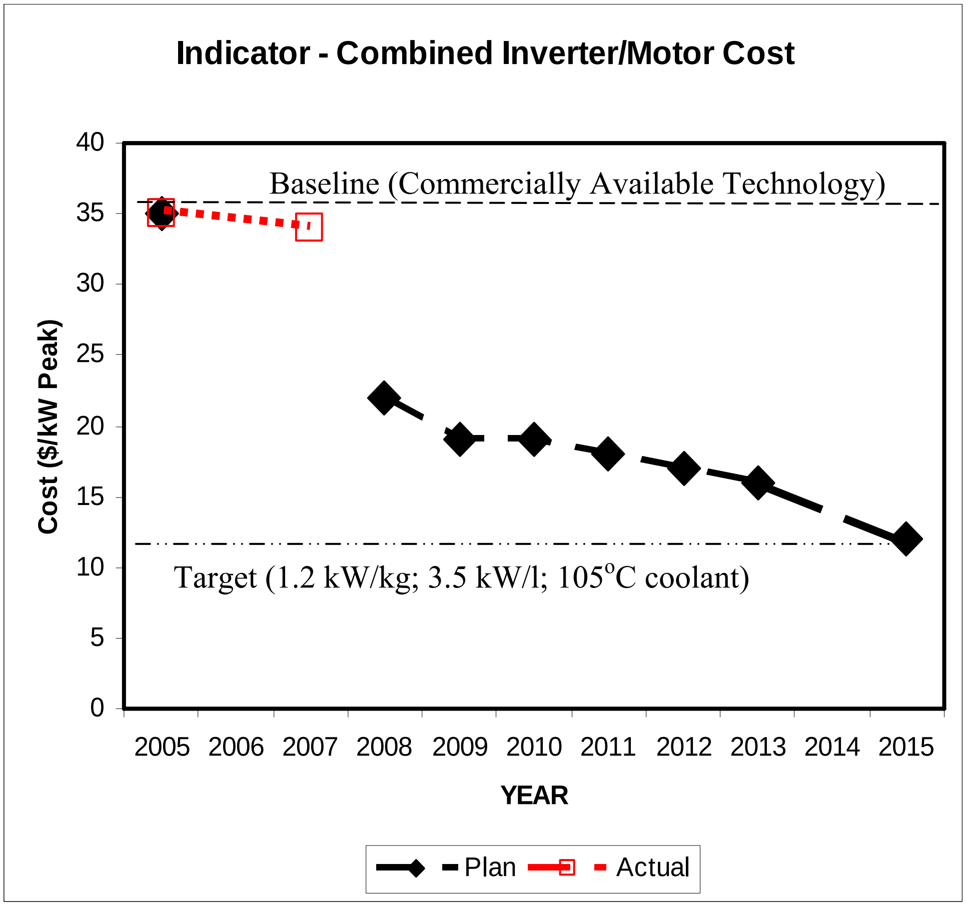
The Hybrid Electric Systems subprogram supports achieving the VT Program goal (04.02.00.00) by addressing those technology elements important to the utilization of electric energy storage, electric drives, and energy recovery in new, more efficient vehicle designs.

A key objective of the Hybrid Electric Systems R&D subprogram is to reduce the production cost of a high-power 25 kW battery for use in passenger vehicles from $3,000 in 1998 to $500 by 2010 (having met an intermediate goal of $750 in 2006), helping to enable cost competitive market entry of hybrid vehicles. Also by 2015, the program will develop an integrated electric propulsion system that costs no more than $12/kW peak and can deliver at least 55 kW of power for 18 seconds and 30 kW of continuous power, with a lifetime of 15 years when operated with an inlet coolant temperature of 105^{o}C.

Progress is indicated by cost per 25 kW battery system estimated for a production level of 100,000 battery systems per year and cost of hybrid power systems. Actual and projected progress for these indicators are shown graphically below:



Note: 1998 value is baseline.



Note: 2005 and 2007 Actual data are cost for commercially available systems.

Additionally in FY 2009, the subprogram will continue to accelerate the development of low-cost, high-energy batteries and corresponding improvements to the electric drive systems (motors, power electronics, and electric controls) needed for cost-effective plug-in hybrid electric vehicles. Plug-in hybrids (i.e., those that can be plugged into and recharged from an electric outlet) offer the potential to provide significant additional fuel savings benefits, particularly for commuter and local driving, for either combustion or fuel cell powered hybrid passenger vehicles.

Technology Validation will provide an accurate assessment of technology readiness and the risks to success facing continued government and industry investment helping to enable the automotive, energy and utility industries to determine if a business case can be made for technology deployment. The activity supports the Hydrogen Technology Program's mission by providing critical statistical data to predict whether fuel cell vehicles can meet the 2015 targets for fuel cell durability, vehicle range, and fuel cost. Specifically, the program will demonstrate an increase in durability from approximately 1,000 hours in 2003 (laboratory) to 2,000 hours by 2011 in a vehicle fleet (approximately 50,000 vehicle miles). Technology Validation also provides information in support of codes and standards development and for the development of best practices regarding safety.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Vehicle and Systems Simulation and Testing	**0**	**28,201**	**21,126**

The Vehicle and Systems Simulation and Testing (VSST) activity integrates the modeling, systems~~,~~ research, and testing efforts. The VSST activity uses a systems approach to define technical targets and requirements, guide technology development, and validate performance of DOE-sponsored technologies for passenger and commercial vehicles. The activity develops and validates models and simulation programs to predict the performance, component interaction, fuel economy, and emissions of advanced vehicles. With industry input, these models are used to:

- develop performance targets for the complete range of vehicle platforms and their components; and
- develop advanced control strategies to optimize the interaction between components and the overall performance and efficiency of advanced hybrid electric, plug-in hybrid electric, and fuel cell vehicles.

The models also are used in conjunction with "hardware-in-the-loop" laboratory testing (testing that operates selected pieces of hardware linked to a real-time simulation of the rest of the vehicle) to validate the performance of advanced technology components and systems developed within VT R&D activities without the need to build and test a complete vehicle.

The modeling and validation effort is supported by laboratory and field testing to benchmark and validate the performance of passenger and commercial vehicles that feature one or more advanced technologies. By benchmarking the performance and capabilities of advanced technologies, the effort supports the development of industry and DOE technology targets. The testing results also are used in component, system, and vehicle models, as well as in hardware-in-the-loop testing.

This activity also will research heavy vehicle systems to develop, in collaboration with commercial vehicle manufacturers and their suppliers, advance heavy vehicle systems models, as well as R&D on technologies that will reduce non-engine parasitic energy losses from aerodynamic drag, friction and wear, under-hood thermal conditions, and accessory loads.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

In FY 2009, the subprogram will expand simulation studies of advanced control strategies and components for plug-in hybrid electric vehicles (PHEV) as well as the validation of advanced PHEV technology components' and systems' performance in the laboratory. Data collected during laboratory and field tests will be used to enhance vehicle and systems modeling capabilities and to validate the accuracy of the component models. The program also will continue work on a series of detailed component models linked to the overall vehicle systems integration model that will ensure the use of the most accurate component data within the systems and vehicle models. This effort, which builds upon an existing cooperative research and development agreement (CRADA) with industry, aims to achieve greater accuracy for model results and to allow the activity to conduct simulations supporting R&D in all other VT subprograms.

The VSST activity will utilize the PHEV Mobile Automotive Technology Testbed (MATT), completed in FY 2007, and hardware-in-the-loop techniques to emulate vehicle systems to determine systems interactions (e.g., energy storage requirements for different cumulative electric range control strategies and power electronics components and configurations). In FY 2009 the activity will be expanded to begin incorporation of advanced combustion technologies developed by other VT R&D subprograms. The activity also will expand the use of engine emission models for analyzing the impact of emission control equipment on fuel economy. VSST efforts will validate, in a systems environment, performance targets for deliverables from the power electronics and energy storage technology research and development activities, and examine overall vehicle impacts associated with integration of other advanced vehicle technologies.

The activity also will conduct laboratory and closed track baseline testing and real-world monitored fleet evaluations of advanced plug-in hybrid electric vehicles and conduct tests of vehicles retrofitted with components developed through VT R&D activities. Test results will help identify component and system performance and reliability weaknesses to be addressed through future R&D activities. Data from these tests will expand the currently limited PHEV knowledge base and help accelerate market introduction of these fuel saving vehicles. Efforts will be focused on infrastructure/vehicle interface evaluations and the potential impact on the electricity grid.

VSST activities will continue to work with industry partners to enhance the capabilities of the heavy vehicle systems model to incorporate on-road tests and proprietary industry data and to complete the integration of turbulence and other computational fluid dynamics (CFD) models. In FY 2009, vehicle testing data from VSST activities, as well as other independent testing sources, will be utilized to validate the heavy vehicle model. In FY 2009, VSST also will conduct a focused on-road and wind tunnel evaluation of the most promising aerodynamic drag reduction devices developed previously in a joint effort with the Truck Manufacturers Association. The funds also will support CRADAs and National Laboratory projects to reduce drivetrain friction and wear and to develop and evaluate under-hood thermal management approaches that will improve vehicle efficiencies while increasing component reliability and life. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $18,127,000; 21CT $2,916,000.)

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Technology Validation	**0**	**0**	**14,789**

In FY 2009 the Technology Validation activity was transferred from the Hydrogen Technology Program to the Vehicles Technology Program. The rationale for this change is to consolidate all of the vehicle demonstration activities into one program. Four automobile manufacturer and energy company partnerships were selected in 2004 to design and construct hydrogen fuel cell vehicles and fueling stations to support "learning demonstrations" in the Controlled Hydrogen Fleet and Infrastructure Technology Demonstration and Validation Project. The primary goals are to validate progress towards the 2009 target of 2,000 hours fuel cell durability and 250+ mile range. The fuel cell vehicle technology validation effort will quantify the performance, reliability, durability, maintenance requirements and environmental benefits of fuel cell vehicles under real world conditions and provide valuable information to researchers to help refine and direct future R&D activities related to fuel cell vehicles.

In FY 2009, the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project will complete the fifth year of data collection on first generation vehicles, including chassis dynamometer tests. This data collection will facilitate a better understanding of vehicle and infrastructure interface issues of hydrogen fueled vehicles. Composite data products will continue to be updated and information regarding generation 2 vehicle operation and maintenance will be reported. Second generation vehicles, introduced in FY 2007, will begin their second full year of testing with more advanced fuel cell and storage systems that will ultimately validate the fuel cell system durability and range targets.

The partnerships will continue to operate hydrogen fueling stations and associated infrastructure using new hydrogen production technology to validate whether the new technologies reach the 2009 target of $3.00/gge hydrogen (untaxed) with 68 percent natural-gas-based well-to-pump efficiency and to provide hydrogen to the fuel cell vehicles in the project.

The infrastructure efforts through FY 2009 will include operating stations in Northern and Southern California, Michigan, Washington, D.C., Florida and the New York City area. Hydrogen production concepts being demonstrated will explore viable options for the near and long term. High-efficiency energy stations that co-produce electricity and hydrogen fuel for vehicles will be deployed as potential low-cost fuel providers and early infrastructure options in FY 2009. Data relevant to key vehicle and refueling interface issues such as refueling times, hydrogen purity impacts, energy efficiency of the hydrogen generation plant, and plant availability and reliability will be produced and published to provide a data base for system modelers.

(dollars in thousands)

In past budgets, this funding was requested as two budget items: validation of fuel cell vehicles and validation of hydrogen infrastructure, although the work was performed as an integrated project. In FY 2007 the split is $25.0 million for fuel cell vehicles and $14.566 million for infrastructure. In FY 2008 funding was requested as a single budget item, and the comparable split is $18.65 million for fuel cell vehicles and $11.224 million for infrastructure. In FY 2009 the anticipated split is $11.0 million for fuel cell vehicles and $4.0 million for infrastructure.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $11,000,000; other $3,937,000)

	FY 2007	FY 2008	FY 2009
Energy Storage R&D	**0**	**48,236**	**49,457**

The Energy Storage activity supports long-term research, applied research, and technology development of advanced batteries. Low-cost, abuse-tolerant batteries with higher energy, higher power, excellent low-temperature operation, and longer lifetimes are needed for the development of the next-generation of hybrid electric vehicles (HEVs), plug-in hybrid vehicles (PHEVs), and pure electric vehicles (EVs). Lithium-based batteries offer the potential to meet all three applications.

The program's long-term research is focused on developing advanced materials for the next generation of energy storage technologies. This research effort is being conducted at universities and national laboratories. Applied research conducted at 7 National Laboratories (ANL, BNL, INL, LBNL, NREL, ORNL, and SNL) is focused on the development and validation of low-cost, abuse-tolerant, and long-life lithium-ion batteries for vehicle applications. Nearer-term technology development is conducted in cooperation with industry through the United States Advanced Battery Consortium (USABC). All USABC subcontracts to develop advanced batteries are awarded under a competitive process and are at least 50 percent cost-shared by developers.

The Energy Storage activity coordinates with other DOE programs doing relevant work in advanced battery technologies in order to maximize the return on DOE's technology investments in this area. Close cooperation with the Office of Basic Energy Sciences provides valuable technical and programmatic support. The activity also coordinates with the Energy Storage Program in the Office of Electricity Delivery and Energy Reliability on the development of batteries and components that might serve both transportation and stationary applications. Interagency coordination on advanced battery development is conducted through the government-sponsored Interagency Advanced Power Group (IAPG) that brings together representatives from the Department of Energy, NASA, the Army, the Navy, and the Air Force.

In FY 2009, the Energy Storage long-term activity will continue to examine innovative materials and electrochemical couples that offer the potential for significant improvements over existing technologies for use in both hybrid and plug-in hybrid electric vehicles. These efforts are being coordinated with the Office of Science to assure best utilization of the research efforts.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

This activity supports the research and development aimed at reducing the detrimental effects of the volume change during cycling of metallic and intermetallic alloys (1,000 to 4,000 mAh/g) as a replacement for carbon/graphite materials (372 mAh/g) used in present-day lithium batteries. Efforts are underway to accelerate the development of solid polymer electrolytes with significantly higher stiffness and improved ionic conductivity at room temperature that show promise in retarding dendrite formation in cells with lithium metal anodes (3,800 mAh/g). (Dendrites are metallic particles that form on the surface of an electrode during cycling and eventually cause an internal short circuit resulting in battery failure.) Emphasis will be placed on block copolymers, with one block providing conduction and other block offering stiffness, and protective single-ion conducting ceramic glasses to isolate the lithium metal from the electrolyte.

In addition to new high-voltage electrolytes, research effort will also be devoted to the development of redox shuttle additives to prevent overcharging, additives that form a good interface between the electrode and the electrolyte for improved life and fast charge capability, and electrolyte formulations and additives for low-temperature operation.

The activity will continue to develop advanced diagnostic techniques to investigate and better understand life- and performance-limiting processes in lithium-based batteries in transportation applications. The program will develop and apply electrochemical models to understand failure mechanisms, thermal runaway mechanisms in lithium batteries, and to design new functional materials.

In coordination with the Office of Basic Energy Sciences, and the Office of Electricity Delivery and Energy Reliability, the VT energy storage activity will participate in integrated activities to support development of nanoscale materials and architectures for electrical energy storage. Nanomaterials can exhibit superior performance over conventional battery materials in terms of high pulse discharge and recharge power and improved performance at low temperatures. However, the behavior of these materials is not well understood and is thought to be more than just a length-scale effect. New diagnostic tools and techniques could be required to investigate these materials.

In FY 2009, the Energy Storage applied research will continue to focus on the investigation of cell behavior, developing methodologies to more accurately predict battery life, understanding factors that limit the inherent abuse tolerance, investigating factors that limit low-temperature performance, and identifying approaches to overcome barriers to the introduction of lithium-ion batteries. This activity also supports the development of other energy storage devices, such as ultracapacitors, that might be used for micro hybrids (start/stop power only) and fuel cell hybrid electric vehicles.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

Ultracapacitors still have relatively low specific energy (less than 3 Wh/kg) which limits their capacity to serve as the main energy-storage devices in hybrid vehicles, but they offer the possibility of improved vehicle performance in a battery-plus-ultracapacitor hybrid configuration. This configuration will be evaluated and optimized for lower cost and durability in a PHEV platform when the ultracapacitor is sized for power assist and the battery is sized for energy. Ultracapacitor development focuses on the use of low-cost, high-capacity carbon electrodes and improved electrolytes which will allow the capacitors to operate at a higher voltage to improve their specific energy.

In FY 2009, the Energy Storage technology development will continue to support cost-shared subcontracts through the USABC with multiple battery suppliers to drive down the cost of lithium-ion batteries. The program will continue to develop full-sized lithium-ion modules using low-cost, thermally stable, high-performance anode and cathode materials. The emphasis is on driving down the cost and extending the life of lithium-ion batteries (currently at 10 years) to 15 years (the expected life of a vehicle).

New emphasis is on accelerating the development of batteries for plug-in hybrid vehicles. The dual use of batteries in PHEV applications for electric drive range during charge-depleting mode and for engine power assist during charge-sustaining mode challenges the design of the battery and the methodology to evaluate its performance and life. As a result, materials with higher energy capacity than currently being used are preferred. Also, as the battery becomes larger, abuse-tolerance (susceptibility to damage or failure from vibration or impact, over-charging, fire, etc.) becomes a primary concern requiring higher stability between the electrodes and the electrolyte and adequate/active thermal management at the module and system level. This activity will continue to validate requirements and refine standardized testing procedures to evaluate performance and life of PHEV batteries, and will continue to identify areas for additional R&D and address the specific needs of plug-in hybrid vehicles. The program will continue to solicit proposals and award additional subcontracts to battery suppliers for development of batteries for plug-in hybrid application. The goal is to reduce the cost of the PHEV battery to $300/kWh by 2014. New activities in FY 2009 include a Request for Proposal to support the development of advanced materials to strengthen the U.S. based manufacturing of lithium-ion batteries, a detailed study on the recycling and reuse of lithium batteries, and a detailed study on the impact of battery cost and trade-off due to limited production and battery life. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $49,518,000).

Advanced Power Electronics and Electric Motors R&D	**0**	**15,462**	**15,604**

This activity encompasses the Advanced Power Electronics activity previously included in the Hybrid and Electric Propulsion subprogram. The Advanced Power Electronics and Electric Motors R&D activity supports long-term R&D on power electronics, electric motors and other electric propulsion components, and the thermal control subsystems that are necessary for the development and ultimate

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

adoption of fuel cell, electric and plug-in hybrid electric vehicles. Supporting R&D on capacitors, magnets and wide bandgap materials (such as silicon carbide [SiC]) for advanced power electronics technologies also is included to enable the higher operating temperatures that are necessary to reduce systems cost and to meet PHEV and fuel cell HEV performance and reliability requirements.

In FY 2009, R&D efforts will continue on inverters, advanced permanent magnet motors, DC-to-DC converters, SiC components, low-cost permanent magnet materials, high temperature capacitors, advanced thermal systems, and motor control systems to meet future passenger vehicle hybrid systems requirements. Existing work in these areas will be expanded to address the more stringent performance requirements for plug-in hybrid systems including utilizing the power electronics to provide plug-in capability by integrating the battery charging function into the traction drive, thereby reducing electric propulsion system cost. The synergies of technologies for advanced vehicles, including plug-in and fuel cell hybrid vehicles, will be achieved by maintaining close collaboration among researchers, device manufacturers, and users of the technologies. The developed technologies will be tested at National Laboratories for validation of performance and conformance to specifications. Crosscutting technologies also will be evaluated for potential application for advanced vehicle applications. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $15,623,000).

SBIR/STTR	**0**	**2,236**	**2,385**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program. (FreedomCAR, $2,227,000; 21st Century Truck, $84,000)

Total, Hybrid Electric Systems	**0**	**94,135**	**103,361**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Vehicle and Systems Simulation and Testing	
The decrease allows for most Vehicle Systems Simulation and Testing (VSST) efforts to continue in FY 2009. There will be a reduced effort in heavy vehicle systems optimization R&D to lower energy losses in commercial vehicles. Reductions also will be made in modeling and simulation, advanced vehicle testing, and laboratory benchmarking activities. The net reduction in funding will also be accommodated by improved efficiency in data collection using newly developed instrumentation and better integration of information technologies. The PHEV demonstration activities will be sustained to the maximum extent possible.	-7,075
Technology Validation	
The increase is for learning demonstrations ("Technology Validation") previously funded by the Hydrogen Technology Program are transferred to Hybrid Electric Systems in FY 2009 in order to consolidate all vehicle demonstration activities into one program. The request of $14.9 million will continue to validate progress towards the 2011 target of 2,000 hours fuel cell durability and 250+ mile range. It also completes the installation of high-efficiency energy stations that co-produce electricity and hydrogen fuel for vehicles. On a "comparable" basis to the FY 2008 request, this is a $15.2 million reduction, which requires postponement of testing of vehicles with advanced "generation 2" fuel cells, in order to fund R&D priorities with higher potential for oil savings and greenhouse gas emissions reduction. FY 2009 will complete the fifth year of data collection on first-generation fuel cell vehicles and related hydrogen fueling infrastructure. Second generation fuel cell vehicles will begin their second year of testing with more advanced fuel cell and storage systems that will ultimately validate the fuel cell system durability and range targets.	+14,789
Energy Storage R&D	
The program's near and mid-term activities continue to focus on the development and validation of low-cost, abuse-tolerant, and long-life lithium-ion batteries for vehicle applications and expands the work on high-energy/high-power batteries for plug-in hybrids, while the long-term activities will continue to examine innovative materials and electrochemical couples that offer the potential for significant improvements over existing technologies for use in both hybrid and plug-in hybrid electric vehicles. These efforts are being coordinated with the Office of Science to assure best utilization of the research efforts.	+1,221

	FY 2009 vs. FY 2008 ($000)
Advanced Power Electronics and Electric Motors R&D	
In FY 2009, R&D efforts will continue on inverters, advanced permanent magnet motors, DC-to-DC converters, SiC components, low-cost permanent magnet materials, high temperature capacitors, advanced thermal systems, and motor control systems to meet future passenger vehicle hybrid systems requirements. The additional funding will support phase 2 activities with industry for research and development with focus on increasing the operating temperature of power electronics, thereby reducing costs and improving reliability.	+142
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+149
Total Funding Change, Hybrid Electric Systems	**+9,226**

Vehicle Systems

Funding Schedule by Activity

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		
Vehicle Systems			
Heavy Vehicle Systems R&D			
Vehicle Systems Optimization	5,951	0	0
Total, Heavy Vehicle Systems R&D	5,951	0	0
Ancillary Systems	293	0	0
Simulation and Validation	6,762	0	0
Total, Vehicle Systems	13,006	0	0

Description

In FY 2008, this subprogram was entirely incorporated within the Vehicle and Systems Simulation and Testing activity of the Hybrid Electric Systems subprogram. The material presented here applies to FY 2006-2007 and is included for reference.

The Vehicle Systems subprogram funds R&D on advanced vehicle technologies and ancillary equipment that could achieve significant improvements in fuel economy for passenger and commercial vehicles without sacrificing safety, the environment, performance, or affordability. This subprogram's funding contributes to both the FreedomCAR and 21st Century Truck budgets.

The Vehicle Systems subprogram contributes directly to the Vehicle Technologies Program's climate benefits described in the beginning of the chapter. Applied R & D benefits are not parsed to individual subprograms because of the interdependency of the research, development and technologies within the program. The Vehicle Technologies Program continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Heavy Vehicle Systems R&D	**5,951**	**0**	**0**

The Heavy Vehicle Systems R&D activity was moved to the Vehicle Systems, Simulations, and Testing activity within the Hybrid Electric Systems subprogram in FY 2008. The activity developed, in collaboration with heavy-duty commercial vehicle manufacturers and their suppliers, technologies that will reduce non-engine parasitic energy losses from aerodynamic drag, tire rolling resistance, friction and wear, under-hood thermal conditions, and accessory loads.

▪ **Vehicle Systems Optimization**	**5,951**	**0**	**0**

FY 2007 activities continued the viability assessment of various approaches to aerodynamic drag reduction.

The program also continued a project on the electrification of medium-duty trucks, building on lessons learned from the very successful More Electric Truck (Class 8) And worked on engine thermal control approaches.

Ancillary Systems	**293**	**0**	**0**

The Ancillary Systems activity and its work on air-conditioning and other indirect engine loads was moved to the Vehicle and Systems Simulation and Testing activity within the Hybrid Electric Systems subprogram in FY 2008.

Simulation and Validation	**6,762**	**0**	**0**

The Simulation and Validation activity was moved to the Vehicle Systems, Simulations, and Testing activity within the Hybrid Electric Systems subprogram in FY 2008. The activity developed models and simulation programs to predict the performance and optimize system performance of advanced vehicles.

Total, Vehicle Systems	**13,006**	**0**	**0**

Hybrid and Electric Propulsion

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Hybrid and Electric Propulsion			
Energy Storage			
High Power Energy Storage	17,199	0	0
Advanced Battery Development	17,352	0	0
Exploratory Technology Research	6,361	0	0
Total, Energy Storage	40,912	0	0
Advanced Power Electronics	13,699	0	0
Subsystem Integration and Development	4,629	0	0
Light Vehicle Propulsion and Ancillary Subsystems	4,629	0	0
Total, Subsystem Integration and Development	4,629	0	0
Total, Hybrid and Electric Propulsion	59,240	0	0

Description

In FY 2008, the Hybrid Electric Propulsion subprogram activities (Energy Storage, Advanced Power Electronics, and Subsystem Integration and Development) were incorporated within the Hybrid Electric Systems subprogram, with Subsystem Integration and Development incorporated within the Vehicle and Systems Simulation and Testing activity. The material presented here applies to FY 2007 and is included for reference.

The Hybrid and Electric Propulsion subprogram funded research and development for both passenger and commercial vehicles. R&D efforts include research in energy storage systems, advanced power-electronics and electric motors, and hybrid system development and integration, including new activities in FY 2007 on plug-in hybrids. In FY 2007 there were three activities: Energy Storage, Advanced Power Electronics, and Subsystem Integration and Development.

The Hybrid and Electric Propulsion subprogram contributes directly to the Vehicle Technologies Program's climate benefits described in the beginning of the chapter. Applied R & D benefits are not parsed to individual subprograms because of the interdependency of the research, development and technologies within the program. The Vehicle Technologies Program continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Energy Storage	**40,912**	**0**	**0**

The Energy Storage activity supported long-term research, applied research, and technology development for both passenger and commercial vehicles focused on developing advanced energy storage technologies for electric and hybrid-electric vehicles.

▪ **High Power Energy Storage**	**17,199**	**0**	**0**

Beginning in FY 2008, these activities were funded in the Energy Storage R&D activity within the Hybrid Electric Systems subprogram. The FY 2007 effort continued to develop full-sized lithium-ion cells using low-cost, stable, high-performance cathode materials such as manganese oxide.

▪ **Advanced Battery Development**	**17,352**	**0**	**0**

Beginning in FY 2008, these activities were funded in the Energy Storage R&D activity within the Hybrid Electric Systems subprogram. In FY 2007 the effort accelerated the benchmarking of candidate technologies for electric vehicle and plug-in hybrid applications.

▪ **Exploratory Technology Research**	**6,361**	**0**	**0**

Beginning in FY 2008, these activities were funded in the Energy Storage R&D activity within the Hybrid Electric Systems subprogram. In FY 2007 this research examined innovative energy storage systems that offer the potential for significant improvements over existing technologies for use in both electric and hybrid electric vehicles. These efforts were coordinated with the Office of Science to assure best utilization of DOE's research assets.

Advanced Power Electronics	**13,699**	**0**	**0**

Beginning in FY 2008, these activities were funded in the Advanced Power Electronics and Electric Motors R&D activity within the Hybrid Electric Systems subprogram. In FY 2007, the Advanced Power Electronics activity included R&D on power electronics, electric motors and other components, and thermal-management systems for fuel cell and hybrid vehicles.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Subsystem Integration and Development	**4,629**	**0**	**0**

Beginning in FY 2008, these activities were funded in the Vehicle and Systems Simulation and Testing activity within the Hybrid Electric Systems subprogram. In FY 2007, subsystem Integration and Development validated achievement of technical targets for components and subsystems by using hardware-in-the-loop testing, and also benchmarked and characterized advanced commercial vehicles and components to determine commercial progress against research performance goals.

▪ **Light Vehicle Propulsion and Ancillary Subsystems**	**4,629**	**0**	**0**

In FY 2007, this effort used hardware-in-the-loop techniques to determine vehicle systems interactions (e.g., energy storage requirements for different fuel cell subsystems) and analyzed the impact of expected emission control requirements on fuel economy of advanced hybrid passenger vehicle systems.

Total, Hybrid and Electric Propulsion	**59,240**	**0**	**0**

Advanced Combustion Engine R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Advanced Combustion Engine R&D			
Combustion and Emission Control	26,778	38,816	28,771
Heavy Truck Engine	14,495	0	0
Solid State Energy Conversion	4,579	4,527	3,888
Health Impacts	2,494	0	0
SBIR/STTR	0	1,248	941
Total, Advanced Combustion Engine R&D	48,346	44,591	33,600

Description

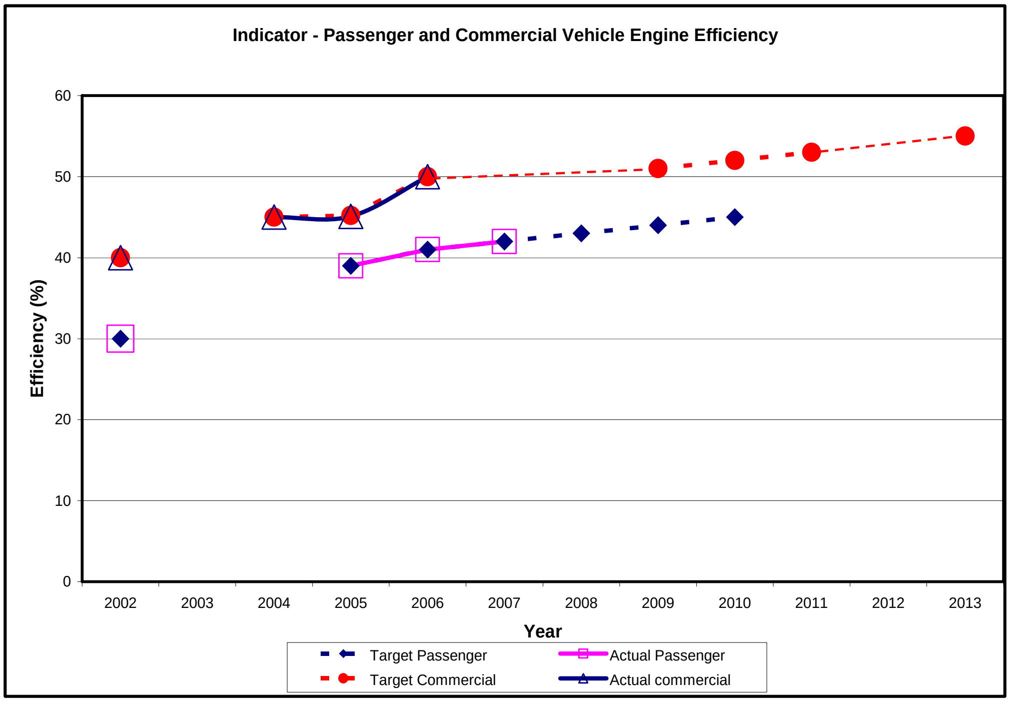
The Advanced Combustion Engine R&D subprogram focuses on removing critical technical barriers to commercialization of higher efficiency, advanced internal combustion engines in passenger and commercial vehicles. The goals are to improve the efficiency of internal combustion engines for passenger vehicle applications from 30 percent in 2002 to 45 percent by 2010, and for commercial vehicles from 40 percent in 2002 to 55 percent by 2013, while meeting cost, durability, and emissions constraints. Research will be conducted in collaboration with industry and industry partnerships, National Laboratories, and universities. The Advanced Combustion Engine R&D subprogram includes Combustion and Emission Control R&D and Solid State Energy Conversion activities.

The most promising method to reduce petroleum consumption through efficiency improvements in the mid-term (10-20 years) – or until fuel cell hybrid vehicles dominate the market – is to develop high-efficiency combustion engines and enable their introduction in conventional and hybrid electric vehicles. Improvements in engine efficiency alone have the potential of increasing fuel economy by 40 to 50 percent. Accelerated research on advanced combustion regimes, including homogeneous charge compression ignition (HCCI) and other modes of low-temperature combustion, is aimed at realizing this potential and making a major contribution to improving the U.S. energy security, environment, and economy.

The Advanced Combustion Engine R&D subprogram and Fuel Technology subprogram will contribute to the Vehicle Technologies Program goals by dramatically improving the efficiency of internal combustion engines and will identify fuel properties that improve the system efficiency or can displace petroleum based fuels. Improved efficiency and petroleum displacement both can directly reduce petroleum consumption.

The key objective is to meet the FreedomCAR and 21st Century Truck goals to improve the efficiency of internal combustion engines from 30 percent (2002 baseline) to 45 percent by 2010 for passenger vehicles and from 40 percent (2002 baseline) to 55 percent by 2013 for commercial vehicles. An advanced fuel formulation will be utilized that incorporates a non-petroleum based blending agent to reduce petroleum dependence while enhancing combustion efficiency.

Progress is indicated by efficiency of passenger and commercial vehicle internal combustion engines.



Note: 2002 value is baseline.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Combustion and Emission Control	**26,778**	**38,816**	**28,771**

The Combustion and Emission Control R&D activity was expanded to include the Heavy Truck Engine and the Health Impacts activities in FY 2008, which were previously funded as part of this subprogram. This integrated all engine R&D into one activity. Combustion and Emission Control research supports the Vehicle Technologies Program goal to enable energy-efficient, clean vehicles powered by advanced internal combustion engines using clean, petroleum- and non-petroleum-based fuels and hydrogen**.** Although advanced diesel engine technology has demonstrated Tier 2 emissions performance; energy consumption, cost and durability of the emission control system will limit the rate of market penetration. This research activity focuses on developing technologies for passenger and commercial vehicle engines operating in advanced combustion regimes, including Homogeneous Charge

(dollars in thousands)

FY 2007	FY 2008	FY 2009

Compression Ignition (HCCI) and other modes of low-temperature combustion (LTC), which will increase efficiency beyond current advanced diesel levels and reduce engine emissions of NO_x and particulate matter (PM) to near-zero levels. This will greatly reduce the need for exhaust after-treatment that typically utilize precious metals and allow the use of lower-cost emission control systems with little or no energy consumption and greater durability. By overcoming these challenges, more efficient lean-burn combustion engines can be cost-competitive with current gasoline engines in passenger vehicles, and further improve the efficiency and reduce the cost of engines used in commercial vehicles. The purpose of this activity is to develop technologies for advanced engines with the goal of improving thermal efficiency by optimizing combustion, fuel injection, emission control, and waste heat recovery systems, along with reducing friction and pumping losses while ensuring that no new air toxic compounds are generated. The activity will be closely coordinated with the Fuels Technology subprogram since different fuel characteristics and reduced property variability may be needed to meet the goals.

In FY 2009, the Combustion and Emission Control activity will continue emphasis on research and development of advanced combustion engines that can achieve FreedomCAR and 21st Century Truck efficiency goals for passenger and commercial vehicles while maintaining cost and durability levels and achieving near-zero regulated emissions. The activity will complete a cooperative agreement to develop high-efficiency gasoline and diesel fueled engines, for passenger vehicle applications, that operate in advanced combustion regimes. This activity will continue to fund cooperative agreements awarded in FY 2007 for passenger vehicle low temperature combustion technologies and complete two competitively awarded cooperative agreements for improving heavy-duty engine efficiency through the utilization of advanced combustion regimes (HCCI, LTC and mixed-mode). Also, a new solicitation will be issued with the intent of working in partnership with industry to incorporate new technologies into a complete engine system capable of achieving 55% efficiency by 2013 while meeting prevailing emissions standards. One or two participants will be selected to develop a complete engine system incorporating technologies for heavy-duty diesel engines, such as optimized combustion, fuel injection, emissions control, and waste heat recovery systems while reducing parasitic losses, friction and pumping losses, to meet the 2013 thermal efficiency goal.

Examples of specific activities to be conducted for passenger and commercial vehicles include the development of multi-mode combustion processes which combine the various forms of HCCI, partial HCCI and traditional diffusion combustion. Components needed to enable the advanced combustion system described above will include advanced ultra high pressure injectors and charge air and exhaust gas recirculation (EGR) handling systems. Advanced injectors must be capable of tightly packed multiple injection events within a given engine cycle. Advanced charging air systems will allow for precision control of air flow and charge temperature. Efforts also will be undertaken to develop and integrate innovative control strategies for NO_x and PM emissions to meet the durability requirement of 435,000 miles for commercial vehicles and 120,000 for passenger vehicles while both meeting emission standards and anticipating changes in emission control strategies and regulations due to changing engine-out emissions constituents. The activity will conduct optical laser diagnostics of in-cylinder combustion process for advanced combustion regimes such as, HCCI, other modes of LTC and mixed-mode regimes. Through simulation and experimentation, conduct R&D on advanced thermodynamic strategies that will enable engines to approach 60 percent thermal efficiency. The activity also will utilize laser-based, optical diagnostics to conduct in-cylinder engine research focused on overcoming barriers to the development of high-efficiency, hydrogen-fueled IC engine technology in coordination with the Hydrogen Technology Program. Development of detailed chemical kinetic models of advanced combustion regimes and emissions processes, including fuel composition effects, to aid the development of advanced, high-efficiency combustion engines using LTC and mixed-mode combustion regimes will continue. The activity will utilize x-rays from the Advanced Photon Source to study fuel-injection spray characteristics near the injection nozzle.

Cost-shared cooperative agreements awarded in FY 2006 and FY 2007 to automotive suppliers and universities will continue to develop innovative component technologies such as variable valve timing, variable compression ratio, and NO_x and PM sensors that enable cost-effective implementation of advanced combustion regimes with high efficiency and near-zero emissions of NO_x and PM.

The health impacts research will continue to evaluate the relative toxicity and consequent human health implications of emissions from new combustion technologies, new fuels derived from unconventional feedstocks, and new blending agents such as biodiesel and hydroisomerized vegetable oils. Early DOE basic research results of the flame combustion chemistry of unconventional feedstocks (oil sands derived syncrude compounds, biodiesel esters, alcohols) indicate that toxic compounds (polyaromatic hydrocarbons, aldehydes, ketones) are being generated in the combustion process. In FY 2009, emissions from the low temperature combustion in engines of fuels derived from these unconventional feedstocks will be studied and toxic compounds formed in the combustion process will be identified and quantified. In addition, collaborative efforts through the Coordinating Research Council to determine potential health impacts from aldehydes and organic acids generated by combustion of ethanol fuels will continue. Other emissions such as lubricant-derived particulate matter as well as from permeation of alcohol and gasoline hydrocarbons through fuel lines due to the polar nature of alcohols will be quantitatively characterized and screened for toxic compounds.

Also in FY 2009, the fourth full year of the Advanced Collaborative Emissions Study (ACES), the activity will continue generating and characterizing emissions from 2010 emissions compliant commercial vehicle diesel engines and from Selective Catalytic Reduction (SCR) Urea after-treatment devices. DOE is responsible for the generation, characterization and collection of samples for ACES. These characterized engine emissions are being routed to expose animals (rats and mice) in FY 2009 and subsequent years for chronic bioassays from animal exposure studies supported by the other ACES sponsors.

In FY 2009 the research activities at the Watt Road Truck Stop in Knoxville, TN will experiment with several different remote sensing techniques in an attempt to quantitatively measure air toxic compounds which have been qualitatively identified in prior years research

In addition, these funds may be used to support efforts such as peer reviews; data collection and

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $20,703,000; 21CT, $8,068,000)

Heavy Truck Engine	**14,495**	**0**	**0**

The Heavy Truck Engine activity was incorporated within the Combustion and Emission Control R&D activity in FY 2008. The activity developed technologies for diesel engines, such as optimized combustion, fuel injection, emissions control, and waste heat recovery systems, along with reduced friction and pumping losses.

Solid State Energy Conversion	**4,579**	**4,527**	**3,888**

The Solid State Energy Conversion activity develops technologies to convert waste heat from engines and other sources to electrical energy to improve overall thermal efficiency and reduce emissions. This activity will focus on the R&D of thermoelectrics and other solid state systems that recover energy from waste heat.

In FY 2009, the activity will complete one of three cost-shared cooperative agreements awarded in FY 2004 to develop and fabricate high efficiency thermoelectric generators that will directly convert a nominal 1 kW of electric power from engine waste heat for passenger vehicle and up to 5kW for commercial vehicles. These improvements could increase vehicle fuel economy by up to 10 percent.

The activity will continue to fund cost-shared cooperative agreement(s) awarded in FY 2008 for research on 2nd generation thermoelectric generators to demonstrate modules with conversion efficiencies greater than 20 percent. These agreement(s) will also develop thermoelectric devices that can operate as coolers/heaters to replace current R134-a gas air conditioners in passenger and commercial vehicles. Continue investigating the use of segmented or modified bulk materials and high-efficiency nano-scale superlattice materials that have shown potential for greater than 30 percent efficiency in laboratory evaluations. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $2,100,000; 21CT, $1,788,000)

Health Impacts	**2,494**	**0**	**0**

The Health Impacts activity was incorporated within the Combustion and Emission Control activity in FY 2008.

SBIR/STTR	**0**	**1,248**	**941**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Advanced Combustion Engine R&D	**48,346**	**44,591**	**33,600**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Combustion and Emission Control	
The Combustion and Emission Control activity will continue emphasis on research and development of advanced combustion engines that can achieve FreedomCAR and 21st Century Truck efficiency goals for passenger and commercial vehicles while maintaining cost and durability levels and achieving near-zero regulated emissions. The health impacts research will continue to evaluate the relative toxicity and consequent human health implications of emissions from new combustion technologies, new fuels derived from unconventional feedstocks, and new blending agents.	
FY 2009 funding for commercial vehicle combustion engine R&D is reduced in order to place greater emphasis on R&D that has a higher potential for oil savings. This means that only one or two awardees will be selected from the competitive solicitation issued in 2008 to develop a complete engine system capable of achieving 55% efficiency by 2013. This selection will be focused on the highest risk technologies with industry absorbing more of the moderate risk R&D activities.	-10,045
Solid-State Energy Conversion (formerly Waste Heat Recovery)	
The Solid State Energy Conversion activity develops technologies to convert waste heat from engines and other sources to electrical energy to improve overall thermal efficiency and reduce emissions. This activity will focus on the R&D of thermoelectrics and other solid state systems that recover energy from waste heat and also can operate as coolers/heaters. The reduction is the result of one of three cooperative agreements awarded in 2004 to develop first-generation thermoelectric generators reaching completion at the end of FY 2008.	-639
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-307
Total Funding Change, Advanced Combustion Engine R&D	**-10,991**

Materials Technology

Funding Schedule by Activity

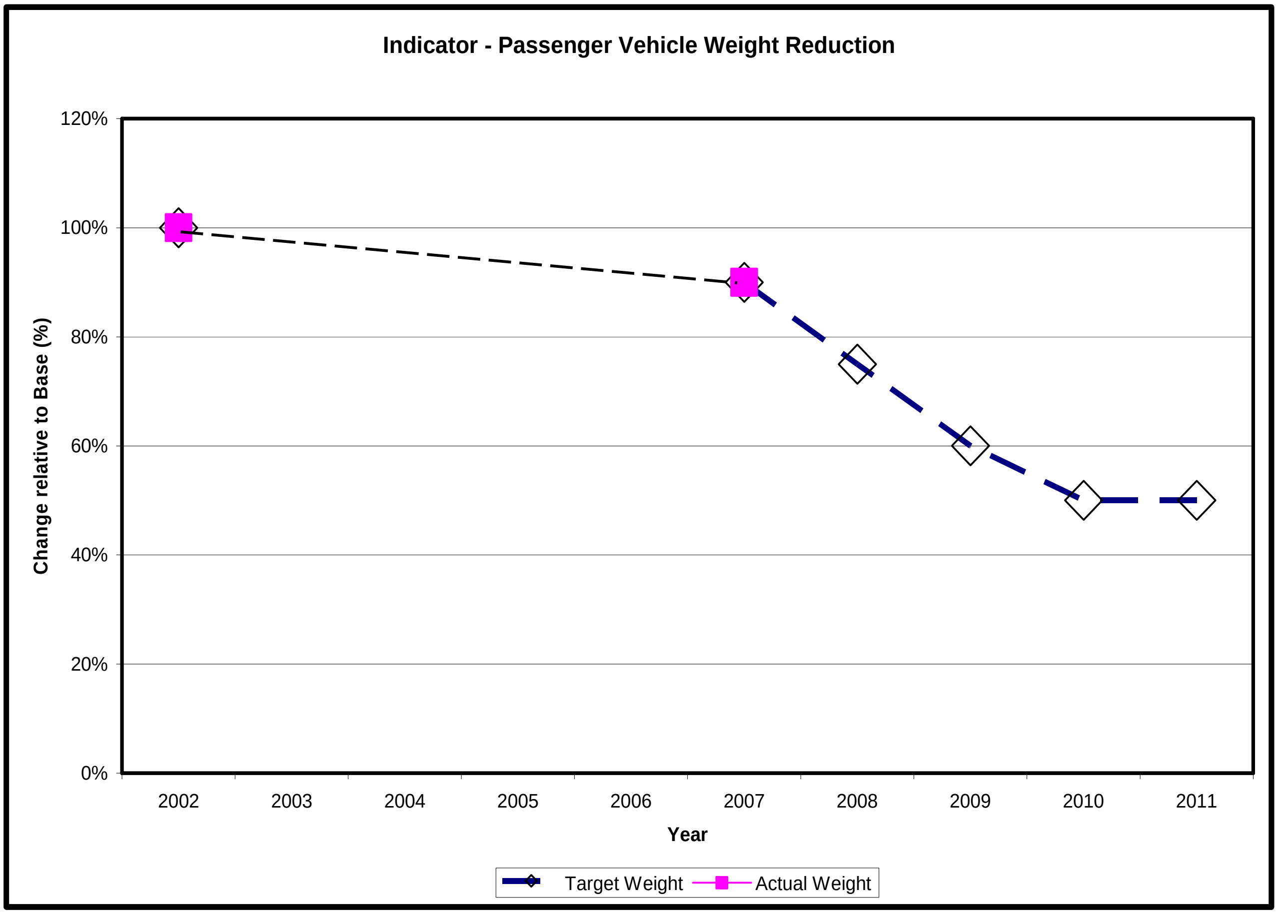
	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Materials Technology			
Propulsion Materials Technology	5,846	9,631	10,742
Lightweight Materials Technology	18,738	22,331	19,458
High Temperature Materials Laboratory	4,460	6,564	5,670
SBIR/STTR	0	1,110	1,033
Total, Materials Technology	29,044	39,636	36,903

Description

The Materials Technologies subprogram supports the development of cost-effective materials and materials manufacturing processes that can contribute to fuel-efficient passenger and commercial vehicles. This subprogram is a critical enabler for concepts developed elsewhere in the Vehicle Technologies Program. The subprogram consists of three activities: Propulsion Materials Technology, Lightweight Materials Technology, and the High Temperature Materials Laboratory (HTML).

The Materials Technology subprogram contributes to the VT Program goal by developing higher performing, more cost-effective materials that will make lighter vehicle structures and more efficient power systems possible. Lighter vehicles require less energy to operate and thus reduce fuel consumption. Likewise, better propulsion materials can enable more efficient power systems that will contribute to a vehicle's reduced energy consumption.

A key goal for the Materials Technology subprogram is to develop material and manufacturing technologies by 2010 that, if implemented in high volume, could cost-effectively reduce the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to that of 2002 vehicles. This is a broader goal than the previous goal of reducing the projected mass-production price of carbon-fiber materials to $3 per pound. The broader goal encompasses both further progress in carbon-fiber composites and advances in a variety of other lightweight automotive materials.



Note: 2002 value is baseline

Climate Change Technology Subprogram Benefits

The Materials Technology subprogram contributes directly to the Vehicle Technologies Program's climate benefits described in the beginning of the chapter. Applied R & D benefits are not parsed to individual subprograms because of the interdependency of the research, development and technologies within the program. The Vehicle Technologies Program continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Propulsion Materials Technology	**5,846**	**9,631**	**10,742**

The Propulsion Materials Technology key activity will conduct research and development of

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

improved materials for engines, sensors, energy storage, chassis components, thermal management systems, and hybrid electric drive systems that can contribute to greater passenger car and commercial vehicle efficiency by way of improved material properties and design.

In FY 2009, Propulsion Materials will evaluate specialized materials and processing techniques developed for hydrogen-fueled and other internal combustion engines operating in an advanced combustion regimes using specialized characterization techniques and in research engines. The activity will expand support to the advanced combustion engine and fuels research by addressing the implications of changes to fuel formulations and combustion regimes on engine materials. In support of this effort, Propulsion Materials will assess the materials needs for on-board diagnostics and closed loop control sensors necessary for engines operating in advanced combustion regimes. The key activity will also explore integrated surface modification of materials for reduced friction and new applications for lightweight cast alloys. Propulsion Materials will provide expanded support for hybrid-drive systems materials requirements associated with the development of new high-efficiency electric drives for plug-in hybrids. The key activity will explore concepts for improved catalysts, electrical energy storage, and thermoelectric materials using advanced characterization and atomic-scale theoretical computational modeling tools. Activities will include collaborative, pre-competitive research and development with support to automotive suppliers States, and other automotive manufacturing organizations to develop promising new technologies for energy efficient, performance-specific, factory-ready materials, processes, and designs. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $5,882,000; 21CT, $4,860,000).

▪ **Automotive Propulsion Materials** (Integrated into the Propulsion Materials Technology activity in FY 2008)	**1,945**	**0**	**0**
▪ **Heavy Vehicle Propulsion Materials** (Integrated into the Propulsion Materials Technology activity in FY 2008)	**3,901**	**0**	**0**
Lightweight Materials Technology	**18,738**	**22,331**	**19,458**

This activity supports R&D on advanced concepts to reduce the weight of passenger vehicles. This is accomplished primarily by substitution of lower density or stronger materials for current materials. Materials include fiber-reinforced polymer matrix composites, magnesium, aluminum, advanced high-strength steels, and titanium. Since cost-effectiveness is the major materials challenge, this element supports research, development and validation of materials needed to meet the FreedomCAR goal of 50 percent body and chassis weight reduction as well as designing and manufacturing components and structures from these materials. The objective is to lower the potential costs and cost uncertainties of advanced materials to approach the FY 2010 goal of cost neutrality.

Efforts begun in FY 2008 to assist industry with implementation of some of the low-cost carbon-fiber production technologies developed in earlier years will continue, as will research and development on the even more advanced technologies worked more recently. Research, development and validation on design and manufacture of cost-effective automotive components and structures from composites, magnesium (Mg), and low-cost titanium (Ti) will continue. While the design and manufacture of composites will still emphasize carbon-fiber reinforcements, work on hybrid reinforcements with carbon, glass and natural fibers, begun in FY 2007, will increase. Initial efforts on warm-forming-stamping of Mg sheet will conclude, while work on Mg casting and on-line/real-time nondestructive evaluations/inspections will continue. Base technology work on a third generation of advanced high strength steels, also begun in FY 2008, will also continue. Ways of enhancing the North American capability for Mg research and development will be sought. New efforts will begin on cost-effective repair and recycling of automotive structures made from these new materials. These are aimed at minimizing consumer costs and eliminating waste. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $19,457,000)

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
High Temperature Materials Laboratory	**4,460**	**6,564**	**5,670**

The FY 2009 funding will provide continued support of the HTML and the HTML user program. The HTML facility is an advanced materials R&D industrial user center located at the Oak Ridge National Laboratory. The HTML strives to maintain world-class, state-of-the-art advanced materials characterization (i.e., the determination of the composition and structure of materials which determine their properties and functionality) capabilities not available elsewhere and makes them available to U.S. industries and academia for use in solving complex materials problems. It develops cutting-edge analytical techniques to identify innovative materials for use in transportation applications. Activities include the investigation and determination of the composition, structure, physical and chemical properties and performance characteristics of metals, alloys, ceramics, composites, and even novel nano-phase materials under development for vehicle applications. The increased funding will enable acquisition of new analytical capabilities at the HTML, including instruments and tools to characterize the properties and performance of new high efficiency thermoelectric materials (e.g., Seebeck Coefficient); deployment of an intense neutron flux diffractometer, VULCAN, enabling research on chemical reactions occurring in the solid state and rapidly occurring changes in materials subjected to stresses; and a special purpose scanning transmission electron microscope (STEM) modified for in-situ characterization of catalysts, advanced battery, and thermoelectric materials. The HTML user program provides funding for pre-competitive non-proprietary research projects submitted by academia and US companies for the advancement of high efficiency vehicle transportation technologies in alignment with the goals of the FreedomCAR and 21st Century Truck partnerships. Typically, 100 projects are completed each year under this program, with results published in peer reviewed journals, industry presentations, and trade press. (HTML $5,671,000)

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**1,110**	**1,033**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Materials Technology	**29,044**	**39,636**	**36,903**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Propulsion Materials Technology	
Propulsion Materials Technology will continue research and development of improved materials for engines, sensors, energy storage, thermal management systems, and hybrid electric drive systems that can contribute to greater passenger car and commercial vehicle efficiency by way of improved material properties and design. The increase reflects the expansion of activities collaboration with the automotive supplier community to accelerate the use of innovative materials in production components. The increase also supports efforts to apply advanced computational modeling techniques to the development of materials for catalysts and thermoelectric materials.	+1,111
Lightweight Materials Technology	
The Lightweight Materials Program will develop materials processing technology and materials engineering solutions that can contribute to meeting the aggressive weight reduction goals. The program will develop technology that supports increased use of magnesium, aluminum, high strength steel, carbon and natural fiber composites, joining methods, non-destructive evaluation, as well as recycling technology for these materials. The decrease reflects FY 2008 funds (not requested in FY 2009) that were used for capital equipment for the North American Mg R&D capabilities and large-scale validation of technologies for recycling automotive polymers, both as mentioned in the narrative above. It also reflects effort on explorations of some high-risk concepts completion most of which will not be continued in FY 2009.	-2,873
High Temperature Materials Technology	
The HTML develops cutting-edge analytical techniques to identify innovative materials for use in transportation applications. Activities include the investigation	-894

	FY 2009 vs. FY 2008 ($000)
and determination of the composition, structure, physical and chemical properties and performance characteristics of metals, alloys, ceramics, composites, and even novel nano-phase materials under development for vehicle applications.	
The request provides for maintenance, repair, and replacement of scientific instruments within the High Temperature Materials Laboratory and full funding of the HTML research and development user program. The decrease is a result of equipment purchases in FY 2008 for which there was not a need in FY 2009.	
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-77
Total Funding Change, Materials Technology	**-2,733**

Fuels Technology

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Fuels Technology			
Advanced Petroleum Based Fuels (APBF)	6,511	6,451	5,808
Non-Petroleum Based Fuels and Lubricants (NPBFL)	11,902	10,885	9,863
SBIR/STTR	0	500	451
Total, Fuels Technology	18,413	17,836	16,122

Description

The Fuels Technology subprogram supports R&D that will provide vehicle users with cost-competitive fuel options that enable high fuel economy with low emissions, and contribute to petroleum displacement. Tightening emissions standards present a challenge to advanced engine technologies which, even now, are more sensitive to variations in fuel composition than were earlier engines. Different fuels meeting the same specifications can have widely-varying impact on engine performance and emissions. This trend is likely to be accentuated as technology advances and emissions standards become progressively more stringent. Future refinery feedstocks may increasingly be from non-conventional sources including, but not limited to, oil sands, shale oil, and tar sands. The impact of changes in refinery feedstocks on finished fuels is an area of relatively-new concern to engine manufacturers, regulators and users. Balance of refinery feedstocks also has to be considered to assure that the slate of refining products matches end-use needs and is efficiently accommodated. In the nearer term, this subprogram addresses technology barriers associated with increased use of biomass-based fuels as blendstocks with conventional fuels. This subprogram supports the mission of the Vehicle Technologies Program to develop more energy-efficient and environmentally-friendly highway transportation vehicles that enable America to use less petroleum. It consists of two activities: Advanced Petroleum-Based Fuels (APBF) and Non-Petroleum-Based Fuels and Lubricants (NPBFL). These activities have been coordinated with and are supportive of EPA's fuels and emissions related activities, as mentioned in their strategic plan.

The APBF and NPBFL activities are undertaken: (1) to enable post-2010 advanced combustion regime engines and emission control systems to be more efficient while meeting future emission standards; and, (2) to reduce reliance on petroleum-based fuels through direct fuel substitution by non-petroleum-based fuels. To differentiate these two activities, an advanced petroleum-based fuel is envisioned as consisting primarily of highly-refined, petroleum-derived base fuel comprising a likely-future mix of refinery feedstocks, possibly blended with performance-enhancing non-petroleum components derived from renewable resources such as biomass or from non-petroleum or non-conventional fossil resources such as natural gas or coal. In contrast, a non-petroleum-based fuel consists of components derived primarily from non-crude-oil sources, such as agricultural products, other biomass, natural gas, bitumen, shale, or coal. The benefit of the APBF activity is that it enables harmonization of the fuel requirements of advanced engine and vehicle manufacturers with the product specifications of future refineries. The additional benefit of NPBFL is that it will provide non-petroleum-based blendstock specifications to enable both high fuel economy and direct displacement of petroleum fuels.

Climate Change Technology Subprogram Benefits

The Fuels Technology subprogram contributes directly to the Vehicle Technologies Program's climate benefits described in the beginning of the chapter. Applied R & D benefits are not parsed to individual subprograms because of the interdependency of the research, development and technologies within the program. The Vehicle Technologies Program continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Advanced Petroleum Based Fuels (APBF)	**6,511**	**6,451**	**5,808**

The APBF activity develops petroleum-based fuels and lubricants that will enable extremely high efficiency engines for passenger and commercial vehicle applications. This effort employs the expertise and shared funding of the Government, energy companies, emission control manufacturers, and engine and vehicle manufacturers. The main goal is to identify and exploit fuel properties that can enable engines to operate in the highest-efficiency mode while meeting future emissions standards and to expand the operating conditions in which maximum efficiency is achievable. These activities are undertaken in close coordination with the Advanced Combustion Engine R&D subprogram.

In FY 2009, APBF will continue to study the effects of physical and chemical property variation in petroleum-based fuels on the performance and emissions of advanced combustion engines, in cooperation with the Advanced Combustion Engine subprogram.

Also in FY 2009, APBF will continue to monitor data in open literature and within VT technology portfolio resulting from use of FACE fuel formulations to determine whether FACE fuels matrices needs parametric revision based on FY 2008 data. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $3,475,000; 21CT, $2,333,000).

Non-Petroleum Based Fuels and Lubricants (NPBFL)	**11,902**	**10,885**	**9,863**

The NPBFL activity formulates and evaluates non-petroleum-based fuels and lubricants that can be used as neat (pure) alternative fuels or as blendstocks in transportation fuels. With a primary focus on biomass-based renewable and synthetic fuels, specific areas being investigated include fuel quality and stability; detailed chemical composition and the relationship between this and fuel bulk properties; the effect of physical and chemical properties on engine performance and emissions; and safety associated

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

with storage, handling, and toxicity

In FY 2009, the activity will continue studies of the effects of physical and chemical property variation in synthetic and renewable fuels on the performance and emissions of advanced combustion engines, in cooperation with the Advanced Combustion Engine subprogram. The activity also will continue to monitor data in open literature and within VT technology portfolio on testing with FACE fuel formulations to determine whether the non-petroleum-containing FACE fuels within the matrices require parametric revision based on FY 2008 data.

The activity also will do the following:

- Complete work on ethanol-optimized engines aimed at minimizing the ethanol MPG efficiency penalty for second generation FFV (so that project partners can accelerate market introduction of improved engine & vehicle systems for renewable fuels).
- Conduct comprehensive testing of the impact of intermediate ethanol blends (between 10% and 50%) on emissions, fuel system materials, OBD, and durability of engines/catalysts for automotive and non-road engines, and related refueling station components (in cooperation with EPA, the automotive industry, the non-road engine industry, and fuel providers). This work will help to identify critical technical and safety issues that must be addressed before ethanol based fuels can be introduced in significant volumes to broader engine & vehicle markets; and,
- Continue monitoring fuel quality and utilization for biomass-derived diesel fuels.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. *(FreedomCAR, $5,832,000; 21CT, $4,031,000)*

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**500**	**451**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Fuels Technology	**18,413**	**17,836**	**16,122**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Advanced Petroleum Based Fuels (APBF)	
In FY 2009, APBF will continue to study the effects of physical and chemical property variation in petroleum-based fuels on the performance and emissions of advanced combustion engines, in cooperation with the Advanced Combustion Engine subprogram. The reduction of funds in this area reflects the increased emphasis on non-petroleum-based fuels for advanced combustion regimes relative to petroleum-based fuels.	-643
Non-petroleum Based Fuels (NPBF)	
In FY 2009, NPBF will continue studies of the effects of physical and chemical property variation in synthetic and renewable fuels on the performance and emissions of advanced combustion engines, in cooperation with the Advanced Combustion Engine subprogram. The decrease in this area is a consequence of completion of several ethanol optimization projects begun in FY 2007.	-1,022
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-49
Total Funding Change, Fuels Technology	**-1,714**

Technology Integration

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Technology Integration			
Graduate Automotive Technology Education (GATE)	0	496	700
Advanced Vehicle Competitions	0	1,387	1,500
Education	0	0	4,000
Safety and Code and Standards	0	0	12,238
Legislative and Rulemaking	0	1,986	1,804
Vehicle Technologies Deployment	0	12,481	10,096
Biennial Peer Reviews	0	495	500
SBIR/STTR	0	0	262
Total, Technology Integration	0	16,845	31,100

Description

In FY 2009 Technology Integration incorporates two activities previously part of the Hydrogen Technology Program budget: the Education activity and the Safety and Codes and Standards activity. This move strengthens and builds on synergy with related efforts in the Vehicle Technologies Program. For example, experience gained in hydrogen safety and education can be applied to other alternative fuels and advanced technologies, such as the safety and transport of lithium ion batteries.

The Technology Integration subprogram accelerates the adoption and use of alternative fuel and advanced technology vehicles, including fuel cell vehicles, to help meet national energy and environmental goals and accelerate dissemination of advanced vehicle technologies through demonstrations and education. This subprogram's efforts logically follow successful research by industry and government and help to accelerate the commercialization and/or widespread adoption of technologies that are developed in other VT program areas. Deployment activities linked to R&D also provide early market feedback to emerging R&D.

Subprogram functions include both regulatory and voluntary components. The regulatory elements include legislative, rulemaking, and compliance activities associated with alternative fuel requirements identified within the Energy Policy Acts of 1992 and 2005 (EPACT 1992 and EPACT 2005). Voluntary efforts include demonstration of advanced technology vehicles to verify market readiness and public information, education, outreach and technical assistance efforts. The Vehicle Technologies Program works with public/private partnerships between DOE and local coalitions of key stakeholders around the Nation (such as Clean Cities), to implement strategies and projects that displace petroleum. In addition, the annual DOE/EPA Fuel Economy Guide publication and related data dissemination efforts (required by law) are produced as part of this activity along with the website at www.fueleconomy.gov.

In FY 2009 the Education activity from the Hydrogen Technology Program was transferred to the Vehicles Technologies Program. This activity along with the Graduate Automotive Technology Education (GATE) and the Advanced Vehicle Competitions activities comprise the Vehicle Technologies education portfolio. The portfolio is designed to increase knowledge and understanding of advanced sustainable transportation technologies for passenger and commercial vehicle applications. These technologies and practices include but are not limited to alternative fuels (including hydrogen), fuel cells, advanced combustion regimes, idle-reduction, and batteries and electric drive components for hybrid and plug-in hybrid vehicles. Efforts are aimed at educating a broad spectrum of audiences including teachers and students at all levels, the general public, as well as state and local government representatives, safety and code officials, and potential end-users. The education portfolio responds to the President's National Energy Policy recommendation to the Secretary of Energy to develop an education campaign that communicates the benefits of alternative energy, including hydrogen, and supports the Energy Policy Act of 2005 that also calls for enhanced education relating to hydrogen and other alternative fuels. The education portfolio contributes to both the Vehicle Technologies and Hydrogen Technology Program missions by supporting the development of students with technical skills in the same areas of technology where the program is engaged in advanced R&D.

The Safety and Codes and Standards activity funds research to provide the technical data on hydrogen technologies (such as fuel cells and hydrogen production, storage, and distribution systems) and other alternative fuels that is necessary to support and inform the codes and standards development process. Its work in FY 2009 includes fundamental studies to determine the flammability, explosive, reactive, and dispersion properties of hydrogen and other alternative fuels, and testing of components, subsystems, and systems to check design practices and verify failure-mode prediction analysis. The technical data obtained from these activities will be provided to the appropriate codes and standards developing organizations (e.g., International Code Council, National Fire Protection Association) to write and publish applicable codes and standards. The subprogram will also support the development of passive and active safety systems based on new sensor technologies, and will fund comprehensive safety analysis of hydrogen components and systems.

The Technology Integration subprogram contributes to the VT Program goal by accelerating the adoption and use of alternative fuels, hybrid and fuel efficient vehicles, and idle reduction technologies in commercial highway vehicles. These fuels and vehicles will reduce the consumption of petroleum-based fuels thus contributing to achieving the program goal.

Education aids in overcoming institutional barriers to widespread use of advanced vehicle technologies and alternative fuels. Activities such as the Advanced Vehicle Competitions and GATE encourage the interest of university student engineers and engage their participation in advanced technology development. This helps address the need for more highly trained engineers in hybrid and fuel cell technologies to overcome barriers in the market place. The GATE effort also supports a pipeline into the auto industry of new engineers familiar with the most advanced technologies. In addition, unlike other more familiar alternative fuels and technologies, low awareness and false perceptions about safety risks of hydrogen, present among all key target audiences, threaten the success of today's demonstration projects and future commercialization. Education can overcome the significant challenges by training critical needs personnel, making available objective and technically-accurate information to decision-makers at the state and local levels, and building public confidence in the safe use of hydrogen and fuel cells, as well as other alternative fuels and advanced vehicle technologies.

Wide acceptance of hydrogen and other alternative fuel technologies depends on meeting safety standards in which the public has confidence. The Safety, Codes and Standards activity supports the establishment of a global technical regulation for hydrogen and fuel cell vehicles and infrastructure needed to allow the technologies to compete in a global market.

The Technology Integration subprogram contributes directly to the Vehicle Technologies Program's climate benefits described in the beginning of the chapter. Applied R & D benefits are not parsed to individual subprograms because of the interdependency of the research, development and technologies within the program. The Vehicle Technologies Program continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Graduate Automotive Technology Education (GATE)	**0**	**496**	**700**

The Education portfolio is designed to increase knowledge and understanding of advanced sustainable transportation technologies for passenger and commercial vehicle applications and includes the GATE, Advanced Vehicle Competitions, and the Education activity from the Hydrogen Technology Program.

In FY 2009, this activity will fund GATE Centers of Excellence (competitively selected) to develop new curricula and provide research fellowships for approximately 30 students for research in advanced automotive technologies. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $700,000)

Advanced Vehicle Competitions	**0**	**1,387**	**1,500**

In FY 2009, the Advanced Vehicle Competitions activity will pursue the next advanced vehicle competition series. Participating teams will be selected through a competitive process in FY 2008. Selected teams will be challenged to integrate advanced vehicle technologies (including fuel cells and plug-in hybrid electric vehicles) and appropriate fuels to develop an approach that minimizes use of petroleum fuel. Many students who graduate from these vehicle competitions and from the GATE Program go on to take jobs in the auto industry where they bring with them an unprecedented appreciation and understanding of advanced automotive efficiency technologies. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $1,500,000)

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Education	**0**	**0**	**4,000**

Education was moved from the Hydrogen Technology Program to the Vehicle Technologies Program in FY 2009 to build on synergy with related and similar efforts focused on other alternative fuels and advanced vehicle technologies. The Education activity will collaborate with Safety and Codes and Standards to provide training for first responders and code officials to facilitate the approval and implementation of hydrogen and alternative fuel vehicle and refueling projects. Key target groups include fire fighters and fire department training coordinators, law enforcement personnel, and emergency medical technicians, as well as code officials, fire marshals, city planners, and other hydrogen users. In FY 2009, the Education activity will continue its outreach effort for the "Introduction to Hydrogen Safety for First Responders" and update it to include similar information relevant to other alternative fuels and advanced vehicle technologies.

It will also build on work completed in FY 2008 with the deployment of a more advanced first responder training course that incorporates the use of a hands-on hydrogen fuel cell vehicle prop. Both first responder courses leverage the resources and expertise of the Volpentest Hazardous Materials Management and Emergency Response (HAMMER) Training and Education Center. Building on prior year efforts, in FY 2009 the Education activity will also expand the implementation and deployment of an introductory course designed specifically for code officials. Working with partners, the course will be made available to a national audience through distance learning and targeted, in-person training workshops in critical needs areas.

In cooperation with automotive and energy industry partners involved in infrastructure projects, as well as key state government partners, the Education activity will conduct targeted outreach to the public and key target audiences in communities with existing or planned hydrogen and alternative fuel refueling stations. Using new forms of media, this effort will help build public familiarity and confidence with the safe use of hydrogen and other alternative fuels. Thereby helping to facilitate the market adoption of hydrogen technologies over the long-term. The Education activity will also work in partnership with regional, state, and local government partners to expand the availability of training opportunities for state and local government officials and future potential alternative fuel vehicle transportation end users. Training will include technology overviews that introduce the hydrogen, other alternative fuels, and advanced vehicle technologies and provide the resources to help these target audiences make sound decisions on opportunities for near-term demonstration and early adoption.

Building on efforts initiated in FY 2008, the Education activity will also fund the development and expansion of undergraduate and graduate programs at universities that train the future workforce of scientists, engineers, and vehicle technicians needed in government, industry, and academia. These efforts will be coordinated with industry partners and leading universities in the U.S. and other countries. Funds will also support the development and expanded distribution of classroom guides and hands-on activities for middle and high school students, as well as the expanded availability of training and professional development for teachers, whose understanding of hydrogen, alternative fuels, and advanced vehicle technologies is critical to the successful introduction of the subject to their students in the classroom. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (Hydrogen Initiative, $4,000,000)

Safety and Codes and Standards	**0**	**0**	**12,238**

In FY 2009 the Safety and Codes and Standards subprogram was moved from the Hydrogen Technology Program to the Vehicle Technologies Program as an activity within the Technology Integration Subprogram. The activity provides the underlying research to enable the development of technically sound codes and standards for the safe use of alternative fuels (including hydrogen) in all applications. The effort also supports the development of a global technical regulation (GTR) for hydrogen fuel cell vehicles. Global consistency in standards will ensure that different technologies need not be developed for each region of the world. The drafting and adoption of alternative fuel codes and standards is supported through the development of alternative fuel characterization and behavior data and through limited direct support of Standards Development Organizations (SDOs) and Codes Development Organizations (CDOs). Alternative fuel release data and incident scenario analysis will support a quantitative risk assessment approach for codes and standards development activities focused on enabling technology readiness. DOE will collaborate with DOT, EPA, NIST and other government agencies to ensure that vehicle and fuel standards development proceeds in agreement with existing regulatory authorities. The cooperating agencies will maximize available resources and expertise in areas such as alternative fuel vehicle dispensing measurement (NIST), vehicle safety (DOT National Highway Traffic Safety Administration) and international standards development (DOT, EPA).

The activity will conduct an analysis of potential accident scenarios to identify both potential alternative fuel systems weaknesses and to identify the R&D required to improve systems safety. The scenarios report will also help guide a risk analysis effort that uses Probabilistic Risk Analysis (PRA) and Failure Modes Effects Analysis (FMEA) methods to quantitatively estimate systems risk. Risk assessment activities will provide information to guide the codes and standards development process. This information also will be made available to key industry stakeholders, such as fuel providers and insurers.

The activity will conduct comprehensive R&D to provide critical data and develop a database to characterize the properties of releases of alternative fuels when impeded by obstacles/equipment for input into the calculation of codes for setback distances.

FY 2009 funding will support the development of computational fluid dynamics models to support the risk assessment activities for fueling, production infrastructure, and vehicle operation in tunnels and garages. Funding will also support R&D for the development of on-board and off-board leak detection technologies such as sensors.

The PNNL Hydrogen Safety Panel will continue to monitor the safety of DOE hydrogen projects. The Panel will conduct site visits, interviews and safety plan reviews of all DOE funded projects involving hydrogen.

(dollars in thousands)

In FY 2009 the effort will quantify the effects of hydrogen contaminants on system components to support development of a hydrogen quality standard, and it will also develop analytical methods to allow verification of hydrogen purity on a cost-effective basis. Hydrogen metering technologies will also be supported to allow accurate measurement of delivered hydrogen.

Furthermore, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (Hydrogen Initiative, $12,500,000)

Legislative and Rulemaking	**0**	**1,986**	**1,804**

The Legislative and Rulemaking activity consists of implementation of the State and Alternative Fuel Provider Regulatory Program 10 CFR Part 490, alternative fuel designations, the Private and Local Government Fleet Regulatory Program, and the normal implementation of other EPACT 2005 requirements including reports and rulemaking, analyses of the impacts from other regulatory and pending legislative activities, and the implementation of legislative changes to the EPACT fleet activities as they occur. The fleet programs require selected covered fleets to procure alternative fuel passenger vehicles annually. The Department also reviews and processes petitions to designate new alternative fuels under EPACT. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Vehicle Technologies Deployment	**0**	**12,481**	**10,096**

The Vehicle Technology Deployment activity promotes the adoption and use of petroleum reduction technologies and practices by working with state, regional, and local coalitions (including Clean Cities) and their stakeholders, industry partners, fuel providers, and end-users. Technology focus areas include: alternative fuel vehicles, alternative fuel infrastructure development, idling reduction for commercial trucks and buses, expanded use of non-petroleum and renewable fuel blends, hybrid vehicles, driving practices for improved efficiency, and engine/vehicle technologies that maximize fuel economy. Working in conjunction with technology experts at the National Laboratories, activities include outreach, training, and technical assistance related to each technology focus area. Critical tools and information will be provided via internet, telephone hotline, publications, and direct interaction with experts. The program also will continue efforts to provide technical assistance for early adopters of technologies and provide training and workshops to coalitions, public safety officials, and stakeholders related to infrastructure development and targeted niche market opportunities (like transit, refuse trucks, school bus, delivery trucks, municipal fleets, etc.).

In support of the National Energy Policy, Section 405 of EPACT 1992, and Sections 721, 1001, and 1004 of EPACT 2005 directing the Department to expand consumer education, to promote technology transfer, and to address implementation barriers, the program will identify and support opportunities to showcase the technology focus areas and continue to build national and regional alliances to promote petroleum reduction strategies and will support further expansion of ethanol infrastructure deployment. A portion of the request will be used to support demonstration and deployment of alternative-fuel and

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

petroleum reduction technologies and practices developed by DOE, so that the technologies are not left "sitting on the shelf." Efforts to support the development and promote the use of the (legislatively mandated) Fuel Economy Guide and associated www.fueleconomy.gov website also will continue. In addition, these funds may be used to support efforts such as technology transfer/technology exchange meetings and forums with industry stakeholders, peer reviews, data collection and dissemination, and technical, market feasibility, economic, and other analyses.

Biennial Peer Reviews	**0**	**495**	**500**

Funding will be used to conduct biennial reviews of the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership by an independent third party, such as the National Academy of Sciences/National Academy of Engineering, to evaluate progress and program direction. Reviews will include evaluation of progress toward achieving the technical and program goals supporting each partnership, as well as an assessment of the appropriateness of Federal investment in each of the activities. The 21st Century Truck Partnership review to be held in FY 2009 will address relevant elements of the Vehicle Technologies Program. Based on the evaluations, resource availability, and other factors, the partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate. (FreedomCAR, $0; 21st Century Truck, $500,000.)

SBIR/STTR	**0**	**0**	**262**

The FY 2009 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Technology Integration	**0**	**16,845**	**31,100**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Graduate Automotive Technology Education GATE will fund competitively-selected Centers of Excellence to develop new curricula and provide research fellowships for approximately 30 students for research in advanced automotive technologies. The $204,000 increase is requested to cover anticipated increased costs at the universities for fellowships and other activities.	+204

Advanced Vehicle Competitions

	FY 2009 vs. FY 2008 ($000)
The Advanced Vehicle Competitions activity will continue the next advanced vehicle competition series. Teams (selected in FY 2008) will be challenged to develop an approach to integrate advanced vehicle and fuel technology to develop an approach that minimizes petroleum fuel use. The additional funds will be used for increased modeling and testing.	+113
Education	
This activity was previously funded within the Hydrogen Technology Program. Education supports the development and dissemination of informational materials and training for target audiences involved in advancing the use of hydrogen and other alternative fuels. Target audiences include safety and code officials, state and local government representatives, potential end users, the public, and teachers and students of all levels. Additional funds will support the expanded availability of training for code officials in critical needs areas, including communities with new hydrogen, fuel cell, and alternative fuel installations. The change relative to the comparable previous request is +$209,000.	+4,000
Safety and Codes and Standards	
The increase reflects the transfer of this activity, previously funded within the Hydrogen Technology Program, to the Vehicle Technologies Program. This activity aims to develop and implement practices and procedures to ensure safety for DOE funded projects and to perform the necessary research to facilitate the development and harmonization of technically sound domestic and international alternative fuels codes and standards.	
The change relative to the FY 2008 request on a “comparable” basis is a $3.5 million decrease and is made to support technologies having a greater potential for reducing oil consumption. Efforts in quantitative risk assessment, component and system level testing, leak detection technologies, and fuel quality R&D will be reduced significantly. Safety oversight of all projects, including the Safety Panel’s activities, materials compatibility studies, hydrogen behavior R&D, and facilitating the harmonization of codes and standards development, however, are high priorities for FY 2009.	+12,238
Legislative and Rulemaking	
Activities, which primarily consist of implementation of the State and Alternative Fuel Provider Regulatory Program, 10 CFR Part 490, alternative fuel designation rulemakings pursuant to Sec. 301(2) of Pub. L. 102-486, and the Private and Local Government Fleet Regulatory Program, will continue as in previous budget years.	

	FY 2009 vs. FY 2008 ($000)
The mandatory fleet alternative fuel vehicle acquisition program, Alternative Compliance rule (Subpart I) published in March 2007, and other required changes to these areas in EPACT 2005 will continue to be implemented. The decrease results from the completion of the fleet reporting database.	-182

Vehicle Technology Deployment

Activities, which primarily consist of promoting to stakeholders the adoption of petroleum reduction technologies and practices by working with state, regional and local coalitions and their stakeholders, industry partners, fuel providers and end users, will continue. The focus of these activities will continue to be on adoption of technologies including alternative fuels and vehicles, alternative fuel infrastructure, idling reduction for commercial trucks and buses, expanded use of non-petroleum and renewable fuel blends, hybrid vehicles, fleet and driver management practices for improved efficiency and engine/vehicle technologies that maximize fuel economy. This area will continue to implement outreach, training and technical assistance related to each technology. Tools and information will continue to be provided via the internet, telephone hotline, publications and direct interaction by experts. Technical assistance will also continue to be provided for early adopters of technologies through training and workshops for coalitions, public safety officials, infrastructure developers and targeted niche markets (i.e., transit, refuse trucks, school buses, delivery trucks, and municipal fleets).

The change relative to the FY 2008 results from the completion of several hardware intensive projects. Future activity will focus on encouraging the private sector to invest in hardware while focusing DOE activities on removing technical barriers and providing technical assistance and outreach. -2,385

Biennial Peer Reviews

There is no significant change in funding for the Biennial Peer Review activities in FY 2009.

The funding will be used to conduct the biennial review of the 21st Century Truck partnership by an independent third party, such as the National Academy of Sciences/National Academy of Engineering, to evaluate progress and program direction. The review will address all elements of the Vehicle Technologies Program that contribute toward the 21st Century Truck goals. +5

SBIR/STTR

The change reflects that the Safety and Codes and Standards activity was not part of Vehicle Technologies in FY 2008.	+262
Total Funding Change, Technology Integration	**+14,255**

Innovative Concepts

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Innovative Concepts			
Graduate Automotive Technology Education (GATE)	500	0	0
Total, Innovative Concepts	500	0	0

Description

In the new budget structure, the Innovative Concepts subprogram has been dropped and its one activity, Graduate Automotive Technology Education (GATE), has been moved to the Technology Integration subprogram. GATE contributes to activities of both the Vehicle Technologies and Hydrogen Technology Program missions by supporting the development of students with technical skill in the same areas of technology where the program is engaged in advanced R&D.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Graduate Automotive Technology Education	**500**	**0**	**0**

Beginning in FY 2008, GATE was funded within the Technology Integration activity.

The GATE activity aided in the development of interdisciplinary curricula to train the future workforce of automotive engineers.

Total, Innovative Concepts	**500**	**0**	**0**

Technology Introduction

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Technology Introduction			
Legislative and Rulemaking			
State and Fuel Provider Fleet	990	0	0
Federal Fleets	700	0	0
Regulatory Support	114	0	0
Total, Legislative and Rulemaking	1,804	0	0
Clean Cities[a]	4,393	0	0
Testing and Evaluation			
Vehicle Evaluation	5,484	0	0
Infrastructure Testing	2,050	0	0
Total, Testing and Evaluation	7,534	0	0
Advanced Vehicle Competitions	1,300	0	0
Total, Technology Introduction	15,031	0	0

Description

In FY 2008, all of the activities in Technology Introduction (except Testing and Evaluation) were funded in the Technology Integration subprogram. The Testing and Evaluation activity was included in the vehicle systems subprogram beginning in FY 2008. Funding for some Federal Fleets activities under the Legislative and Rulemaking activity was requested within the Federal Energy Management Program in FY 2008 and the remainder — activities to support E85 ethanol fuel deployment and additional regulatory support — were included within the Legislative and Rulemaking activity within the Technology Integration subprogram.

[a] Clean Cities was funded in Weatherization and Intergovernmental Activities in FY 2006 under the heading of Gateway Deployment. Comparable funding for FY 2005 and 2006 was $10.626 million and $6.510 million respectively.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Legislative and Rulemaking	**1,804**	**0**	**0**

The Legislative and Rulemaking was shifted to the Technology Integration subprogram in FY 2008. The activity consisted of the State and Alternative Fuel Provider Regulatory Program, Fuel Petitions, Private and Local Government Fleet Regulatory Program, Federal Fleet requirements and the normal implementation of other EPACT 2005 requirements.

▪ **State and Fuel Provider Fleet**	**990**	**0**	**0**

The State and Fuel Provider Fleet subactivity was included within the Legislative and Rulemaking activity within the Technology Integration subprogram. In FY 2007, this activity promoted the use of alternative fuel in the state fleets through outreach and partnership building between the state and alternative fuel providers (EPACT Sec 507 (1992)).

▪ **Federal Fleets**	**700**	**0**	**0**

In FY 2008, part of the Federal Fleet activity (tracking of Federal fleet AFV acquisitions) was moved to FEMP. Remaining activities to support E85 deployment and additional regulatory support were included within the Legislative and Rulemaking activity within the Technology Integration subprogram.

▪ **Regulatory Support**	**114**	**0**	**0**

The Regulatory Support subactivity was included within the Legislative and Rulemaking activity within the Technology Integration subprogram. In FY 2007, the program continued tracking and analysis of energy legislation and revised EPACT 2005 Renewable Fuel goal.

Clean Cities	**4,393**	**0**	**0**

In FY 2008, the Clean Cities activity was reorganized as Vehicle Technology Deployment within the Technology Integration subprogram. In FY 2007, Clean Cities continued to promote petroleum displacement strategies by working with local Clean Cities coalitions and their partners. Technologies included: alternative fuel vehicles, idling reduction devices in commercial trucks and buses, expanded use of non-petroleum fuel blends, and hybrid technologies.

Testing and Evaluation	**7,534**	**0**	**0**

The Testing and Evaluation activity has been integrated into the Vehicle Systems subprogram. The primary goal of the Advanced Vehicle Testing Activity (AVTA) is to benchmark and validate the performance of passenger and commercial vehicles that feature one or more advanced technologies. These include: internal combustion engines burning advanced fuels, such as 100 percent hydrogen and hydrogen/compressed natural gas-blended fuels; hybrid electric, pure electric, and hydraulic drive systems; advanced batteries and engines; and advanced climate control, power electronic, and other

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		

ancillary systems.

▪ **Vehicle Evaluation**	**5,484**	**0**	**0**

In FY 2007, expanded the controlled, closed track baseline testing and real-world monitored fleet evaluations of advanced plug-in hybrid electric vehicles, identified weaknesses to be addressed through future R&D, and tested first generation hydrogen-fueled internal combustion engine hybrid electric vehicles and second generation advanced hybrid electric vehicles.

▪ **Infrastructure Testing**	**2,050**	**0**	**0**

In FY 2007, continued evaluation of vehicle refueling and recharging systems required for advanced plug-in hybrid electric vehicles and hydrogen-fueled vehicles.

Advanced Vehicle Competitions	**1,300**	**0**	**0**

In FY 2007, the program conducted the third year of the Challenge X competition in partnership with General Motors.

Total, Technology Introduction	**15,031**	**0**	**0**

Building Technologies

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation[a]	FY 2008 Original Appropriation	FY 2008 Adjustments[b]	FY 2008 Current Appropriation	FY 2009 Request
Building Technologies					
Residential Buildings Integration	17,270	24,700	-225	24,475	26,900
Commercial Buildings Integration	8,699	12,000	-109	11,891	13,000
Emerging Technologies	41,840	37,756	-343	37,413	39,465
Technology Validation and Market Introduction	18,249	13,361	-122	13,239	24,400
Equipment Standards and Analysis	16,925	22,183	-202	21,981	20,000
Total, Building Technologies	102,983	110,000	-1,001	108,999	123,765

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act" (1978)
P.L. 95-619, "National Energy Supply Policy Act" (NECPA) (1978)
P.L. 95-620, "Power Plant and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Supply Act" (1987)
P.L. 100-357, "National Appliance Energy Supply Amendments" (1988)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the Building Technologies Program (BT) is to develop technologies, techniques, and tools for making residential and commercial buildings more energy efficient, productive, and affordable. The portfolio of activities includes efforts to improve:

- the energy efficiency of building components and equipment

[a] Excludes amounts transferred to the Science appropriation for carrying out SBIR / STTR. All subsequent tables in this program also reflect this transfer.

[b] Reflects amounts rescinded by General Provision, section 312, of the Omnibus Appropriations Act, 2008.

- effective integration using whole-building-system-design techniques
- building codes and equipment standards
- The integration of renewable energy systems into building design and operation
- adoption of these technologies and practices

Accomplishing the mission will benefit the demand sides of the Department's energy security equation, enabling more productive use of the energy we consume.

Buildings account for more than two-thirds of the electric energy consumed in the U.S. today. Building Technologies Program initiatives are aligned with DOE's goal to improve energy security by developing reliable, affordable, and environmentally sound renewable energy and energy efficiency technologies that significantly reduce the energy consumption and peak electrical demands of residential and commercial buildings. The Building Technologies Program strives to make net zero energy homes and buildings a reality by bringing together state-of-the art, energy efficient construction and appliances with commercially available renewable energy systems. This can help reduce national energy demand requirements in the build environment and avoid construction of homes and buildings that "lock in" less than optimal energy efficient homes and building for generations.

By pushing on all fronts to make new and existing homes and buildings less energy intensive, Building Technologies is tapping into significant primary energy savings that are achievable today, with even greater future savings in the pipeline, thus reducing electricity generation and carbon emissions dramatically.

The Building Technologies Program pursues its mission through integrated activities designed to improve the energy efficiency and productivity of our economy. Achievement of the program's goals is expected to yield energy security, economic and environmental benefits. Additionally, building energy efficiency technologies provide less easily quantifiable benefits, such as improved lighting quality and building occupant productivity. The benefits estimates reported exclude any expected acceleration in the deployment of the technologies that may result from the unique field partnerships that provide the basis for the Residential Building Integration R&D, or synergies with the ENERGY STAR® Home Program.

Achievement of program goals could result in a reduction in cumulative net consumer expenditures of nearly $140 billion by 2030 and nearly $1.4 trillion by 2050. Cumulative savings to the electric power industry are expected to be over $100 billion by 2030 and nearly $350 billion by 2050. The program's expected economic, environmental and security benefits are described in more detail under the "Expected Program Outcomes" sections.

In the near term, widespread adoption of advanced commercially available technologies, such as ENERGY STAR® compliant equipment, can improve efficiency of energy-using equipment in the primary functional areas of energy use. In residential buildings, these functional areas include space heating, appliances, lighting, water heating, and air conditioning. In commercial buildings, functional areas are lighting, space heating, cooling and ventilation, water heating, office equipment, and refrigeration. Through concerted research, major technical advances have occurred during the past 20 years, with many application areas seeing efficiency gains of 15 percent to 75 percent.

Over the longer term, more advances can be expected in these areas, and significant opportunities also lie ahead in the areas of new buildings design, retrofits of existing buildings, and the integration of whole building systems and multi-building complexes through use of sensors, software, and automated maintenance and controls.

By 2025—with advances in building envelopes, equipment, and systems integration—it may be possible to achieve up to a 70 percent reduction in a building's energy use, compared to the average energy use in an equivalent building today (DOE 2005). If augmented by on-site energy technologies (such as photovoltaics or distributed sources of combined heat and power), buildings could become net-zero GHG emitters and net energy producers.

In the near term, building energy use and CO_2 emissions could be lowered in several ways. Especially in new construction, design strategies that incorporate energy- and material-saving strategies from the very start of the building process can result in significant avoided carbon. Intelligent building systems (such as load balancing and automated sensors and controls) can also be included to help ensure the comfort, health, and safety of residents, as well as aid in the reduction of CO_2. In the building envelope, application of advanced materials such as high R-value insulation, foams, vacuum panels, and spectrally selective windows can reduce space conditioning loads significantly. Choosing highly recyclable materials such as aluminum can reduce the end-of-life impact of building design and contribute to sustainable building practices. Technologies to improve the efficiency of lighting, appliances, heating, cooling, and ventilation are other options.

In the long term, more advanced research on the building envelope—including dynamic switchable window glazings and dynamic walls, panelized housing construction, façade and roof integration of photovoltaics, and new storage technologies—can drive CO_2 emissions even lower. Distributed power systems, advanced refrigeration and cooling technologies, integrated heat pumps that serve space conditioning and water heating, and solid-state lighting technology are among some of the more promising options for equipment. Among the alternatives, building integration should focus on including sensors and controls, community-scale integration tools, and urban engineering.

Program Deliverables and Interdependencies

The following expected program deliverables are expected based upon proposed budgets:

- New homes with zero-net energy performance
- New commercial buildings with zero-net energy performance
- Existing homes and existing commercial buildings with 35-50 percent increases in total energy performance.
- Component performance breakthroughs and advances including:
    - 40-70 percent improvements in Heating, Ventilating and Air-Conditioning Systems
    - 160 lumen-per-watt solid-state lighting sources
    - Advanced window systems with cost-effective R-10 performance
    - R-50 roofing systems
    - 35 percent reductions in miscellaneous and other end-uses

- EnergyPLUS simulation tool with full capabilities to model all emerging technologies

Interdependencies Include:

- WIP providing consumers and decision makers with information on cost, performance, and financing of energy efficiency and renewable energy projects. WIP also supports cross-cutting market transformation efforts by state and local policy makers so that energy-saving technologies are economically competitive. It maintains direct working relationships with state and local governments, weatherization agencies, and Native American tribal governments. Through the Weatherization Assistance Program, DOE delivers weatherization services to low-income households in every county in the Nation and on Native American Tribal lands. Through a network of partnerships with more than 970 local Weatherization agencies, the program improves the energy efficiency of more than 100,000 low-income dwellings a year.
- FEMP promoting energy efficiency and the use of renewable energy resources at federal facilities. FEMP does this to ensure that the federal government, the largest energy consumer, works toward meeting the goals set forth in legislative mandates and Executives Orders for saving energy. As the largest energy consumer in the United States, the federal government has both a tremendous opportunity and a clear responsibility to lead by example with smart energy management. By promoting energy efficiency and the use of renewable energy resources at federal sites, the Federal Energy Management Program helps agencies save energy, save taxpayer dollars, and demonstrate leadership with responsible, cleaner energy choices. Reducing the generator cost of energy from high wind resource sites through operation, reliability and performance enhancement to pay higher transmission costs for delivery.
- The Solar Buildings Initiative accelerating R&D and large scale commercialization of distributed photovoltaic technology for buildings.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Building Technologies Program supports the following goals:

Strategic Theme 1, Energy Security

Strategic Goal 1.4, Energy Productivity: Cost-effectively improve the energy efficiency of the U.S. economy.

And concurrently supports:

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Theme 3, Scientific Discovery and Innovation

Strategic Goal 3.3, Research Integration: Integrate basic and applied research to accelerate innovation and to create transformational solutions for energy and other U.S. needs.

The Building Technologies Program has one GPRA Unit Program goal which contributes to Strategic Goals 1.4 in the "goal cascade:"

GPRA Unit Program Goal 1.4.20.00: Building Technologies - The Building Technologies Program goal is to develop cost effective tools, techniques and integrated technologies, systems and designs for buildings that generate and use energy so efficiently that buildings are capable of generating as much energy as they consume.

Contribution to GPRA Unit Program Goal 1.4.20.00 (Building Technologies)

The principal Building Technologies Program contributions to Strategic Theme 1 (Energy Security) and Strategic Theme 3 (Scientific Discovery and Innovation), are improving energy efficiency, and incorporating productive power technologies into the whole building infrastructure. Key technology pathways that contribute to achievement of the goal include:

- Residential Buildings Integration R&D Activities: Provide the energy technologies and solutions that will catalyze 70 percent reduction in energy use of new prototype residential buildings that when combined with onsite energy technologies result in zero energy homes (ZEH)[a] by 2020 and, when adapted to existing homes result in a significant reduction in their energy use. By 2010, develop, document and disseminate five cost effective technology packages that achieve an average of 40 percent reduction in whole house energy use. Performance indicators include the number of: subsystem technological solutions developed, researched, and evaluated; technology package research reports developed, researched, and evaluated against the Building America benchmark[b] for homes; builder best practices manuals developed; existing homes retrofitted to achieve 20 percent or more improvement in energy efficiency, and project and demonstration homes developed in the Building America (BA) Program.

- Commercial Buildings Integration R&D Activities: By 2010, collaborate with industry to develop, document and disseminate a complete set of 14 technology packages that provide builders energy efficient options to meet their complex performance demands that can achieve 30 percent reduction in the purchased energy use in new, small to medium-sized commercial buildings relative to ASHRAE 90.1-2004. Complete an initial technology option set that establishes a basis for achieving 50 percent energy use reductions. Performance indicators include the number of technology packages and option sets developed, researched, and evaluated for their demonstrated potential to contribute to the target reduction of energy use in new buildings.

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[a] The zero energy building (ZEB) referred to as zero energy homes (ZEH) in the residential sector research initiative is bringing a new concept to homebuilders across the United States. A zero energy home combines state-of-the-art, energy efficient construction and appliances with commercially available renewable energy systems such as solar water heating and solar electricity. This combination can result in a net zero energy consumption. A ZEH, like most houses, is connected to the utility grid, but can be designed and constructed to produce as much energy as it consumes on an annual basis. With its reduced energy needs and renewable energy systems, a ZEH can, over the course of a year, give back as much energy to the utility as it takes.

[b] Building America Benchmark, Version 3.1, November 2003, National Renewable Energy Laboratory

- Emerging Technologies Activities: Accelerate the introduction of highly-efficient technologies and practices for both residential and commercial buildings. The emerging technologies activities support the BT goal through research and development of advanced lighting, building envelope, windows, space conditioning, water heating and appliance technologies. In the area of solid state lighting (SSL) our goal is to achieve lighting technologies with double the efficiency of today's most efficient lighting sources. Without advanced components and subsystems developed in the Emerging Technologies activities, the goal of Zero Energy Buildings (ZEB) will not be met. The performance indicators include the number of potentially market viable technologies demonstrated each of which is expected to contribute to the ZEB based upon individual builder objectives.

- Equipment Standards and Analysis: Increase minimum efficiency levels of buildings and equipment through codes, standards, and guidelines that are technologically feasible, economically justified, and save significant energy. By 2010, issue 13 formal proposals, consistent with the law, for enhanced product standards and test procedures. By 2011, complete one rulemaking for every product in the backlog. Performance indicators include product standards and test procedures proposed/issued that will result in more efficient buildings energy use.

- Technology Validation and Market Introduction: Accelerates the adoption of clean and efficient domestic energy technologies through such activities as Rebuild America, ENERGY STAR,® and Building Energy Codes. By 2010, increase the market penetration of ENERGY STAR® labeled windows to 54 percent (40 percent, 2003 baseline), and maintain 28 percent market share for ENERGY STAR® appliances. ENERGY STAR® activities will work to remove technical, financial and institutional barriers to the widespread awareness, availability, and purchase of highly efficient appliances, compact fluorescent lighting products, windows and other products, including new advanced products. Rebuild America activities will work to remove technical, financial and institutional barriers to the widespread awareness, availability and application of highly efficient buildings including building design, construction, retrofit and operations practices. The Building Energy Code activities will support the development and implementation of energy efficient building codes which increases the construction of more energy efficient buildings. The Solar Decathlon activities will include a high-profile university competition held biannually in Washington, D.C. (next one to be held in 2009), that promotes public awareness of highly efficient building technologies and zero-energy homes using solar energy.

Funding by Strategic and GPRA Unit Program Goal

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Strategic Goals 1.4, Energy Productivity			
GPRA Unit Program Goal 1.4.20.00, Building Technologies			
Residential Buildings Integration	17,270	24,475	26,900
Commercial Buildings Integration	8,699	11,891	13,000
Emerging Technologies	41,840	37,413	39,465
Technology Validation and Market Introduction	18,249	13,239	24,400

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Equipment Standards and Analysis	16,925	21,981	20,000
Total, GPRA Unit Program Goal 1.4.20.00, Building Technologies	102,983	108,999	123,765

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.4.20.00 (Building Technologies)					
Residential Buildings Integration					
Initiate 5 design packages that provide promising technological solutions considering regional and housing type differences targeting 40 - 50 percent reductions in residential space conditioning loads, compared to IECC 2003, through Building America Consortia. Strategies to reduce the major loads, including energy used for hot water, lighting and clothes dryers were also investigated. [MET GOAL]	Complete the research for production-ready new residential buildings that are 30 percent more efficient than the whole-house Building America benchmark in 2 climate zones and document the results in Technology Package Research Reports. [MET]	Complete system research with lead builders in two climate zones demonstrating production-ready new residential buildings that are 30 percent more efficient than the whole-house Building America benchmark and document the results in Technology Package Research Reports. [MET]	Document in Technology Package Research Reports research results for production ready new residential buildings that are 30 percent more efficient in 1 climate zone and 40 percent more efficient in 1 climate zone than the whole-house Building America benchmark.	Complete one design technology package for new residential buildings (that is 40 percent more energy efficient relative to the 2004 Building America benchmark) at net zero financed cost to the homeowner for one climate zone	Complete two design technology packages for new residential buildings (that are 40 percent more energy efficient relative to the 2004 Building America benchmark) at net zero financed cost to the homeowner for two climate zones.
	Analyze and develop code change proposals that are expected to result in a cost-effective improvement in energy efficiency in residential buildings of approximately 1-2 percent. [MET]				
Commercial Buildings Integration					
	Complete assessments of controls technology, optimization methods and market opportunities, with substantial input from designers and building owners, to establish a framework for development of programmatic pathways to achieve 50 percent or better energy performance in significant numbers of buildings enabling development of design and/or technology packages for new commercial buildings. [MET]	Complete the development of one design technology package to achieve 30 percent or better energy savings, focusing on a single, high priority building type, such as small commercial retail or office buildings, based on the technical and market assessments completed in 2005. [MET]	Complete the development of two new design technology packages for a second small to medium sized commercial building type to achieve 30 percent energy savings over ASHRAE 90.1-2004.	Complete four additional design technology packages for new commercial buildings (that achieve 30 percent increase in energy efficiency relative to the ASHRAE 90.1-2004 benchmark) with five year or less payback. These design technology packages will be for small to medium-sized commercial buildings.	Complete four additional design technology packages for new commercial buildings (that achieve 30 percent increase in energy efficiency relative to the ASHRAE 90.1-2004 benchmark) with five year or less payback. These design technology packages will be for small to medium-sized commercial buildings.
	Analyze and develop code change proposals that are				

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
	expected to result in a cost-effective improvement in energy efficiency in commercial buildings of approximately 1-2 percent. [MET]				
Emerging Technologies					
Complete a solicitation and award five or more competitively based research awards for cost-shared research on technology (such as materials and light extraction) to contribute to the goal of 160 lumens/Watt (lm/W) and $11/Klm of white light from solid state devices with industry, National Laboratories, and universities. [MET GOAL]	Select five new competitively based research awards for cost-shared research on technology (such as optical materials and device structures) to achieve ≥65 lm/W white light from solid state devices with industry, National Laboratories, and universities. [MET]	Conduct cost-shared, competitively selected research on technology to achieve = 65 1m/W (in a laboratory device) of white light from solid state devices with industry, National Laboratories, and universities. [MET]	Achieve at least 86 lumens per Watt (in a laboratory device) of white light from solid state devices based on cost-shared research which is competitively selected.	Achieve efficiency of "white light" solid-state lighting in a lab device, of at least 101 lumens per Watt.	Achieve efficiency of "white light" solid-state lighting in a lab device, of at least 107 lumens per Watt.
	Complete a prototype dynamic window that will have a Solar Heat Gain Coefficient (SHGC) in the range of 0.05 to 0.60 , while meeting American Society for Testing and Materials (ASTM) durability standards for cycling in a high temperature, high ultraviolet light environment. [MET]				
	Complete a thermodynamic study of emerging refrigerants. Based on study results, make go/no-go decision on initiation of first stage development of a laboratory prototype, high efficiency residential 1-ton air-conditioning and heat pump unit that uses a novel approach to the vapor compression refrigeration cycle and has the potential for a Seasonal Energy Efficiency Ratio (SEER) of over 20. [MET]				

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Equipment Standards and Analysis					
Prepare for issuance up to four rules to amend appliance standards and test procedures for some of the following products: Residential Furnaces, Boilers, and Mobile Home Furnaces; Electrical Distribution Transformers; Commercial Unitary Air-Conditioners and Heat Pumps; and Residential Niche Product Air-Conditioners and Heat Pumps. [MET]	Complete analytical and regulatory steps necessary for DOE issuance of 3-4 rules, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. [MET]	Complete analytical and regulatory steps necessary for DOE issuance of 4 rules, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. Develop for DOE issuance notices of proposed rulemaking (NOPRs) regarding energy conservation standards for electric distribution transformers, commercial unitary air conditioners and heat pumps, and residential furnaces and boilers. [MET]	Final rules will be issued for 3-5 product categories, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. This includes final rules for distribution transformers and residential furnaces and boilers.	Complete 11-13 proposals to update appliance standards and test procedures publish in the Federal Register. Final rules will be issued for 1-2 of these product categories, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings For this measure "proposal" includes unique product inclusions in ANOPRS, NOPRS, and Final Rules. Multiple proposals (covering a number of product categories) could be bundled in Federal Register Notices.	Complete 14-16 proposals to update appliance standards and test procedures publish in the Federal Register. Final rules will be issued for 4-6 of these product categories, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. For this measure "proposal" includes unique product inclusions in ANOPRS, NOPRS, and Final Rules. Multiple proposals (covering a number of product categories) could be bundled in Federal Register Notices.
Technology Validation and Market Introduction/Rebuild America					
Assist over 500 new and existing Rebuild America community partnerships to upgrade 70 million square feet of floor space in K-12 schools, colleges, public housing, and state/local governments, reducing the average energy used in these buildings by 18 percent. [MET]	Help Rebuild America community partnerships to upgrade 60 million square feet of floor space in K-12 schools, colleges, public housing, and state/local governments, reducing the average energy used in these buildings by 18 percent. [MET]				

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Technology Validation and Market Introduction/ENERGY STAR®					
Recruit 500 additional retail stores, 5 additional utilities and 10 additional manufacturers. Add domestic hot water heaters to the program. Begin work on a Commercial Window Specification. Expand room air-conditioner program to include heating cycle. Continue outreach to non-English speaking communities and Weatherization activities. [NOT MET]	Recruit 500 additional retail stores, 5 additional utilities and 10 additional manufacturers. Complete draft Commercial Window specification. Begin update of Residential Window specification. Expand coordination with all gateway activities. [MET]	Increase market penetration of appliances (clothes washers, dishwashers, room air conditioners and refrigerators) to 38 to 42 percent (baseline 30 percent calendar year 2003), to 2 to 3 percent for Compact Fluorescent Lamps (baseline 2 percent calendar year 2003) and 40 to 45 percent for windows (baseline 40 percent calendar year 2004). Estimated energy savings will be 0.030 Quads and $657 million in consumer utility bill savings. [MET]	Increase market penetration of appliances to 30 to 32 percent (baseline 30 percent calendar year 2003), to 2.5 to 4 percent for CFL's (baseline 2 percent calendar year 2003) and 45 to 50 percent for windows (baseline 40 percent for calendar year 2003). Estimated energy savings will be 0.032 Quads and $671 million in consumer utility bill savings.	Achieve market penetration target for ENERGY STAR® appliances of 33 percent (baseline 30 percent in 2003), 6 percent for CFLs (baseline 2% in 2003), and 48 percent for windows (baseline 40 percent in 2003).	Achieve market penetration target for ENERGY STAR® appliances of 39 percent (baseline 30 percent in 2003), 12 percent for CFLs (baseline 2 percent in 2003), and 56 percent for windows (baseline 40 percent in 2003). Revised criteria for clothes washers, refrigerators and windows Release criteria for photovoltaic systems. Complete evaluation for developing ENERGY STAR® criteria for small wind turbines.
Contributed proportionately to EERE's corporate goal of reducing corporate and program uncosted to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [Not MET: EERE actively accelerating costing of funds]	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline in 2004 ($33,417k) until the target range is met. [NOT MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.

Means and Strategies

The Building Technologies Program will use various means and strategies, as described below, to achieve its GPRA Unit Program goal. “Means” include operational processes, resources, information, and the development of technologies, and “strategies” include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program’s goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Department will implement the following means:

- The Residential Buildings Integration subprogram focuses on improving the efficiency of the approximately 1.5 to 2.0 million new homes built each year and the 100+ million existing homes, including multifamily units. These improvements are accomplished through research, development, demonstration, and technology transfer activities. This includes efforts to improve the energy efficiency of residential energy uses such as space heating and cooling, ventilation, water heating, lighting, and home appliances. Overall the program seeks to make improvements through the application of a systems engineering approach to optimize the technologies in whole buildings and concurrently ensure health and safety of the buildings in addition to integrating renewable technologies into buildings.

- The Commercial Buildings Integration subprogram addresses energy savings opportunities in new and existing commercial buildings ($270 billion spent annually for new building construction and over $160 billion for renovation in 2004, according to 2006 Buildings Energy Data Book (US Department of Energy, September 2006)). This includes research, development and demonstration of whole building technologies, such as sensors and controls, design methods and operational practices. These efforts support the net zero energy buildings goal not only by reducing building energy needs, but also by developing design methods and operating strategies which seamlessly incorporate solar and other renewable technologies into commercial buildings;

- The Emerging Technologies subprogram conducts R&D and technology transfer associated with energy-efficient products and technologies, for both residential and commercial buildings. These efforts address high-impact opportunities within building components such as lighting, building envelope technologies (including advanced windows), solar heating and cooling, and analysis tools and design strategies.

- The Equipment Standards and Analysis subprogram leads to improved efficiency of appliances and equipment by conducting analyses and developing standards that are technologically feasible and economically justified, under the Energy Policy and Conservation Act, as amended (EPCA). Analysis performed under this program will also support related program activities such as Energy Star to ensure a consistent methodology is used in setting efficiency levels for related programs; and

- Technology Validation and Market Introduction: Activities will be developed to accelerate the adoption of clean, efficient, and domestic energy technologies. The three major activities are: ENERGY STAR,® Rebuild America, and Building Energy Codes. ENERGY STAR® is a joint Department of Energy/Environmental Protection Agency activity designed to identify and promote energy efficient products. The Rebuild America Program element is aligned with the Commercial Building Integration research and development activity to accelerate the adoption of advances in commercial building integrated design, software tools, practices and advanced controls, equipment and lighting. The activity will target decision-makers with national and regional market scope such as multi-brand corporations in the retail, lodging, and restaurant sectors, commercial property developers, owners, and operators as well as in the schools, hospital, and commercial retail sector. Building Energy Codes provides technical and financial assistance to States to update and implement their energy codes in support of Energy Conservation and Production Act, Section 304. It also includes the current building energy code activities previously conducted under Residential and Commercial Building Integration. The activity also targets residential decision makers through the Builders' Challenge project.

BT's challenge is to address the opportunities with appropriate strategies, and design programs that give appropriate consideration to the marketplace and barriers to energy efficiency. To accomplish this, the Building Technologies Program will implement the following strategies:

- Focus the R&D portfolios to ensure that the most promising, revolutionary technologies and techniques are being explored, align the Residential and Commercial Integration subprograms to a vision of zero net energy buildings, and appropriately exit those areas of technology research that are sufficiently mature or proven to the marketplace, and close efforts where investigations prove to be technically or economically infeasible ("off ramps");
- Use a "whole buildings" approach to energy efficiency that takes into account the complex and dynamic interactions between a building and its environment, among a building's energy systems, and between a building and its occupants. Our analysis suggests that this approach has achieved energy savings of 30 percent beyond those obtainable by focusing solely on individual building components, such as energy-efficient windows, lighting, and water heaters;[a]
- Investing in collaborative research with the Solar Energy Program to reduce barriers to the installation and operation of photovoltaic technology on zero energy homes and buildings;
- Develop technologies and strategies to enable effective integration of energy efficiency and renewable energy technologies and practices;
- Increase minimum efficiency levels of buildings and equipment through codes, standards, and guidelines that are technologically feasible and economically justified. BT develops standards through a public process and submits codes proposals to International Energy Conservation Code (IECC) and ASHRAE;
- The management strategy for developing affordable net zero energy buildings requires a high level of coordination with other programs in the Office of Energy Efficiency and Renewable Energy. These include the Solar Energy Technology Program, Biomass Program, Wind Energy Program, Hydrogen Technology Program (fuel cells), Federal Energy Management Program and the Weatherization and Intergovernmental Program that may have important technologies to contribute. The Building Technologies Program also invests in technical program and market analysis and performance assessment in order to direct effective strategic planning; and

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[a] Building Science Corporation, Final Report: Lessons Learned from Building America Participation, February 1995 – December 2002, February 2003, NREL/SR-550-33100

- Provide technical information to customers through deployment of cost-effective energy technologies, forming partnerships with private and public sector organizations.

These strategies can result in significant cost savings and a significant reduction in the consumption of energy, an increase in the substitution of clean and renewable fuels, and can cost effectively reduce America's demand for energy, thus lowering carbon emissions and decreasing energy expenditures.

The following external factors could affect Building Technologies' ability to achieve its strategic goal:

- There are several factors that can hinder the private sector making R&D investments in energy efficient building technologies. These include a highly diversified industry comprised of thousands of builders and manufacturers, none of which has the capacity to sustain research and development activities over multi-year periods.

- Another factor is the compartmentalization of the building professions, in which architects and designers, developers, construction companies, engineering firms, and energy services providers do not typically apply integrated strategies for siting, construction, operations and maintenance.[a]

- The high initial cost of energy efficient building appliances can keep consumers from purchasing them even if they are cost effective in the long run.

In carrying out the program's mission, Building Technologies performs the following collaborative activities:

Partnerships and cost share arrangements with industry and other Federal agencies become critical management tools that can build a critical mass to address these barriers. ENERGY STAR® is a joint DOE and Environmental Protection Agency Program (EPACT 2005) with more than 4,000 retailers to label ENERGY STAR® qualified appliances and energy efficient products, while Rebuild America will partner with decision-makers with national and regional market scope such as multi-brand corporations in the retail, lodging, and restaurant sectors, the schools and hospital sector, as well as commercial property developers, owners and operators. DOE coordinates its research and development, regulatory activities, and technology demonstrations with EPA's marketplace activities (http://www.energystar.gov/). Through these activities with EPA, BT contributes to the Administration's objective of reducing greenhouse gas emissions.

The Building Energy Code activities include technical and financial assistance to the States to update and implement their energy codes in support of Energy Conservation and Production Act, Section 304. BT works with national, regional, and state building code officials and stakeholders to help building owners, builders and the design community understand the science, benefits, and techniques for going significantly beyond code with added value strategies. BT also trains approximately 2,000 code officials, designers, and builders to implement these codes and updates and improves the core materials and code compliance software to reflect recent changes in the model energy codes and emerging energy efficiency technologies.

- Partners with the Solar Energy Program to work toward the goal of zero energy homes.

- Coordinates with the Office of Science in basic research on solid state lighting technology.

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[a] Scott Hassell, Anny Wong, Ari Houser, Debra Knopman, Mark Bernstein, RAND Corporation: *Building Better Homes: Government Strategies for Promoting Innovation in Housing, 2003*.

- The program's management strategy involves four key elements: a customer-focused, team-based organization for greater accountability and improved results; systematic multi-year planning including collaboratively developed technology roadmaps to provide for a more integrated, customer driven R&D portfolio; utilization of stage-gate management processes to ensure progress and market relevance; greater competition in project solicitations to increase innovation and broaden research participation; and increased peer review to assure scientifically sound approaches.
- The program interacts regularly with industry to ensure relevance of research, including research and development workshops (e.g., biennial reviews in solid state lighting and windows research) and peer reviews.

Validation and Verification

To validate and verify program performance, the Building Technologies Program will conduct various internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accountability Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. The table below summarizes validation and verification activities.

Data Sources: EIA Annual Energy Review (AER); Commercial Building Energy Consumption Survey (CBECS); Residential Energy Consumption Survey (RECS); and Annual Energy Outlook (AEO) ISTAR (ENERGY STAR® database). U.S. Department of Commerce (DOC) Current Industrial Reports (CIR). Various trade publications. Information collected directly from Building Technologies performers or partners.

Baselines: The following are key baselines used in the Building Technologies Program:

- New Residential Buildings: Energy use varies by climate region, based on the Building America Benchmark. The program will focus on creating design technology packages to reduce energy consumption from the Building America Benchmark. In 2003, 0 technology package research reports at 30/50/70 percent energy savings.
- New Commercial Buildings Energy Use Intensity: Varies by climate region and building type (ASHRAE 90.1-2004). The program will focus on creating design technology packages to reduce energy consumption by 30 and 50 percent for small commercial buildings (baseline 1 technology packages for 30 percent and 0 technology packages for 50 percent in 2005).
- Solid State Lighting (2002): 25 lumens/Watt efficacy (solid state lighting whitelight).
- Windows (2003): 0.33 to 0.75 U-values (varies by region).
- Residential Heating and Cooling (2003): Average total heating and cooling system energy use, defined by reported consumption in EIA for residential buildings and all existing buildings, and the Building America benchmark for new residential buildings, by climate region.
- New Residential Building Codes: 2003 International Energy Conservation Code (IECC), International Code Council.

- New Commercial Building Codes: ASHRAE 90.1-2004.

ENERGY STAR®: Federal appliance minimum standards and applicable national building codes (windows). ENERGY STAR® baseline is market share for ENERGY STAR® appliances of 30 percent in 2003, compact fluorescent light bulb market share of 2 percent in 2003, windows market share of 40 percent in 2003.

Frequency: Complete revalidation of assumptions and results can only take place every three to four years, due to the reporting cycle of two crucial publications: CBECS and RECS. However, updates of most of the baseline forecast and BT Program outputs will be undertaken annually.

Evaluation: In carrying out the program's mission, the Building Technologies Program uses several forms of evaluation to assess progress and to promote program improvement:

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal technical and management reviews of program and subprogram portfolios;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule, R&D Investment Criteria, President's Management Agenda and Program Assessment and Rating Tool (PART) reviews;
- Peer reviews as needed when evaluating go/no go decision points in each research area; and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage: EIA and DOC data sources are publicly available. Trade publications are available on a subscription basis. BT Program output information is contained in various reports and memoranda.

Verification: Calculations are based on assumptions of future market status, equipment or technology performance, and market penetration rates. These assumptions can be verified against actual performance through technical reports, market survey and product shipments.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. BT has incorporated feedback from OMB into its results based management strategy reflected in the FY 2007 Budget Request, and continues to improve performance along the lines suggested by the PART.

The Building Technologies Program was rated as “Adequate” in its PART for 2003 receiving the following scores: Purpose (80), Planning (50), Management (88), and Results (42). The program has addressed many of the original PART recommendations through activities including: a multi-year planning effort that focuses on the development of technical pathways and the integration of the systems and component research to achieve Zero Energy Buildings; increasing funding for solid state lighting and reducing support for other technologies near commercialization; and continued development of adequate long-term and annual performance measures with OMB assistance which have been reflected in a multi-year program plan and annual operating plan. A more recent PART recommendation to improve management processes that will accelerate analyses to reduce the backlog of statutorily mandated energy efficiency regulations is reflected in the program’s detailed timeline and report to Congress on this topic.

Expected Program Outcomes

The Building Technologies Program pursues its mission through integrated activities designed to improve the energy efficiency and productivity of our economy. Achievement of the program’s goals is expected to yield energy security, economic and environmental benefits. Additionally, building energy efficiency technologies provide less easily quantifiable benefits, such as improved lighting quality and building occupant productivity. The benefits estimates reported exclude any expected acceleration in the deployment of the technologies that may result from the unique field partnerships that provide the basis for the Residential Building Integration R&D, or synergies with the ENERGY STAR® Home Program.

Estimates of the security, economic and environmental benefits from 2009 through 2050 that would result from realization of the program’s goals are shown in the table below.

EERE’s Building Technology benefits reflect the increasing penetration of building technologies over time, as the program’s goals are met. Not included are any policies or regulatory mechanisms, or other incentives not already in existence, that might be expected to support or accelerate the achievement of the program goals. The expected benefits reflect solely the achievement of the program’s goals.

The goals are modeled in contrast to the “baseline” case, in which no DOE R&D exists. The baseline case is identical to those used for all DOE applied energy R&D programs.[a] Further, across EERE, and across all of DOE’s applied energy R&D programs, the expected outcome benefits are being calculated using the same fundamental methodology. Finally, the metrics by which expected outcome benefits are measured are identical for all of DOE’s applied energy R&D programs.[b] This standardization of

[a] The starting point for the baseline case is the Energy Information Administration’s “reference case,” as published in the AEO 2007. Program analysts from across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO’s technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

[b] The set of expected outcome metrics being used this year differs in substantial ways to that of previous years. In addition to the standardization across DOE’s applied energy R&D programs, the list is expanded and more comprehensive than in

methods and metrics has been undertaken as part of the Department's efforts to respond to Strategic Management System initiative and OMB's request to make all programs' outcomes comparable.

The difference between the baseline case and the program goal case results in economic, environmental and security benefits. For example, achievement of program goals results in a reduction in net consumer expenditures of 138 billion dollars in 2030 and 1.2 trillion in 2050. Savings to the electric power industry are expected to be 111 billion dollars in 2030 and 343 billion dollars in 2050. Finally, the program would also result in carbon emissions reductions of 1.6 billion metrics tons in 2030 and 7.9 billion metric tons in 2050. The results are generated by modeling the program goals within two energy-economy models: NEMS-GPRA09 for benefits through 2030, and MARKAL-GPRA08 for benefits through 2050.[a] The full list of modeled benefits appears on the next page.

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past years. Further, the list maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

[a] Documentation on the analysis and modeling, can be found at http://www.eere.energy.gov/ba/pba/

Primary Benefits Metrics for FY09– NEMS and MARKAL

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	0.2	2.1
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	1.0	2.2	5.2	N/A
		MARKAL	0.6	1.1	5.2	18.6
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	75	330	1611	N/A
		MARKAL	142	517	2143	7872
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	121	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	17	31	138	N/A
		MARKAL	50	133	458	1271
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	13	34	111	N/A
		MARKAL	20	52	136	343
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	10	20	80	N/A
		MARKAL	13	35	177	302

1. “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

Residential Buildings Integration

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Residential Buildings Integration			
Research and Development: Building America	16,775	23,659	26,006
Residential Building Energy Codes	495	0	0
SBIR/STTR	0	816	894
Total, Residential Buildings Integration	17,270	24,475	26,900

Description

The long-term goal of the Residential Buildings Integration subprogram is to develop cost effective, production ready systems in five major climate zones that result in houses that produce as much energy as they use on an annual basis.

In order to achieve the technical capability for zero energy homes by 2020, integrated cost-effective whole-building strategies will be developed to enable residential buildings to use up to 70 percent less total energy than the Building America Benchmark and provide energy for the remaining 30 percent of energy requirements through the use of integrated onsite power systems.[a] Building America is a private/public partnership that conducts research on energy solutions for new and existing homes on a cost shared basis with major stakeholders in the homebuilding industry. The Building America Program combines the knowledge and resources of industry leaders with the U.S. Department of Energy's technical capabilities. Together, they act as a catalyst for energy efficient change in the home-building industry. Industry partners provide all costs for equipment, construction materials and construction labor used in research projects.

Building America is also integrating energy efficiency and onsite/renewable power solutions, demonstrated on a production basis by building community subdivisions which will reduce whole-house energy use in new homes by an average of 50 percent by 2015 and 70 percent by 2020 compared to the Building America Benchmark[b] at net zero financial cost to the home owner.[c]

To ensure meeting the performance goals, Building America has specified the following interim performance targets for completion of technology package research reports for each climate region,

[a] Whole house energy savings for all residential end uses are measured relative to the BA Research Benchmark Definition (Building America, Building America Research Benchmark Definition, Version 3.1, November 11, 2003, National Renewable Energy Laboratory). (www.buildingamerica.gov)

[b] Whole house energy savings are measured relative to the BA Research Benchmark Definition (Building America, Building America Research Benchmark Definition, December 29, 2004, National Renewable Energy Laboratory) which consists of the 2000 IECC requirements plus lighting, appliances and plug load energy levels (www.buildingamerica.gov).

[c] Net cash flow is the monthly mortgage payment for energy options minus the monthly utility bill cost savings. “Zero or less net cash flow” means that monthly utility bill cost savings are greater than the monthly mortgage payment for energy options. In other words, the increase in mortgage payment is offset by the energy savings.

shown below. The annual performance goals will be evaluated and adjusted due to market conditions and the degree of technical complexity involved in developing solutions for each climate.

The Energy Policy Act of 2005 (EPACT) and the consumer tax incentives it provides for residential energy efficiency could accelerate the current target dates. Increased demand from consumers for energy efficient products may improve participation by manufacturers and builders, thus improving the cost-effectiveness of advanced energy efficient technology.

Residential Integration Performance Targets by Climate Zone

Target (Energy Savings)	Marine	Hot Humid	Hot/Mixed Dry	Mixed Humid	Cold
30%	2006	2007	2005	2006	2005
40%	2009	2010	2007	2008	2009
50%	2011	2015	2012	2013	2014
70%[a]	2020	2020	2020	2020	2020

The Residential Buildings Integration subprogram is an integral part of the Building Technologies Program which evaluates research in the context of the market.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Research and Development: Building America	**16,775**	**23,659**	**26,006**

The residential systems research, driven by the performance targets by climate zone and the financial constraint of zero or less net cash flow, is conducted in five stages for each climate zone.[b] During the five stages, Building America acts as a national residential energy systems test bed where homes with different system options are designed, built and tested at three levels of system integration, including research houses, production prototype houses, and community scale housing. A summary of the five stages follows.

[a] The current Building America target year for completion is 2020. Climate zone target dates for the 70 percent level are dependent upon progress at lower target (energy savings) levels and will be determined in a future planning cycle; some climate zones may be completed before 2020.

[b] Building America deals with five climate zones in the U.S. – Marine, Hot Humid, Hot/Mixed Dry, Mixed Humid, and Cold. These climate zones require unique approaches to reach the 30-40-50 percent energy target savings.

Stage 1 Technology Pathways Leading to Zero Energy Homes

Parametric studies are conducted using BEopt[a] and other energy analysis tools to evaluate technology pathways, gaps, and advanced components needed to achieve multi-year performance goals. BEopt finds optimal and near-optimal building designs along the path based on discrete building options reflecting realistic construction options.

Stage 2 Systems Evaluations

The Building America Consortia design, construct and test subsystems for whole house designs in research houses to evaluate how components perform. The focus of Stage 2 is to evaluate and field test prototype subsystems to determine the most reliable and cost effective solution for a given performance level and climate.

Stage 3 Prototype House Evaluations

The successful Phase 1 subsystems are designed and constructed by production builders working with the Building America Consortia to evaluate the ability to implement the systems on a production basis. The focus of Stage 3 research is to move the research prototype house and building practices to the point that they are production-ready, capable of being integrated with production construction techniques practiced by today's builders.

Stage 4 Initial Community Evaluations

The Building America Consortia provide technical support to builder partners to advance from the production prototypes to evaluation of initial production houses in a subdivision. The results are documented in a case study report. Several of these reports are distilled into a final research report that describes the system design and construction practices needed to achieve a particular level of energy savings within each climate zone targeted by the program.

Stage 5 Final Evaluations in Occupied Homes

After sufficient homes have been completed to provide accurate measurements of average energy savings in occupied homes, an evaluation is made to determine final energy savings and occupant satisfaction with Building America homes.

From the technology package research reports developed from Stage 4, "Best Practices" manuals are designed for builders, manufacturers, homeowners, real estate agents, educators, insurance companies, and mortgage providers. The Best Practices manuals present the research results in illustrated text that is targeted to a specific audience to make it easily assimilated, and then synthesize research findings into energy-efficient processes for the building industry.

The five research stages currently take approximately four years. For more advanced energy

[a] BEopt is an analytical energy simulation software package, which uses sequential search technique to identify optimal building designs along the path to Zero Net Energy (ZNE).

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

efficiency levels at and above 50 percent whole house savings, the system research process is expected to take additional iterations of whole house testing before implementation in production ready homes.

In FY 2009, BT will continue research at the 40 percent efficiency level for the hot humid climate and will complete the research in the marine and cold climates. Research at the 40 percent efficiency level for the mixed humid zone is expected to be completed in 2008. The specific climate zone targets may be adjusted due to market conditions and the degree of technical complexity involved in developing solutions for each climate.

During 2009, BT will also be testing strategies to achieve a 50 percent reduction in the energy used in a home. The focus of the 50 percent systems research will continue work to reduce the energy used to heat and distribute hot water, field test lower cost efficient windows and methods of space heating and cooling in a very efficient home. Electric energy used by the miscellaneous appliances in the home continues to be the focus area.

Additionally, BT will invest in collaborative research with the Solar Energy Program Office to reduce barriers to the installation and operation of solar systems on homes and buildings. The focus of the BT funded efforts will be on the building/solar system interface and maximizing the amount of energy from the solar system that is actually delivered to meet electricity needs in the home. For example, there are inherent losses in the inverters that convert the DC power from the solar system to AC power needed by the home systems. Efficient fluorescent lighting and many of the appliances in the home use DC power which is produced by power supplies at the device. These power supplies use energy even when the devise is not in use (standby losses). Research will be conducted to determine the feasibility of directly connecting the home lighting and appliances to the solar system to eliminate the losses in the inverter and power supplies.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Residential Building Energy Codes	**495**	**0**	**0**

These activities will be carried out within Technology Validation and Market Introduction/Building Energy Codes to more effectively coordinate with the market transformation activities.

SBIR/STTR	**0**	**816**	**894**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Residential Buildings Integration	**17,270**	**24,475**	**26,900**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Research and Development: Building America	
The increase allows BT to continue research at the 40 percent efficiency level for the hot humid climate and to complete the research in the marine and cold climates and to begin testing strategies to achieve a 50 percent reduction. The increased funding will be used for additional iterations of whole house testing before implementation in production ready homes at the 40 percent efficiency level for hot humid, marine and cold climates	+2,347
Residential Building Energy Codes	
These activities will be carried out within Technology Validation and Market Introduction/Building Energy Codes to more effectively coordinate with the market transformation activities.	0
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+78
Total Funding Change, Residential Buildings Integration	**2,425**

Commercial Buildings Integration

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Commercial Buildings Integration			
Research and Development	7,204	11,891	13,000
Commercial Building Energy Codes	1,495	0	0
Total, Commercial Buildings Integration	8,699	11,891	13,000

Description

In order to reach net zero energy buildings (ZEB) by 2025, DOE will develop integrated whole-building strategies to enable commercial buildings to be designed, constructed, and operated to use 60 to 70 percent less energy relative to ASHRAE Standard 90.1-2004. By 2010, the BT goal is to develop five or more cost-effective design technology packages using highly efficient component technologies, integrated controls, improved construction practices, streamlined commissioning, maintenance and operating procedures that will make new and existing commercial buildings durable, healthy and safe for occupants. These design technology packages aim to reduce energy use for new small commercial buildings by 30 percent, relative to conventional practice.

The long-term goal of the Commercial Buildings Integration subprogram is to develop cost-effective technologies, integrated design strategies and operating procedures for commercial buildings such that they produce as much energy as they use on an annual basis. Research will focus on integrating energy efficient technologies to reduce the total energy use in commercial buildings by 60 to 70 percent by 2025. These improvements in energy efficiency coupled with renewable energy supply could result in marketable net zero energy commercial buildings.

The subprogram's initial focus is on whole-building design packages for specific building types to achieve modest (30 percent) efficiency improvements beyond current energy codes. However, a different approach is needed to achieve higher levels of performance, particularly in medium to larger-size buildings. The commercial buildings sector is characterized by: tremendous diversity of building types, sizes and uses; significant variability in design, construction and operational approaches; a one-building-at-a-time, customized design process; and a variety of institutional arrangements that influences design decisions. Thus the program's information products must be highly flexible so designers can adapt the embedded knowledge in various ways to meet the requirements and constraints of each individual design job. The prescriptive and monolithic nature of whole-building design packages is not flexible enough to meet designers' needs at performance levels well beyond 30 percent, particularly for mid- to large-size buildings. In addition, despite the wide variety of building types and uses, some technologies could be deployed in several building types with a common strategy.

Therefore, the BT strategy beyond the 30 percent improvement level is to develop "technology option sets". A technology option set is an integrated group of envelope, equipment and control system technologies that interact in a primary way and which can be combined in various ways to reach the 50 percent to 70 percent energy savings level. Validation of these option sets in real buildings will begin in FY 2011, through partnerships with national account firms that own or operate large numbers of buildings and associated design firms. Validation could involve the building life cycle from design through construction and far enough into operation to determine that a particular technology option set will achieve design energy performance and maintain or improve building function.

The challenges inherent in designing and operating high performance and net zero energy buildings demand a number of breakthroughs, both in technology and in the fundamental knowledge of how to integrate and operate technology so as to optimize whole building performance. Systems integration and improved component technology (HVAC, lighting, windows, etc.) are required in order to achieve progressively higher levels of energy performance. Also required is a much richer understanding of the market itself, given the heterogeneity of the commercial buildings sub sector, which varies widely across the dimensions of size, surface-to-volume ratio, vintage of construction, complexity of function, and energy use. This understanding is necessary to target the R&D to realize the largest opportunities to save energy in commercial buildings.

The commercial buildings integration activities are focused on small to medium-sized repeatable building designs such as strip malls, retail stores, office buildings, and schools. BT is focused on these buildings because these building types consume the largest share of commercial sector energy use. There are greater opportunities for energy savings (developers of smaller commercial buildings do not usually have engineering budgets sufficient to perform comprehensive energy analysis) and these buildings are replicated more times. To increase leverage, BT will form partnerships with commercial companies that build numerous similar buildings and are favorably disposed to investments that yield 50 percent or more energy savings.

DOE's principal technical approach will be development of whole-building technologies, integrated design strategies and operating procedures which can be used by architects, engineers and others to design, build and operate commercial buildings in an integrated manner. The prescriptive design technology packages for modest efficiency gains will be enhanced with the development of "technology option sets" for achieving efficiency gains of 50 percent or higher. The BT method validates the process with architects and engineers on actual buildings, encompassing numerous requirements for cost-effective technology, marketability, maintenance of real estate value, building durability and grid connection reliability. Such an approach is clearly targeted at new construction, because the opportunities for aggressive performance improvement are so much greater than in existing buildings, where many building parameters (orientation, envelope, etc.) are set in steel and concrete. However, this does not exclude the renovation and existing building market, as many of the strategies can be adapted and deployed in this sector. Research results will be transferred through close cooperation with the Rebuild America activity that transferred to BT in FY 2007. The design technology packages will be developed in collaboration with industry and technical societies to ensure rapid dissemination across the design community.

The new building tax incentives for commercial energy efficiency in EPACT 2005 could accelerate the current target dates. Increased acceptance among commercial building owners of energy efficient products may improve participation by manufacturers and builders, thus improving the cost-effectiveness of advanced energy efficient technology.

Commercial Building Design Technology Packages Performance Targets

Characteristics	Units	2004	2005	2006	2007	2008	2009	2010	2011	2012
Small and Medium Sized Commercial Building Design Technology Packages	30% Energy Savings	0	1	1	2	4	4	2		
Technology Option Sets	50% Energy Savings	0						0	1	1

The Commercial Buildings Integration subprogram is an integral part of the Building Technologies Program which evaluates research in the context of the buildings market.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Research and Development	**7,204**	**11,891**	**12,843**

In 2009, the Building Technologies continue research and development on new design guides that will help drive cost-effective 30-50 percent increases in commercial building energy efficiency over ASHRAE 90.1-2004. Based on a series of design guides completed through 2008 and increased testing and validation of technologies and integration strategies carried out in FY 2008, in FY 2009 BT will begin public-private partnership work with the retail, office and school building segments of the commercial building market. The program will encourage these consortia to develop highly efficient prototypical designs and challenge consortia members to build and demonstrate their version of these designs that are at least 50 percent more efficient than current designs. The program will continue to focus on commercial building efficiency R&D and will assist the partnerships with research and technical assistance. When necessary the program will complete energy design analysis and develop specifications for technologies. These public-private partnerships have the potential to move several commercial building sectors rapidly forward towards our net zero energy goal.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Commercial Building Energy Codes	**1,495**	**0**	**0**

These activities will be carried out within Technology Validation and Market Introduction/Building Energy Codes to more effectively coordinate with the market transformation activities.

Total, Commercial Buildings Integration	**8,699**	**11,891**	**13,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Research and Development	
Increases in FY 2009 funding will support research aimed at 50% improved efficiency in institutional buildings.	+1,109
Commercial Building Energy Codes	
These activities will be carried out within Technology Validation and Market Introduction/Building Energy Codes to more effectively coordinate with the market transformation activities.	0
Total Funding Change, Commercial Buildings Integration	**+1,109**

Emerging Technologies

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Emerging Technologies			
Lighting R&D	29,192	23,937	19,113
Space Conditioning and Refrigeration R&D	2,845	2,819	3,845
Building Envelope R&D	7,119	7,054	8652
Analysis Tools and Design Strategies	2,684	2,660	3149
Solar Heating and Cooling	0	0	3,711
SBIR/STTR	0	943	995
Total, Emerging Technologies	41,840	37,413	39,465

Description

The long-term goal of the Emerging Technologies subprogram is to develop cost effective advanced technologies, (e.g., lighting, windows, and space heating and cooling) for residential and commercial buildings. Research will focus on developing technologies to support the residential and commercial building goal to reduce the total energy use in buildings up to 70 percent. BT is actively analyzing technology advancement in areas that will be required to reach the zero energy buildings goals and using this analysis to inform which technology pathways to fund. The improvement in component and system energy efficiency when coupled with research to integrate onsite renewable energy supply systems into the commercial and residential buildings will establish the technologies from which to package marketable net zero energy designs.

Specifically, the Emerging Technologies subprogram will focus on:

- Solid State Lighting (SSL), which has long term efficiencies that have the technical potential to approach 200 lm/W, compared to most conventional technologies maximum efficiencies in the 85 to 115 lm/W range.

- Heating and cooling systems with the technical potential to reduce annual HVAC, dehumidification and water heating energy consumption by 50 percent aligned with advanced technology performance requirements of the Residential Integration activities.

- Advanced windows that incorporate advanced insulation materials and dynamic solar control have the potential to become net energy producers in many climates by harvesting passive heating, while dramatically reducing peak cooling loads.

The Emerging Technologies subprogram improves energy security by supporting the technology development needs of the Residential Integration and Commercial Integration subprograms and the need for energy efficient replacement technologies in the existing building stock. The advancement of these technologies supports the appliance standards rulemakings by creating more efficient, cost-effective technology advancements that have the potential to be incorporated into future rulemakings.

Emerging Technologies continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Lighting Research and Development

The Lighting Research and Development goal is to achieve lighting technologies with double the efficacy of today's most efficient lighting sources, linear and compact fluorescents.[a] Our primary targets are solid state lighting devices and technologies that can produce white light with efficacies[b] in excess of 160 lumens per Watt in commercial products, with an interim target of 125 lumens per Watt projected for laboratory devices by 2012.

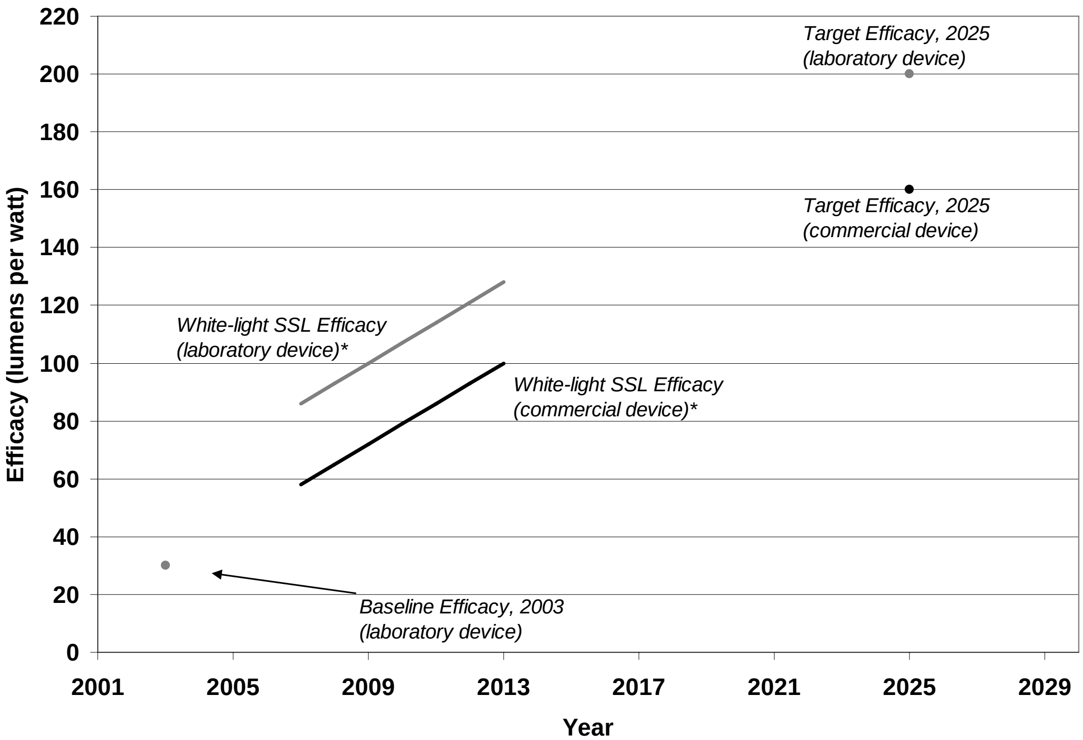
The solid state lighting activity is evaluating both inorganic light emitting diodes (LEDs) and organic light emitting diodes (OLEDs). LEDs have a focused point of light and monochromatic LEDs are used in many of the newly installed traffic signals, exit signs, and brake lights on cars. OLEDs have a distributed light and are used in display technologies on cell phones and digital cameras, but ultimately could be used in innovative and unique lighting designs such as painted on and full wall surface lighting. To prepare these SSL technologies for the highly competitive general illumination market, research, development, demonstration, and commercial application activities will be conducted. The anticipated rate of performance improvement for LEDs is shown in the following diagram.

[a] Linear fluorescent lamps offer efficacies as high as 80 lumens per Watt. Compact fluorescent lamps, a derivative of this technology, are less efficient (approximately 60 lumens per Watt); however they still offer a four-fold improvement over traditional incandescent bulbs.

[b] For solid-state lighting technologies, the performance target is focused on the energy efficiency rating,"efficacy," of the device measured in lumens of light produced per Watt of energy consumed. Several lighting products, including fluorescent lamps and incandescent reflector lamps, are regulated using an efficacy target. The efficacy projections for solid-state lighting are generated for laboratory devices because the Lighting R&D portfolio does not have direct influence over commercially offered products.

Efficacy Projection for White-Light SSL Laboratory Devices (Projections 2005 to 2012)

White-Light LED Efficacy Targets



This projection is translated into point values in the following table, with the five-year target milestones.

Point Values of Efficacy Projections for White-Light SSL Laboratory Devices

Characteristics	Units	2003 (baseline)	2005	2006	2007	2008	2009	2010	2011	2012	2013
Solid State Lighting Performance	lumens / Watt	30	65	65	86	101	107	113	119	125	131

The SSL activity provides a focus on increased efficacy while the state of SSL development in industrial labs and the marketplace is formative and can be influenced. Manufacturers would likely not focus on efficacy but on the unique attributes of solid state lighting (e.g., durability, reliability, etc.) This emphasis on efficacy contributes to the Department's strategic goal to cost-effectively improve the energy efficiency of the U.S. economy.

DOE conducts its SSL R&D through strong industry partnerships that are already producing results such as improvements of 50 percent in efficiency in blue organic light emitting diodes. Industry enthusiasm and cost share on projects is high (>35 percent).

Space Conditioning and Refrigeration Research and Development

Space conditioning systems, which have transformed the 20th century by enabling us to become more productive and comfortable, will play a critical role in achieving BT's goal of zero energy buildings.

Space conditioning equipment for residential and commercial buildings consumes approximately 38 percent of the total energy used in buildings and is the most important contributor to summer peak electricity demand.[a]

In the past, R&D and efficiency standards have focused on increasing the efficiency of the various individual units. Raising the minimum efficiency standard for residential unitary equipment from 10 to 13 Seasonal Energy Efficiency Rating (SEER) is one key example. New approaches, beyond focusing on individual units, can help to further advance heating, ventilation and air-conditioning (HVAC) system efficiency.

In order to assist Building America in its purchased energy reduction goal of 60 – 70 percent, the HVAC, dehumidification and water heating contribution to that reduction is a 25 percent reduction in the energy consumption of that equipment from baseline levels at no additional cost. The measurement protocol will be simulated and compared to chamber test measurements of electric power consumption and demand.

Although the energy efficiency of HVAC equipment has increased substantially in recent years, new approaches, including radically new ideas, are needed to continue this trend. The dramatic reductions in HVAC energy consumption necessary to support the ZEB goals require a systems-oriented approach that characterizes each element of energy consumption, identifies alternatives, and determines the most cost-effective combination of options. Therefore, the first task in this effort will involve system characterizations, identification of necessary upgrades to analysis tools, and an assessment of cost and performance of alternative solutions.

Space Conditioning System Performance Goals

Characteristics	2004 Status	2007 Target	2010 Target
Annual HVAC, Water Heating and Dehumidification Energy Consumption Reduction vs. Building America benchmark (demonstrated product)	Baseline	25%	50%

Building Envelope Research and Development

Thermal Insulation and Building Materials

The Building Envelope element will contribute to Zero Energy Buildings by advancing a portfolio of new insulation and membrane materials, including improved exterior insulation finishes, with both residential and commercial wall application. The next generation of attic/roof systems integrating thermal mass, ventilation and advanced insulated roof structures will be applied to the residential new construction market.

The table below lists the performance goals for the Thermal Insulation activities. All performance measurements are relative to historical baselines that have been set as the Building America regional baseline new construction. Achieving cost-effectiveness and durability are critical aspects of these targets.

[a] US DOE Energy Efficiency and Renewable Energy, *2004 Buildings Energy Databook*, August 2004.

Thermal Insulation and Materials Performance Goals

Characteristics	2004 Status	2007 Target	2010 Target
	(units: R-Value*)	(units: R-Value*)	(units: R-Value*)
Advanced attic/roof system	30	35	Dynamic annual performance equal to conventional R-45
Wall insulation	10	Dynamic annual performance equal to conventional R-20[a]	Dynamic annual performance equal to conventional R-20[b]

***** R-value measures the resistance to heat flow for a material. The higher the R-value, the better your walls and roof will resist the transfer of heat

Windows Technologies

Window performance will also be vital to reaching the residential and commercial buildings goals. Development of cost effective, highly efficient glazing and fenestration systems for all building types and all parts of the country will require a portfolio of technologies matched to those types and climatic conditions. The table below lists the performance measurement targets for the Windows element. All performance measurements are relative to historical baselines that have been set as the baseline new construction in 2003. The next generation of highly insulated and dynamic windows can become net energy producers in climates with heating loads and can dramatically reduce cooling loads and peak electricity demand.

Windows Performance Goals

Percent Reduction in Energy Use*

Characteristics	2003 Status	2007 Target	2010 Target	2015 Target	2020 Target
Energy Consumption Improvement	Base ***ENERGY STAR***® (Low E)	20-30%	30-40%	40-50%	40-60%

* These percentage reductions will only be considered complete after meeting technical performance requirements such as incremental price/sq. ft., size (sq. ft.), visual transmittance, solar heat gain coefficient, durability (American Society for Testing and Materials Tests), U-value, and incremental cost $/sq. ft.

Analysis Tools and Design Strategies

BT has established aggressive goals to create a new generation of residential and commercial building technologies by 2025 that will enable zero energy buildings. Similar technologies and design approaches will also be applied to improve the performance of existing buildings. These ZEB goals cannot be met alone through research to significantly improve the performance of components (e.g.,

[a] Interim target NOT subject to cost constraints and may not be in commercial production.
[b] Subject to no additional operating cost, within the traditional 3.5-in. wall dimension, with acceptable durability characteristics.

windows, appliances, heating and cooling equipment, lighting). It also requires a revolutionary approach to building design and operation that can achieve up to 70 percent reductions in load coupled with careful integration with onsite renewable energy supplies as well as thermal and electrical storage.[a] This in turn requires new design strategies and powerful simulation tools that support evaluation of new ZEB demand-reduction and energy-supply technologies.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Lighting R&D	**29,192**	**23,937**	**19,113**

The R&D agenda of the solid state lighting activities are established through an annual consultative process with general lighting industry, compound semi-conductor industry, universities, research institutions, National Laboratories, trade organizations, other industry consortia, and the Next Generation Lighting Industry Alliance (DOE's competitively selected Solid State Lighting Partnership). The high priority tasks are competitively bid and awarded to entities whose proposals meet these priorities and the SSL portfolio's stated objectives. The solid state lighting activity classifies its projects into four R&D classes: LED Core Technology, LED Product Development, OLED Core Technology and OLED Product Development. Tasks in Core Technology are truly innovative and groundbreaking, fill technology gaps, provide enabling knowledge or data, and represent a significant advancement in the SSL knowledge base.

These Core Technology tasks are focused on gaining pre-competitive knowledge for future application to products, for use by other organizations. Product Development tasks are the systematic use of knowledge gained from basic and applied research to develop or improve commercially viable materials, devices, or systems. Technical activities are focused on a targeted market application with fully defined price, efficacy, and other performance parameters necessary for success of the proposed product. Product development encompasses the technical activities of product concept modeling through to the development of test models and field ready prototypes. Within each R&D class, there are active, detailed R&D agendas which contribute to the larger programmatic objective.

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[a] Building energy performance, particularly in ZEB, is the result of interactions among many elements including climate (outdoor temperature, humidity, solar radiation and illumination), envelope heat and moisture transfer, internal heat gains, lighting power, HVAC equipment, controls, thermal and visual comfort, and energy cost—and these complex interactions cannot be understood and quantified without simulation tools. For example the effect of daylighting dimming controls on the electric lights with daylighting has several effects: lighting electricity use goes down as does the heat gain from lights. Lower heat from lights reduces cooling use (amount depends on cooling equipment efficiency) but in the winter it can significantly increase the heating energy. Thus the annual impact of daylighting on energy use requires detailed calculations that consider these interactions. In a series of field evaluation case study reports, NREL found that simulation tools were one of the essential elements for tuning the building design as well as the operating building performance [Paul A. Torcellini, Ron Judkoff, and Drury B. Crawley, "Lessons Learned: High-Performance Buildings," ASHRAE Journal, September. 2004].

(dollars in thousands)

FY 2007	FY 2008	FY 2009

The SSL portfolio is presently funding nine Core priority R&D topics and eleven Product Development priority R&D topics[a]. Each year, the R&D topics are reviewed for progress on currently funded projects, completion of topical areas, new topics to start, and advice from the Alliance and the research community. The R&D topics are reprioritized for each solicitation.

Solid State Lighting Research Topics

Topic	LEDs		OLEDs	
	Current R&D	Future R&D	Current R&D	Future R&D
Core:	• Phosphors • Semiconductor materials • Defect Physics • Light extraction	• Substrates, buffers and wafers • Alternative Structures • Encapsulating and packaging • Fabrication of component prototypes	• Novel Materials • New architectures • Light extraction • Improved charge injection • Transparent electrodes	• Encapsulating materials • Material/structures evaluation • Substrate materials • Down conversion materials • Modeling of material principles • Electrodes and interconnects • Fabrication and patterning techniques
Product Development:	• Luminaire life and performance • Optical coupling and modeling • Packaging • Manufactured materials • Thermal design • Materials in devices • Light extraction from devices	• Electronic Development • Fabrication and Manufacturing challenges • Device architectures • Mechanical design	• Application of materials in fabrication • Applied light extraction • Manufacturing process optimization • Device encapsulation and packaging	• Surface modification techniques • Demonstration architectures • Simulation tools for devices • Power spreading and driver electronics • Luminaire design • Synthesis manufacturing scale-up • Tools for manufacturing

In FY 2009, the program will continue the solid-state lighting (SSL) research projects that have demonstrated progress. These projects resulted from the competitive solicitations in 2006 and 2007 to develop and deploy SSL products for general illumination. These project topical areas are identified in the table under current R&D and include LED core topics (semiconductor materials, phosphors, defect physics, and light extraction), LED product development topics (optical coupling & modeling, manufactured materials, packaging, thermal design, luminaire life, materials in devices, and light extraction from devices), OLED core topics (novel materials, new architectures, light extraction, improved charge injection, and transparent electrodes), and OLED product development (application

[a] For further information on the SSL R&D Agenda, as discussed at the SSL Workshop by the research community and documented in the Multi-Year Program Plan FY 2008 – FY 2013, see the SSL website for these two documents (http://www.eere.energy.gov/buildings/about/mypp.html and www.netl.doe.gov/ssl)

(dollars in thousands)

of materials in fabrication, applied light extraction, manufacture process optimization and device encapsulation & packaging).

New awards will focus more on the "future R&D" core and product development topic areas for LEDs and OLEDs. The new projects will continue advancements in device efficacy, durability, manufacturing, and cost needed to reach a commercially viable white light with efficacies meeting the 160 lumens per Watt goal. Activities will be continued to analyze and address barriers to enable market introduction and commercialization of technologies resulting from these research projects.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
Space Conditioning and Refrigeration R&D	**2,845**	**2,389**	**3,845**

Two projects, selected in FY 2005, will continue into FY 2009 through various developmental stages, after appropriate evaluation, to demonstrate through laboratory or field testing whether they have the long term potential to reduce annual HVAC, dehumidification and water heating energy consumption by 50 percent in new residential buildings, relative to Building America Benchmarks. These projects include the development of an air-to-air integrated heat pump (IHP) system that can meet the air heating, cooling, dehumidifying, ventilating, and water heating requirements of a tight-envelope mechanically ventilated near-zero-energy house and the development of a ground-source integrated heat pump (GSIHP). The design concepts must also address other critical Building America needs such as humidity control, uniform comfort, and indoor air quality. The R&D projects will emphasize modest cost premiums, since very high efficiency equipment already exists but has low market penetration due to high first cost. The potential for multi-function appliances to contribute to achieving the energy consumption reduction goals will also be evaluated. In FY 2009 the program will work closely with the building industry and manufacturers to begin research on those strategies identified in FY 2008 through Building America and the Commercial Building national energy alliances.

Also in 2009, new strategies for achieving ZEH/ZEB will be assessed, looking at the contribution to ZEH/ZEB as well as overall market potential. These strategies will include novel ways of integrating highly efficient space conditioning and water heating, while also insuring comfort through proper ventilation and humidity control. Strategies which are essential to achieving ZEH but which also have widespread application potential to existing buildings will be a particular focus of the research.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses

Building Envelope R&D

	FY 2007	FY 2008	FY 2009
▪ **Thermal Insulation and Building Materials**	**2,411**	**2,389**	**3,444**

Reducing energy losses through the building enclosure will contribute significantly to DOE's attainment of a practical ZEB. In pursuit of the next generation of attic/roof system that will save 50 percent energy over the Building America baseline, DOE will continue the integration and optimization of key technologies including cool roofs, thermal mass, radiant barriers, and above deck ventilation. In FY 2007, peak heat flux through the roof was reduced by 90 percent in a test facility. The main effort in FY 2009 will be to apply the optimized technologies for energy and cost performance to whole house applications. Detailed monitoring in at least one climate zone will be conducted.

(dollars in thousands)

DOE is developing advanced envelope materials in response to needs identified in the Residential and Commercial Integration activities. In FY 2009, dynamic membranes will be developed and evaluated in cooperation with private industry as a result of research completed in FY 2007 and FY 2008. The membranes will allow for greater performance of insulations while eliminating moisture issues. Whole house full scale applications for insulations with phase change material that offer thermal mass effects to dramatically reduce peak loading will be applied and evaluated in at least one climate. These new insulations could enter the market in FY 2009 and/or FY 2010.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

▪ **Windows Technologies**	**4,708**	**4,665**	**5,208**
Total, Building Envelope R&D	**7,119**	**7,054**	**8,652**

In FY 2009, DOE will continue competitive fundamental science research to develop the second generation of materials, chemical engineering applications, and advanced manufacturing processes that can offer “leap frog” reductions in cost for dynamic windows while maintaining a high level of reliability and durability with a broad range of optical properties.

In FY 2007, second generation dynamic prototypes with significant potential to reduce cost were developed. The key FY 2009 goal will be to conduct research on the prototype(s) that have passed prior stage gate criteria to further improve durability and scale up to larger sizes. The second generation of dynamic windows is targeted to enter the market in the 2010 to 2015 timeframe with substantially lower consumer prices. Work will continue on the development of affordable highly insulating windows that approach U values of 0.20 (R5). Also, in FY 2009 DOE will complete work on one vacuum glazing project with the potential to achieve U values of 0.10 (R10).

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Analysis Tools and Design Strategies	**2,684**	**2,660**	**3,149**

BT will continue to develop, improve, verify, and maintain software packages for researchers, engineers, architects, and builders who design or retrofit buildings to be energy efficient and comfortable. BT will also conduct research on and incorporate additions to EnergyPlus whole-

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

building energy simulation software to allow building designers, operators, owners, and researchers to evaluate technologies for substantially improving the energy efficiency of buildings and reducing energy costs while maintaining comfort. BT will continue to focus on technologies, systems, and controls which are needed in low- and zero-energy buildings, incorporating new modules in EnergyPlus versions which specifically support BT residential and commercial building research, design, analysis and retrofit of low- and zero-energy buildings. EnergyPlus module development research will focus on the top 20-30 features, completing new capabilities for recent state-of-the-art fenestration and envelope, day lighting, building controls and management systems, innovative low-energy HVAC equipment and systems, and renewable energy technologies such as solar, wind and hydrogen systems and assistance with building code development.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
Solar Heating and Cooling	**0**	**0**[a]	**3,711**

Starting in FY 2009 the Solar Heating and Cooling System activities from the Solar Program will be transferred to BT. Since these activities focus primarily on the challenges of integrating solar technologies into building systems and products, it is more appropriate for the Buildings Program to assume lead responsibility for these efforts. These changes are intended to assure that the "downstream" requirements of the building industry drive the activities pertaining to improvement of residential and commercial buildings. This will also help EERE and DOE present a "single face" to the building community, and includes integrating the Builders Challenge. The BT program will utilize the expertise in the Solar Program as needed to ensure the integrated effort is robust.

Activities for Solar Heating and Cooling will include research and development of a conceptual design for an integrated solar electric/thermal system sized for an average single-family home and the development of the prototype systems; providing technical support to states and cities interested in establishing a policy that encourages the use of solar water heaters as a method of saving energy and reducing greenhouse gas emissions; and support of a solar rating and certification system.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**943**	**995**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Emerging Technologies	**41,840**	**37,413**	**39,465**

[a] The Office of Solar Energy Technologies has $1.954 million appropriated for Solar Heating and Cooling in FY 2008.

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Lighting R&D	
Solid State Lighting has made impressive gains in productivity in recent years. The decrease in funding in FY 2009 will be accommodated by focusing only on the most promising “future R&D” core and product development topics areas which will be selected based on the funding level. No additional research topics will be added. The new projects will continue advancements in device efficacy, durability, manufacturing, and cost needed to reach a commercially viable white light with efficacies meeting the 160 lumens per Watt goal. Activities will be continued to analyze and address barriers to enable market introduction and commercialization of technologies resulting from these research projects.	-4,824
Space Conditioning and Refrigeration R&D	
Increased funds in FY 2009 will support research that was developed from strategic planning conducted in FY 2008 in areas such as commercial refrigeration. Two projects, an air-to-air integrated heat pump (IHP) system and a ground-source integrated heat pump (GSIHP), selected in FY 2005, will continue into FY 2009 through various developmental stages, after appropriate evaluation, to demonstrate through laboratory or field testing whether they have the long term potential to reduce annual HVAC, dehumidification and water heating energy consumption by 50 percent in new residential buildings, relative to Building America Benchmarks.	+1,026

	FY 2009 vs. FY 2008 ($000)
Building Envelope R&D	
▪ **Thermal Insulation and Building Materials**	
Increased funds in FY 2009 will help support new research in dynamic membranes, field demonstrations on next generation attic and roofing systems and scoping studies that will be conducted to identify research priorities to reduce the thermal losses through foundations. DOE is developing advanced envelope materials in response to needs identified in the Residential and Commercial Integration activities. In FY 2009, dynamic membranes will be developed and evaluated in cooperation with private industry as a result of intellectual research established at ORNL in FY 2007 and FY 2008.	+1,055
▪ **Windows Technologies**	
In FY 2009, DOE will conduct additional research to aggressively pursue an R10 (U value of 0.10) window. Technology options include vacuum glazings, new multiple glazing concepts, and integration of frame improvements, spacers and window/wall interface.	+543
Total, Building Envelope R&D	+1,598
Analysis Tools & Design Strategies	
Increased funding in FY 2009 will support advancing the computer modeling capabilities of EnergyPlus software which assists standards development and the incorporation of advanced technologies. In FY 2009, BT will continue to develop, improve, verify, and maintain software packages for researchers, engineers, architects, and builders who design or retrofit buildings to be energy efficient and comfortable. BT will conduct research on and incorporate additions to EnergyPlus whole-building energy simulation software to allow building designers, operators, owners, and researchers to evaluate technologies for substantially improving the energy efficiency of buildings and reducing energy costs while maintaining comfort.	+489
Solar Heating and Cooling System	
Starting in FY 2009 the Solar Heating and Cooling System activities will be transferred from the Solar Program.	+3,711
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+52
Total Funding Change, Emerging Technologies	**+2,052**

Technology Validation and Market Introduction

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Technology Validation and Market Introduction			
Rebuild America	7,473	2,808	5,000
ENERGY STAR®	8,776	6,714	8,000
Building Energy Codes	2,000	3,717	8,000
Solar Decathlon	0	0	3,400
Total, Technology Validation and Market Introduction	18,249	13,239	24,400

Description

The Technology Validation and Market Introduction element funds activities that accelerate the adoption of clean, efficient, and domestic energy technologies. The three major activities, transferred to BT in 2007 from Weatherization and Intergovernmental Activities, are: ENERGY STAR®, Rebuild America and Building Codes Training and Assistance. ENERGY STAR® is a joint Department of Energy/ Environmental Protection Agency activity designed to identify and promote energy efficient products. Through it's partnership with more than 7,000 private and public sector organizations, ENERGY STAR® delivers the technical information and tools that organizations and consumer need to choose energy efficient solutions and best management practices and Home Performance with ENERGY STAR®. The Rebuild America Program element has been aligned with the Building Technologies Program's research and development activities to accelerate the adoption of advances in building integrated design, software tools, practices and advanced controls, equipment and lighting. In 2009, BT will help promote energy efficiency within the large number of existing homes by designing activities with local governments to help them expand the availability of their low cost financing for energy retrofits (e.g. using Energy Service Companies' (ESCO) experience) and with retailer partnerships to promote energy efficient home remodeling and retrofits through innovative financing. BT will also expand its building codes effort by developing guidance for energy audits at the time of home resale, including appropriate training materials for real estate agents and lenders. The existing residential and commercial building code activities described below have been transferred and combined with the Building Energy Codes activities. These activities support upgraded state model energy codes and their adoption, implementation and enforcement.

Building Energy Codes (Residential and Commercial)

The activities of the Building Codes and Standards element are established by legislation and the 3-year cycle for upgrading the model building energy codes and standards. Title III of the Energy Conservation and Production Act, as amended (ECPA) (42 USC 6831 et seq.), requires the Department of Energy to:

1. Support the upgrading of model building energy ASHRAE Standard 90.1, for commercial buildings, and the International Code Council's (ICC) International Energy Conservation Code (IECC), for residential buildings). Review and assist in improving the technical basis, determining cost effectiveness, and technical feasibility of code measures and, based on ongoing research activities, recommend and seek adoption of feasible, cost effective measures.

2. Review and upgrade the Federal building energy codes (10 CFR 434 and 435) based on the upgrades to ASHRAE 90.1 and the IECC that are cost-effective. DOE maintains Federal building energy codes as distinct from the voluntary sector building energy codes to reflect the unique financial perspective of the Federal sector and to address the role of the Federal sector in leading the private sector towards greater energy efficiency.

3. Publish a determination in the Federal Register as to whether each new edition of the model codes will improve the energy efficiency of buildings.

4. Provide incentive funding and technical assistance to States to update, implement and enforce their code to meet or exceed the upgraded model codes that the Department of Energy has determined will improve the energy efficiency of buildings.

The model code organizations have established a three-year upgrade cycle, receiving and deliberating on proposed amendments to the model codes and republishing a new edition of each model code every three years.

The Building Technologies Program is responsible for requirements 1, 3 and 4, above, and for coordinating the overall codes effort. The Federal Energy Management Program is responsible for requirement 2.

Technology Validation and Market Introduction contributes to BT goals by developing and implementing cross-cutting, strategically focused approaches to technology deployment through partnerships with state energy offices, building professionals, manufacturers, retailers, associations, non-profit organizations and other critical stakeholders.

The Technology Validation and Market Introduction subprogram is an integral part of the Building Technologies Program because it is the deployment activity of the program's research area.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Rebuild America	**7,473**	**2,808**	**5,000**

The Rebuild America Program element is aligned with the Building Technology Program's research and development activities to accelerate the adoption of advances in building integrated design, software tools, practices and advanced controls, equipment and lighting. The program will expand and update its technical assistance and delivery mechanisms and partners to effectively transfer the technological advances in R&D. In particular, to promote energy efficiency within the large number of existing homes in FY 2009 the program will begin designing activities with local governments to help them expand availability of their low cost financing for energy retrofits (e.g., using the ESCO experience) and with retailer partnerships to promote energy efficient home remodeling and retrofits through innovative financing, and policies and program development for energy audits at the time of home resale. BT will continue implementation of the Commercial Lighting initiative, EnergySmart Hospitals, EnergySmart Schools, the National Builder's Challenge, and the Building Efficiency Application Centers. The National Builder's Challenge is a program designed to support America's homebuilding industry in its efforts to design, build, and sell 100,000 high performance homes by 2009. The Commercial Lighting Initiative is a high-profile campaign challenging commercial building owners to improve their building lighting efficiency by 30 percent or more.

The Building Efficiency Application Centers will serve as a catalyst for stimulating the construction of new buildings that operate at least 50 percent above code (deemed to be ASHRAE 90.1-2004) and reduce the operating energy use of existing buildings by at least 30 percent. These application centers will work with local building stakeholders (including cities, counties, utilities, efficiency program sponsors, non-profits, building professionals and building owners) to coordinate efficiency efforts and create actionable new platforms for achieving aggressive, rapid improvement in buildings. EPACT 2005, Section 917, authorized these technology centers. The program will initially support two pilot application centers. One center is a consortium of 5 states in the Northwest with headquarters at Washington State University. The second center is a consortium of 12 states in the South with headquarters at the Florida Solar Energy Center. These two centers were chosen by competitive solicitation and will be run by the consortium.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

ENERGY STAR®	**8,776**	**6,714**	**8,000**

DOE will continue its focus on raising the efficiency targets of **ENERGY STAR®** products. The DOE **ENERGY STAR®** team will also continue to work with its partner the Environmental Protection Agency (EPA) to help promote its current labeled products, and its growing portfolio of advanced technologies (e.g., solid state lighting, water heaters, photovoltaics, fuel cells, micro-wind turbines, combined heat and power, and other products as identified). For FY 2009, a three-pronged strategy will be deployed to support the portfolio of existing and advanced technologies: 1) Developing and updating efficiency criteria for DOE-managed products in order to keep the label relevant and meaningful in the market, 2) Working with EPA and participating manufacturers, retailers, and energy efficiency program sponsors on product marketing and deployment activities; and 3) Working with EPA to conduct outreach campaigns and initiatives to educate consumers about **ENERGY STAR**® and the benefits of select products and technologies. Activities will include collaborating with EPA to grow the Home Performance with **ENERGY STAR**® Program, including providing the needed technical assistance for this more holistic approach to efficiency. This would include working to expand the base of trained auditors and contractors, and building awareness among homeowners and key market actors -- such as real estate agents. Lastly, DOE will work through regional and national organizations to disseminate information about **ENERGY STAR**® throughout the U.S., create inter- and intra-state partnerships to promote **ENERGY STAR**® best practices and increase the number of **ENERGY STAR**® State Partners, as well as funding for Energy Efficiency Partnerships.

(dollars in thousands)

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
Building Energy Codes	**2,000**	**3,717**	**8,000**

In FY 2009, DOE will complete analyses and support for the upgrading of ASHRAE 90.1-2010 that will have code stringency effects of approximately 30 percent compared to ASHRAE 90.1-2004. BT will also conduct the R&D needed to support an increased code stringency of 30 percent in the next residential model building energy code (the 2010 International Energy Conservation Code (IECC)). DOE will also conduct analyses and publish determinations in the Federal Register as to whether each new edition of the model codes will improve the energy efficiency of buildings. Technical assistance will be provided to States to update and implement their energy codes to update their residential code to meet the 2006 IECC and Standard 90.1-2007.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2007	FY 2008	FY 2009
Solar Decathlon	**0**	**0**	**3,400**

Starting in FY 2009 the Solar Decathlon will be transferred from the Solar Program to the Buildings Program. The Solar Decathlon is a high-profile university competition held biannually in Washington, D.C. (next one to be held in 2009), that promotes public awareness of highly efficient building technologies and zero-energy homes using solar energy. The competition fosters innovation and encourages incorporation of new building technologies and design practices into engineering and architecture university curricula.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Total, Technology Validation and Market Introduction	**18,249**	**13,239**	**24,400**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Rebuild America	
The increase will be used to expand and update technical assistance and delivery mechanisms and partners to effectively transfer the technological advances due to the acceleration of ZEB and ZEH. The program will help technological advances reach new and existing homes, through activities with local governments to help them expand availability of their low cost financing for energy retrofits (e.g. using Energy Service Company (ESCO) experience) and with retailer partnerships to promote energy efficient home remodeling and retrofits through innovative financing; and energy audits at the time of home resale.	+2,192
ENERGY STAR®	
The increase will be used to develop criteria for advanced technologies. Funding will also be used to continue DOE's work with EPA on the expansion of the Home Performance with ENERGY STAR® Program beyond the pilots, and to develop appropriate tools, such as a national audit protocol, to deliver the information to consumers more effectively.	+1,286
Building Energy Codes	
Increased funding is required for DOE to complete necessary research and analyses to support new code changes and will propose those changes to ASHRAE 90.1 and the IECC for residential buildings that will have code stringency effects of approximately 30 percent.	+4,283
Solar Decathlon	
The funding increase reflects the FY 2009 transfer of the Solar Decathlon from the Solar Program to the Buildings Program. BT will plan and hold the 2009 high-profile biennial university competition in Washington, D.C. to promote public	+3,400

	FY 2009 vs. FY 2008 ($000)
awareness of highly efficient building technologies and zero- energy homes using solar energy.	
Total Funding Change, Technology Validation and Market Introduction	**+11,161**

Equipment Standards and Analysis

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Equipment Standards and Analysis	16,925	21,981	20,000
Total, Equipment Standards and Analysis	16,925	21,981	20,000

Description

The goal of the Equipment Standards and Analysis subprogram is to develop minimum energy efficiency standards that are technologically feasible and economically justified. During FY 2005 and FY 2006, the Department identified and implemented significant enhancements to implementation of rulemaking activities. The Department has made a commitment to clear the backlog of delayed actions that accumulated during prior years, while simultaneously implementing all new requirements of the Energy Policy Act of 2005. In FY 2009, the Department will continue to implement productivity enhancements that will allow multiple rulemaking activities to proceed simultaneously while maintaining the rigorous technical and economic analysis required by statute.

Appliance and equipment standards help drive energy-saving. It is estimated that Federal residential energy efficiency standards that have gone into effect since 1988, or will take effect by the end of 2007, could save a cumulative total of 34 quads (quadrillion (10^{15}) British thermal units (Btu)) of energy by the year 2020, and 54 quads by 2030 (in 2004, total U.S. consumption of primary energy was about 100 quads).

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Equipment Standards and Analysis	**16,925**	**21,981**	**20,000**

The Equipment Standards and Analysis subprogram will continue ongoing rule-makings or will begin for the following product categories that will continue in FY 2009:

- Residential Water Heaters
- Direct Heating Equipment
- Pool Heaters
- High-Intensity Discharge Lamps
- Incandescent Reflector Lamps
- Fluorescent Lamps
- Incandescent General Service Lamps
- Residential Dishwashers
- Ranges and Ovens and Microwave Ovens (Electric and Gas)
- Dehumidifiers (Residential) [EPACT 2005]
- Commercial Clothes Washers [EPACT 2005]
- Refrigerated Bottle or Canned Beverage Vending Machines [EPACT 2005]
- Ice-Cream Freezers, Self-Contained Commercial Refrigerators, Freezers, and Refrigerator-Freezers without doors, and remote-condensing commercial refrigerators, freezers and refrigerator-freezers [EPACT 2005]
- Small Electric Motors
- Large Electric Motors
- Fluorescent Lamp ballasts
- Clothes Dryers
- Room Air Conditioners
- Central Air Conditioners and Heat Pumps

The specific standards and test procedure activities listed above have been identified considering existing obligations, new legislative directives and input from a broad range of external stakeholders, and have been prioritized based on expected energy savings. In FY 2009, DOE will complete analytical and regulatory steps necessary for rulemaking activities for 14 -16 product categories. Final rules will be issued for 4 -6 of these product categories, consistent with enacted law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings.

In accordance with Energy Independence and Security Act (EISA) 2007, DOE will continue work on incorporating standby and off mode power consumption into test procedures for residential products. In addition to increasing the number of products for which DOE must develop standards, EISA 2007 significantly alters the scope of certain rulemakings by authorizing DOE to consider regional standards for certain space conditioning products. The central air conditioning rulemaking will explore an expanded scope of the analysis to consider the potential impacts of regional standards, including the impact on consumers, manufacturers, distributors, contractors, and installers.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

Activities in FY 2009 will also include responses to waiver requests from manufacturers and requests for input and recommendations to the Office of Hearings and Appeals. Resource planning becomes critical to minimize delays and availability conflicts of DOE staff and contractor support. Some resources may also be utilized to prepare for challenges such as new technologies utilized in appliances including compound use appliances, networked or interconnected appliances and even test procedure sensing devices that can give false readings of efficiency levels.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Total, Equipment Standards and Analysis	**16,925**	**21,981**	**20,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Equipment Standards and Analysis	
Increased productivity in the development of standards and test procedures allows for decreased funding in Equipment Standards and Analysis. The increased productivity will be achieved by bundling similar products into one rulemaking and by refining the process of "valley filling" whereby staff will work on other rulemakings if unforeseen delays arise during the time of third party reviews.	-1,981
Total Funding Change, Equipment Standards and Analysis	**-1,981**

Industrial Technologies

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation[a]	FY 2008 Original Appropriation	FY 2008 Adjustments[b]	FY 2008 Current Appropriation	FY 2009 Request
Industrial Technologies					
Industries of the Future (Specific)	16,585	11,349	-104	11,245	11,392
Industries of the Future (Crosscutting – Including Inventions and Innovations)	39,178	53,651	-488	53,163	50,727
Total, Industrial Technologies	55,763	65,000	-592	64,408	62,119

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Supply and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-619, "National Energy Supply Policy Act" (NECPA) (1978)
P.L. 95-620, "Powerplants and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Industrial Technologies Program (ITP) is to reduce the energy intensity of the U.S. industrial sector through a balanced portfolio of collaborative technology investments, validation, and dissemination of information on energy-efficiency technologies and best energy management and operating practices that are used and replicated. This reduction in energy intensity reduces carbon emissions and improves national energy security, climate and environment, and economic competitiveness.

ITP develops, manages, and implements a balanced portfolio of technology investments to address industry requirements throughout the technology development cycle. Research and development, particularly high-risk, high-return R&D, is conducted to target energy-saving opportunities in manufacturing processes and crosscutting energy systems unlikely to be addressed by industry alone. As important as developing new technologies is getting them into the hands of the companies who need them. The program therefore heavily promotes the use of proven energy management methods and advanced technologies industry-wide. Dissemination of energy-efficiency technologies and practices is

[a] Excludes amounts transferred to the Science appropriation for carrying out SBIR / STTR. All subsequent tables in this program also reflect this transfer.

[b] Reflects amounts rescinded by General Provision, section 312, of the Omnibus Appropriations Act, 2008.

accomplished through a variety of technology delivery mechanisms that are the near-term focus of program efforts. These activities will help accelerate industry understanding, acceptance, and implementation of efficiency advances as industry starts reaping the benefits of proven technologies, system management decision tools, training, and strategic partnerships. These technology successes are the result of the "industry pull" designed into the Industrial Technologies Program by the involvement of industry in identifying potential energy-saving R&D areas and cost-sharing the R&D.

Accomplishing the mission will benefit the demand sides of the Department's energy security equation, enabling more productive use of the energy we consume.

Industry uses more energy than vehicles, homes, or commercial buildings. This is not surprising considering America's vast business enterprises that are responsible for one-quarter of the world's manufacturing output. Analysis shows that the cheapest and most available source of new energy for the industrial sector is the energy that is wasted. The rapid and significant return on investment from using energy-efficient technology and employing smart energy practices is why industry has led all other sectors in reducing energy intensity. More importantly, industrial energy efficiency is the quickest and most reliable way to reduce future carbon emissions in the United States. Best of all, higher energy efficiency and lower carbon intensity go hand-in-hand with greater productivity and global competitiveness. In short, industrial energy efficiency presents the most compelling national strategy for rapidly reducing carbon emissions, saving energy, and increasing productivity.

The Industrial Technologies Program (ITP) is helping transform the way industry uses energy. Businesses have the motivation and know-how to implement energy efficiency and carbon reduction measures and are best equipped to lead the transition to a more energy efficient economy. Yet the Department of Energy must provide the policies, processes, and strategic investments that accelerate capital investment in leading-edge technologies - - industry cannot. Despite tremendous efficiency gains, a recent International Energy Agency (IEA) study estimated that industry can do more – much more – to reduce energy use and resulting carbon emissions. By using proven technologies and best practices, IEA estimated that industries throughout the world could reduce carbon emissions by 19 to 32%, equivalent to about 7 to 12% of all global emissions.

Moreover, these reductions need not be expensive. Two recent studies[a] showed that of all the options to reduce carbon emissions, energy efficiency was by far the most cost-effective, actually saving money for businesses compared to more costly abatement options. However, unlike many consumers and homeowners, businesses have the financial discipline to value the total cost savings that efficiency investments produce. By treating energy efficiency as a resource – essentially a "fifth fuel" – businesses can broaden their energy options, reduce their carbon footprint, and bring considerable economic resources to the growing energy efficiency products and services industry.

ITP is leading the Federal government's research, development, and deployment efforts in industrial energy efficiency by broadening existing private sector partnerships and building on its proven track record of technology successes. ITP develops real-world energy solutions throughout the manufacturing value chain and helps America's manufacturers uncover affordable energy saving and carbon reducing opportunities. For example, ITP's Save Energy Now effort conducted 200 plant assessments last year

[a] Florian Bressand et al., Curbing Global Energy Demand Growth: The Energy Productivity Opportunity, McKinsey Global Institute, May 2007, and Vattenfall AB, Global Mapping of Greenhouse Gas Abatement Opportunities up to 2030: Industry sector deep-dive, June, 2007.

that identified large energy and cost savings for all types of manufacturers. These savings were equivalent to 5 to 15% of plant energy use, which translates to an average cost savings of $2.5 million per plant annually. The Secretary of Energy recently completed a Memorandum of Understanding with the National Association of Manufacturers that will expand technology outreach efforts to more manufacturers to achieve even greater energy savings that are sustainable over the long term. The joint effort would contribute to the 2005 EPACT goal to reduce energy intensity by 2.5% per year by 2017.

With reduced energy intensity comes improved productivity through yield improvement and resource conservation. Reducing industrial energy intensity also contributes to environmental quality by promoting technologies and practices that minimize adverse environmental impacts. Most importantly, any reduction in energy intensity leads to a corresponding reduction in carbon emissions intensity, since 96% of industrial carbon emissions are the direct result of energy use. These benefits also contribute to energy security by promoting technologies that increase independence from foreign energy sources.

In the short run, deployment activities will help move the results of ITP-funded energy efficiency research into the industrial marketplace. Associated cost savings will improve the competitive position of U.S. industries, and thus help maintain on-shore production, domestic employment, and carbon savings.

Over the past 30 years, industry has shown a remarkable ability to improve energy efficiency, greatly increasing economic output without a corresponding increase in energy use. The Industrial Technologies Program estimates that, in 2005, the most recent year for which complete data is available, it directly contributed to industrial energy savings of over 400 trillion Btus[a] in energy savings worth over $4.4 billion.[b] From the ITP activity's inception in 1977 through 2005, ITP helped develop more than 190 commercialized industrial technologies. Cumulative tracked energy savings over that period are estimated to be over 5.1 Quads.

Yet an expanding economy will increase industrial energy demand. In its Annual Energy Outlook 2007, the Energy Information Administration projects industrial energy use will grow by almost 14 percent from 2004 to 2030, even with assumed efficiency gains and an economic shift to less energy-intensive industries. Reducing energy intensity - - the amount of energy used to produce a given amount of industrial product -- is the key to increasing energy efficiency in industry without impeding economic growth. Because there are significant gaps between current energy use and the practical minimum energy use for most industrial processes, the industrial sector will continue to offer excellent opportunities to improve energy efficiency in the United States over the next 25 years.

If energy use per unit of output in the most energy-intensive industries continued at 2002 levels, these industries would be using over 23 Quads by 2020. However, by that time, partner industries are expected to reduce their energy use by 3 Quads through business-as-usual efficiency improvements (EIA projection of 0.75 percent annually) and, concurrently, activities originally sponsored by the Industrial Technologies Program are projected to help these industries lower energy use and consumer costs significantly in amounts concomitant with the climate benefits. Looking at a broader base of all industries, the continuation of 2002 intensities would result in total industrial energy use of over 50

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[a] See 2007 Impacts report at www1.eere.energy.gov/industy/about/pdfs/impact2005.pdf.

[b] Constant 2004 dollar values for energy savings shown in this budget are based upon Energy Information Administration data from the Annual Energy Outlook 2007(AEO 2007). Average industrial energy prices per million Btu were $7.89 in 2004 and $9.49 for 2005. Source: based on AEO 2007, Table A6, available at http://www.eia.doe.gov/oiaf/aeo/supplement/sup_t2t3.xls

Quads in 2020 to produce the AEO 2007 projected value of shipments. Business-as-usual efficiency improvements would be expected to reduce this total by 6.4 Quads using the EIA projection of 0.75 percent intensity improvement annually, and once again ITP activities are expected to double energy and economic savings to help meet the goal of a 20 percent reduction in industrial energy intensity.

In the near term, advanced technologies can increase the efficiency with which process heat is generated, contained, transferred, and recovered. Process and design enhancements can improve quality, reduce waste, minimize reprocessing, reduce the intensity of material use (with no adverse impact on product or performance), and increase in-process material recycling. Cutting-edge technologies can significantly reduce the intensity with which energy and materials (containing embedded energy) are used. Industrial facilities can implement direct manufacturing processes which can eliminate some energy-intensive steps, thus both avoiding emissions and enhancing productivity. On the supply side, industry can self-generate clean, high-efficiency power and steam and create products and byproducts that can serve as clean-burning fuels. The sector can also make greater use of coordinated systems that more efficiently use distributed energy generation, combined heat and power, and cascaded heat.

In the long term, fundamental changes in energy infrastructure could effect significant demand reductions. Revolutionary changes may include novel heat and power sources and systems, including renewable energy resources, hydrogen, and fuel cells. Innovative concepts for new products and high efficiency processes may be introduced that can take full advantage of recent and promising developments in nanotechnology. As global industry's existing, capital-intensive equipment stock nears the end of its useful service life and as industry expands in rapidly emerging economies in Asia and the Americas, this sector will have an opportunity to adopt novel technologies that could revolutionize basic manufacturing. Advanced technologies will likely involve a mix of pathways, such as on-site energy generation, conversion, and utilization; process efficiency improvements; innovative or enabling concepts, such as advanced sensors and controls, materials, and catalysts; and recovery and reuse of materials and byproducts. In the United States, the development and adoption of advanced industrial technologies can not only provide energy security benefits, but also help to maintain U.S. competitiveness.

In the near term, industrial energy use could be lowered through improvements in the industrial use of electricity and fuels to produce process heat and steam, including steam boilers, direct-fired process heaters, and motor-driven systems, such as pumping and compressed air systems. Opportunities for reducing emissions in these areas lie with the adoption of best energy-management practices and more modern and efficient power and steam generating systems; integrated approaches that combine cooling, heating, and power needs; and capture and use of waste heat. Other areas of opportunity include improvements in specific energy-intensive industrial processes, including hybrid distillation systems; process intensification by combining or removing steps, or designing new processes altogether while producing the same or a better product; the recovery and utilization of waste and feedstocks, which can reduce energy and material requirements; and crosscutting opportunities, such as improved operational capabilities and performance.

In the long term, highly efficient coal gasifiers coupled with CO_2 sequestration technology could provide an alternative to natural gas, and even enable the export of electricity and hydrogen to the utility grid and supply pipelines. Bioproducts could replace fossil feedstocks for manufacturing fuels, chemicals, and materials; while biorefineries could utilize fuels from nonconventional feedstocks to jointly produce materials and value-added chemicals. For noncombustion sources of CO_2, gas capture, separation and sequestration could be applied, or alternative processes or materials could be developed as substitutes. Further, integrated modeling of fundamental physical and chemical properties, along with advanced methods to simulate processes, will stem from advances in computational technology.

By 2030 the Industrial program's technologies could generate cumulative consumer and industry savings of over $200 billion and reduce carbon by 1.5 gigatons, more than doubling that by mid-century. The program's economic, environmental and security benefits that are quantified as expected program outcomes are described in more detail under the "Expected Program Outcomes" sections.

Interdependencies

- Research on specific, energy-intensive, high-carbon emitting processes (including steelmaking, distillation, and paper drying) to lower process energy requirements, eliminate energy-intensive process steps, and develop low energy/low-carbon alternatives;
- Crosscut advances that deliver significant impacts across diverse industries including high-efficiency/low-emission steam generation, isothermal melting technology, nano-structured materials, nanomanufacturing, and wireless motor monitoring;
- Accelerated adoption of proven technologies and practices through promotion of emerging technologies with large manufacturing plants and cost-shared, energy-saving assessments as part of the expansion of the Save Energy Now campaign, increasing the number of energy assessments of manufacturing plants. Partnership activities with NIST's Manufacturing Extension Partnerships, the National Association of Manufacturers, and the U.S. manufacturing supply chain will increase implementation of recommendations and replicate savings at plants up and down the supply chain;
- Accelerated adoption of proven technologies and practices;
- Deployment of new technologies for industry specific applications;
- Expanded industrial adoption of combined heat and power;
- Advanced technologies for processing and energy conversion in energy intensive technology platforms to overcome known barriers to energy efficiency; and
- Funding for a targeted, deployment-focused technology development initiative to take advantage of DOE's alternative fuel source programs.

Program Interdependencies include:

- Public-private partnerships to bring together the strengths of business and Government and to disseminate and share best energy management practices in factories throughout the United States.;
- DOE's Basic Energy Sciences and Fossil Energy Programs to coordinate research in such areas as nanotechnology and mining, respectively;
- National Science and Technology Council interagency working group collaboration on manufacturing technology issues with industry including funding to contribute to the collaborative R&D developed through that group; and
- National Aeronautics and Space Administration, the National Science Foundation, the National Institute of Standards and Technology, Environmental Protection Agency, and the Departments of

Defense, Commerce, Agriculture, and Interior planning, budgets and collaboration to organize industry research efforts in common areas.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission plus 16 Strategic Goals that tie to the Strategic Themes. The Industrial Technologies Program principally supports the following goal:

Strategic Theme 1, Energy Security

Strategic Goal 1.4, Energy Productivity: Cost-effectively improve the energy efficiency of the U.S. economy;

And concurrently supports:

Strategic Theme 3, Scientific Discovery and Innovation: Strengthening U.S. scientific discovery, economic competitiveness, and improving quality of life through innovations in science and technology.

Strategic Goal 3.3, Research Integration: Integrate basic and applied research to accelerate innovation and to create transformational solutions for energy and other U.S. needs.

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

The Industrial Technologies Program has one GPRA Unit Program goal which contributes to Strategic Goal 1.4 in the "goal cascade":

GPRA Unit Program Goal 1.3.19.00: Industrial Technologies - The Industrial Technology Program goal is to partner with our most energy-intensive industries in strategic planning and specific RD&D to develop the technologies needed to use energy efficiently in their industrial processes and cost-effectively generate much of the energy they consume. The result of these activities will save feedstock and process energy, improve the environmental performance of industry, and help America's economic competitiveness.

Contribution to GPRA Unit Program Goal 1.3.19.00 (Industrial Technologies)

The Industry Technologies Program's key contribution to energy security is through improving energy efficiency and directly reducing the demand for oil, natural gas, and electricity. Between 2003 and 2015, industrial technologies will contribute to an 14.9 percent reduction in energy intensity (Btu per unit of industrial output as compared to 2002) in the energy-intensive Industries of the Future (a potential savings of 3.3 Quads, an additional 1.2 Quads above projected baseline efficiency improvements); between 2004 and 2012, target industries and RD&D partners will commercialize over 35 energy-efficiency technologies developed through the ITP partnerships.

The production improvements and direct reduction in both total industrial energy use and the use of fossil fuels will contribute to the Administration goal of an 18 percent reduction between 2003 and 2012 in the greenhouse gas intensity, or total greenhouse gas emissions per unit of Gross Domestic Product, of the U.S. economy. According to an EIA report[a], carbon dioxide emissions from the industrial end-use sector, including fuel burning emissions as well as process emissions, were over 100 metric tons lower in 2006 than in 1996. Over the life of the program to date, ITP estimates that technologies it developed and activities it undertook since 1977 cumulatively saved 103 million metric tons of carbon.

ITP is leading the Federal government's research, development, and deployment efforts in industrial energy efficiency by broadening existing private sector partnerships and building on its proven track record of technology successes. ITP develops real-world energy solutions throughout the manufacturing value chain and helps America's manufacturers uncover affordable energy saving and carbon reducing opportunities. For example, ITP's Save Energy Now effort conducted 200 plant assessments last year that identified large energy and cost savings for all types of manufacturers. These savings were equivalent to 5 to 15% of plant energy use, which translates to an average cost savings of $2.5 million per plant annually. The Secretary of Energy recently completed a Memorandum of Understanding with the National Association of Manufacturers that will expand technology outreach efforts to more manufacturers to achieve even greater energy savings that are sustainable over the long term. The joint effort would contribute to the 2005 EPAct goal of reducing energy intensity by 2.5% per year by 2017

Funding by Strategic and GPRA Unit Program Goal

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Strategic Goal 1.4, Energy Productivity			
GPRA Unit Program Goal 1.3.19.00, Industrial Technologies			
Industries of the Future (Specific)	16,585	11,245	11,392
Industries of the Future (Crosscutting)	39,178	53,163	50,727
Total, Strategic Goal 1.4 (Industrial Technologies)	55,763	64,408	62,119

[a] See EIA Report Emissions of Greenhouse Gases in the United States 2005 at http://www.eia.doe.gov/oiaf/1605/ggrpt/excel/historical_co2.xls

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.3.19.00 (Industrial Technologies)					
Industries of the Future (Specific)					
Commercialize 4 new technologies in partnership with the most energy-intensive industries. [MET: Exceeded, 6 technologies]	Commercialize 3 new technologies in partnership with the most energy-intensive industries. [MET]	Commercialize 3 new technologies in partnership with the most energy-intensive industries. [MET]	Commercialize 3 new technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent.	Commercialize 3 new technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent.	Commercialize 3 new technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent.
Industries of the Future (Crosscutting)					
An additional 600 (leading to a cumulative 6,800) energy intensive U.S. plants will apply EERE technologies and services averaging a 5 percent improvement in energy productivity per plant. [MET: Exceeded, 9,987 cumulative plants]	An additional 200 (leading to a cumulative 7,000) energy intensive U.S. plants will apply EERE technologies and services. [MET]	An additional 200 (leading to a cumulative 8,600) energy intensive U.S. plants will apply EERE technologies and services contributing to the goal of a 20 percent reduction in energy intensity from 2002 levels by 2020. [MET]	An estimated 125 trillion Btus saved by an additional 1,000 energy intensive U.S. plants applying EERE technologies and services	An estimated 100 trillion Btus energy savings from applying EERE technologies and services to 400 energy-intensive U.S. plants.	An estimated 100 trillion Btus energy savings from applying EERE technologies and services to 600 energy-intensive U.S. plants.
Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (2003) until the target range is met. [MET]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($40,741K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.

Means and Strategies

The Industrial Technologies Program uses various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the success of planned investments, means and strategies, and to addressing external factors.

The Industrial Technologies Program implements its portfolio through the following means:

- ITP invests in pre-competitive and high-risk RD&D that individual companies are unable to undertake without Government support. These industry and departmental investments in applied research and pre-commercialization technology represent the greatest opportunities to save energy and improve environmental performance in a cost-effective manner.

- ITP cost-shares the funding of projects with multiple industrial and academic partners. Sharing project costs (industrial partners typically contribute 50 percent) leverages public investment with private resources, increases access to scientific capabilities, increases industry commitment to achieving R&D success, shortens the technology development and commercialization cycle, and facilitates technology delivery. ITP activities are moving from a focus on predominantly industry-specific R&D toward more technology development applicable to multiple industries.

The Industrial Technologies Program implements the following strategies:

- Identify industrial energy savings potentials per type of improvement, to focus on greatest opportunities;

- Address energy losses that when remedied will reduce the energy requirements of industry while stimulating economic productivity and growth and reduce emissions;

- Invest in next-generation manufacturing concepts that cut across industry lines and produce dramatic energy and environmental benefits providing large public benefits. The development of these transformational technologies typically requires high-risk, high-return R&D which one industry cannot typically undertake, such as an entirely new processing route to achieve much lower energy use than current processes. These efforts are expected to yield substantial energy, environmental, and economic benefits.

- Deployment strategies include joint funding of industry energy assessments for small and medium-sized industrial plants through the university-based Industrial Assessment Centers, continuing to deliver the results of energy-efficiency R&D and energy-saving practices to industrial plants nationwide. The Save Energy Now outreach activity includes an Energy Savings Assessments (ESA) effort. The ESA effort reached its 24-month goal of conducting 450 assessments in 2006 and 2007 at the Nation's most energy-intensive industrial facilities, identifying opportunities to save more than 64 trillion Btu of natural gas, the amount used by 1 million average U.S. homes. If implemented, the improvements could save more than a billion dollars per year and reduce carbon dioxide emissions by 5 million metric tons annually.

- In FY 2009 ITP will continue a transition to more multi-industry application and transformational R&D activities in the Energy-Intensive Process R&D key activity while continuing industry-specific R&D in the Industries of the Future (Specific) activity.

The following external factors could affect ITP's ability to achieve its goals:

- Rates of market growth/technology adoption and adoption rates of technologies;
- Industry profit margins;
- Labor and material costs, capital investment requirements, and cost of technologies;
- Foreign competition;
- Energy supply markets and prices; and
- Safety and environmental regulations; and environmental policies at the national and state level, including Federal efforts to reduce carbon and criteria emissions that might affect the choice of energy sources.

In carrying out the program's mission, Industrial Technologies Program performs the following collaborative activities:

- The *National Energy Policy*[a] encourages energy efficiency programs that are modeled as public-private partnerships. The Industrial Technologies Program has used this partnership model for the past ten years to bring together the strengths of business and Government to improve energy efficiency. These partnerships also help to disseminate and share best energy management practices in factories throughout the United States.
- ITP works with DOE's Basic Energy Sciences and other programs to coordinate research in such areas as nanotechnology and materials research.
- On manufacturing technology issues, ITP collaborates through the National Science and Technology Council interagency working group on manufacturing (IWG) with many of the participating agencies, and this budget request includes funding to contribute to the collaborative R&D developed through that group.
- ITP coordinates with other Federal agencies, including the National Aeronautics and Space Administration, the National Science Foundation, the National Institute of Standards and Technology, Environmental Protection Agency, and the Departments of Defense, Commerce, Agriculture, and Interior to organize research efforts in common areas.

Validation and Verification

To validate and verify program performance, the Industrial Technologies Program will report and manage its performance plan and conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accountability Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. ITP will also undertake analyses to address Government Performance and

[a] See National Energy Policy report of the National Energy Policy Development Group (May 2001), P. 4-12.

Results Act (GPRA) and the President's Management Agenda (PMA) requirements, including the Performance Assessment Rating Tool (PART) and the R&D Investment Criteria (RDIC).

The table below summarizes validation and verification activities. Progress toward annual performance targets and results are also tracked on a quarterly basis through the DOE management system, Joule.

Data Sources:	Energy intensity is calculated from the Energy Information Administration's (EIA's) Annual Energy Outlook, Manufacturing Energy Consumption Survey (MECS), and Department of Commerce data. The number of technologies and their energy savings are ascertained through interviews with technology developers and suppliers. Energy savings for the technical assistance programs are estimated based upon past reported participant data. Project financial data is tracked through the EERE Corporate Planning System.
Evaluation:	In carrying out the program's mission, the Industrial Technologies Program uses several forms of evaluation to assess progress and to promote program improvement. ▪ Technology validation and operational field measurement, as appropriate; ▪ Peer review by independent outside experts of both the program and subprogram portfolios; ▪ Annual internal Technical Program Review of the Industrial Technologies Program; ▪ Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate; ▪ Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); PMA, annual departmental and Program Secretarial Officer (PSO) based goals whose milestones are planned, reported and reviewed quarterly); and PART (common government wide program/OMB reviews of management and results); and ▪ Annual review of methods, and recomputation of benefits for GPRA.
Baselines:	The following are the key baselines used in ITP for contributions to its program goal: ▪ Industrial energy intensity (2002) 14,000 Btu/$1996 value of shipments of energy intensive industry output. ▪ The baseline for the cumulative count of new commercialized technologies that achieve 10 percent improvement in energy efficiency is zero in 2003.
Frequency:	EIA/MECS collects energy intensity data once every 4 years, and ITP makes annual estimates based upon data from annual Department of Commerce surveys. ITP collects data on energy savings and technologies commercialized annually. The EERE Corporate Planning System tracks project awards and expenditures continually.
Data Storage:	Energy intensity information is contained in EIA's computer database. Data on energy savings and technologies commercialized are stored in ITP's Impacts Database and are available on the internet at

www1.eere.energy.gov/industry/about/pdfs/impact2005.pdf. Data on the counts and impacts of plants contacted is collected by Lawrence Berkeley National Laboratory and Oak Ridge National Laboratory.

Verification: ITP uses prospective and retrospective peer reviews to evaluate project performance and to adjust support. To verify program performance and results, ITP tracks all technologies commercialized (and the extent of their use) by industry through an analysis of program impacts conducted by Pacific Northwest National Laboratory. ITP also provides EIA quality control and outside peer review of the Manufacturing Energy Consumption Survey. Industry representatives review data on energy savings and technologies commercialized. ITP has conducted reviews of the impacts of several technical programs and assistance programs have also been reviewed several times.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The Industrial Technologies Program received its first OMB PART review in 2005. The PART review included ratings of 80 percent for program purpose, 90 percent for planning, 91 percent for management and 50 percent for program results and accountability with an overall rating of "Adequate". The program is addressing the findings and recommendations in the PART, including a December 2007 report on an independent assessment of ITP's contribution to the long-term goal of improving industrial energy efficiency, and expects to improve its score in the next assessment. These ratings reflect the commitment of EERE program management at all levels to the basic management and planning principles of the President's Management Agenda including the criteria scored in the PART**.**

The Department has responded to the PART recommendation of "Develop guidance that specifies a consistent framework for analyzing the costs and benefits of research and development investments, and use this information to guide budget decisions." The Department continues to work on the development and implementation of common assumptions, a consistent approach to incorporation of risk, and other issues. EERE continues to refine the methods its uses in support of this framework and Departmental processes.

Expected Program Outcomes

Over the past 30 years, industry has shown a remarkable ability to improve energy efficiency, greatly increasing economic output without a corresponding increase in energy use. The Industrial Technologies Program estimates that, in 2005, the most recent year for which complete data is available, it directly contributed to industrial energy savings of over 400 trillion Btu[a] in energy savings worth over $4.4 billion.[b] From the ITP activity's inception in 1977 through 2005, ITP helped develop more than

[a] See 2009 Impacts report at http://www1.eere.energy.gov/ba/pba/

[b] Constant 2004 dollar values for energy savings shown in this budget are based upon Energy Information Administration data from the Annual Energy Outlook 2007(AEO 2007). Average industrial energy prices per million Btu were $7.89 in 2004 and $9.49 for 2005. Source: based on AEO 2007, Table A6, available at http://www.eia.doe.gov/oiaf/aeo/supplement/sup_t2t3.xls

190 commercialized industrial technologies. Cumulative tracked energy savings over that period are estimated to be over 5.1 Quads.

Yet an expanding economy will increase industrial energy demand. In its Annual Energy Outlook 2007, the Energy Information Administration projects industrial energy use will grow by almost 14 percent from 2004 to 2030, even with assumed efficiency gains and an economic shift to less energy-intensive industries. Reducing energy intensity - - the amount of energy used to produce a given amount of industrial product -- is the key to increasing energy efficiency in industry without impeding economic growth. Because there are significant gaps between current energy use and the practical minimum energy use for most industrial processes, the industrial sector will continue to offer excellent opportunities to improve energy efficiency in the United States over the next 25 years.

If energy use per unit of output in the most energy-intensive industries continued at 2002 levels, these industries would be using over 23 Quads by 2020. However, by that time, partner industries are expected to reduce their energy use by 3 Quads through business-as-usual efficiency improvements (EIA projection of 0.75 percent annually) and, concurrently, activities originally sponsored by the Industrial Technologies Program are projected to help these industries lower energy use by another 1.7 Quads. Looking at a broader base of all industries, the continuation of 2002 intensities would result in total industrial energy use of over 50 Quads in 2020 to produce the AEO 2007 projected value of shipments. Business-as-usual efficiency improvements would be expected to reduce this total by 6.4 Quads using the EIA projection of 0.75 percent intensity improvement annually, and ITP activities would contribute about 3.8 Quads of additional savings necessary to meet the goal of a 20 percent reduction in industrial energy intensity.

	Historic					Planned		
	2002	2003	2004	2005	2006	2007	2008	2009
Performance Indicators								
Annual number of technologies commercialized (after 2006, that achieve 10 percent improvement in energy efficiency)								
Target	---[a]	---	4	3	3	3	3	3
Actual	---	---	6	3	7			
Annual energy savings from Industrial Technologies Program activities in partnership with industry (trillion Btu)								
Target		290	220	220	180	180	180	180
Actual	293	352	366	402				
Annual energy savings from ITP technical assistance activities (trillion								

[a] For the purpose of establishing PART goals, the cumulative count of commercialized technologies from ITP R&D efforts was restarted, beginning with 2004 efforts. There were actually 10 commercialized technologies in 2002 and 5 in 2003.

	Historic					Planned		
	2002	2003	2004	2005	2006	2007	2008	2009
Btu)								
Target		200	200	200	200	200	200	200
Actual	172	231	255	303	270 Est.			
Annual number of energy-intensive plants impacted by the program[a]								
Target	600	600	600	200	200	1000	400	400
Actual	738	1647	2089	2634	2216			
Percentage change in energy intensity from 2002								
Target		-1.2	-2.4	-3.7	-4.8	-6.0	-7.2	-8.3
Actual		1.3	5.1	8.3	-7.7 Est.			

Estimates of the security, economic and environmental benefits from 2009 through 2050 that would result from realization of the program's goals are shown in the table below.

EERE's Industrial Technology Program Goal Case reflects the increasing adoption of the technologies in the program's research, development and deployment portfolio over time, as the program's goals are met. Not included are any other policies or regulatory mechanisms, or other incentives not already in existence, which might be expected to support or accelerate the achievement of the program goals. The expected benefits reflect solely the achievement of the program's goals.

The goals are modeled in contrast to the "baseline" case, in which no DOE R&D exists. The baseline case is identical to those used for all DOE applied energy R&D programs.[b] Further, across EERE, and across all of DOE's applied energy R&D programs, the expected outcome benefits are being calculated using the same fundamental methodology. Finally, the metrics by which expected outcome benefits are measured are identical for all of DOE's applied energy R&D programs.[c] This standardization of methods and metrics has been undertaken as part of the Department's efforts to respond to OMB's request to make all programs' outcomes comparable.

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[b] "Impacted" refers to the number of unique plants receiving EERE energy efficiency information or applying EERE energy technologies and practices.

[b] The starting point for the baseline case is the Energy Information Administration's "reference case," as published in the AEO 2007. Program analysts from across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO's technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

[c] The set of expected outcome metrics being used this year differs in substantial ways to that of previous years. In addition to the standardization across DOE's applied energy R&D programs, the list is expanded and more comprehensive than in past years. Further, the list maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

The difference between the baseline case and the program goal case results in economic, environmental, and security benefits. For example, achievement of program goals results in a reduction in cumulative net consumer expenditures of nearly $200 billion dollars by 2030 and more than twice that by mid-century. Savings to the electric power industry are expected to be $33 billion in 2030 three times that by 2050. Finally, the program would also result in carbon emissions reductions of 1.5 gigatons by 2030 and nearly 5 gigatons by 2050. The results are generated by modeling the program goals within two energy-economy models: NEMS-GPRA08 for benefits through 2030, and MARKAL-GPRA08 for benefits through 2050.[a] The full list of modeled benefits is provided below.

[a] Final documentation on the analysis and modeling, including all of the methodologies and underlying assumptions, is expected to be completed and posted on the web by March 31, 2007. Past GPRA modeling and analysis documentation can be found at http://www.eere.energy.gov/ba/pba/gpra.html.

Primary Benefits Metrics for FY09– NEMS and MARKAL

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	0.2	0.6	N/A
		MARKAL	ns	ns	0.2	1.1
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	0.8	2.5	9.4	N/A
		MARKAL	ns	0.3	5.2	23.4
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	134	413	1547	N/A
		MARKAL	139	440	1574	4880
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	24	55	176	N/A
		MARKAL	23	63	199	387
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	4	11	33	N/A
		MARKAL	6	18	49	90
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	30	N/A
		MARKAL	9	3	15	28

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

Industries of the Future (Specific)

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Industries of the Future (Specific)			
Forest and Paper Products Industry	2,888	1,738	1,448
Steel Industry	3,626	3,569	2,256
Aluminum Industry	2,273	1,737	2,139
Metal Casting Industry	986	192	973
Chemicals Industry	6,812	3,710	4,273
SBIR/STTR	0	299	303
Total, Industries of the Future (Specific)	16,585	11,245	11,392

Description

The Industries of the Future (Specific) subprogram supports cost-shared research, development, and demonstration (RD&D) of advanced technologies to reduce the energy intensity while improving the environmental performance of America's energy-intensive and waste-intensive industries. ITP will enter the second year of a three-year process in FY 2009 to transition from predominantly industry-specific research and development to more crosscutting research. The future broader initiatives in Energy-Intensive Process R&D (see below) will enable ITP to shift toward higher impact cross-industry R&D activities while continuing a focus on specific technologies applicable to energy-intensive industries. This dual approach will dramatically improve the energy efficiency and environmental performance of the energy-intensive industries. Through this process, ITP will improve its ability to prioritize activities to meet key programmatic objectives in support of the Department's strategic goals. These funds may also be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

ITP will continue to work with industry partners completing existing IOF Specific R&D efforts with the Steel, Forest Products, Chemicals, and Metal Casting industries. These efforts will contribute toward the EPACT 2005 Section 106 goal of 2.5%/yr reduction in industrial energy intensity.

Key domestic industries will continue industry-specific R&D on industrial efficiency technologies that reduce their energy consumption and improve their competitive position, preserving domestic economic benefits while reducing cost, saving energy and significantly contributing to the Nation's environmental performance, making U.S. industry and products more competitive globally. These partnerships have achieved notable successes. For example, the Steel industry announced in 2005 that they have reduced their average energy consumption per ton of steel by 7 percent and have attributed this milestone to collaborative R&D activities with DOE.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Forest and Paper Products Industry	**2,888**	**1,738**	**1,448**

In FY 2009, efforts within this activity are focused on accelerating the completion of research to investigate avenues for the reduction of natural gas use through transformational technologies. The program will continue activities in the areas of high efficiency pulping and innovative drying. Estimated energy savings in the year 2020 are 32 trillion Btus with carbon savings of 0.5 MMTCE.

The program will continue to support the American Forest & Paper Association and other industry organizations to improve their member companies' energy efficiency and environmental performance through the industry's Agenda 2020. The collaborative activities will include the continuation of cost-shared R&D on as well as the utilization of new improved energy technologies, industrial energy efficiency tools, and energy management best practices.

Steel Industry	**3,626**	**3,569**	**2,256**

In FY 2009, the focus will be on processes that both reduce the use of natural gas and improve energy efficiency in iron and steelmaking. The program will continue work for developing technology such as cokeless ironmaking and advanced process development for improvements in steel manufacturing that can be broadly adopted for next generation steelmaking. Funding will be used to continue research initiated in previous years. Estimated energy savings in the year 2020 are 50 trillion Btus with carbon savings of 0.7 MMTCE.

The program will continue to support the American Iron and Steel Institute, the Steel Manufacturers' Association, and other industry organizations to improve their member companies' energy efficiency and environmental performance. The collaborative activities will include the continuation of cost-shared R&D on as well as the utilization of new improved energy technologies, industrial energy efficiency tools, and energy management best practices.

Aluminum Industry	**2,273**	**1,737**	**2,139**

In FY 2009, key activities will be in the areas of efficient melting and forming. Estimated energy savings in the year 2020 are 47 trillion Btus with carbon savings of 0.7 MMTCE.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Metal Casting Industry	**986**	**192**	**973**

In FY 2009, the program will continue cost-effective activities in advanced melting and efficient net shape manufacturing processes and transfer of research and development results and technologies to industry. Estimated energy savings in the year 2020 are 22 trillion Btus with carbon savings of 0.3 MMTCE.

Chemicals Industry	**6,812**	**3,710**	**4,273**

In FY 2009, this key activity will focus on projects addressing Alternative Processes, Oxidation Reactions, Hybrid Distillations and Micro Reactors. R&D in these areas will result in improved conversion of chemical processes, reduced feedstock consumption, and reduced generation of unneeded by-products and wastes, Expected energy savings in the year 2020 are 94 trillion Btus and carbon savings of 1.4 MMTCE.

SBIR/STTR	**0**	**299**	**303**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Industries of the Future (Specific)	**16,585**	**11,245**	**11,392**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Forest and Paper Products Industry	
This decrease reflects the transition of new R&D activities to the IOF Crosscutting Energy Intensive Process activity.	-290
Steel Industry	
Existing promising projects will continue to be funded, while new projects will generally be funded under the Energy-Intensive Process R&D activity.	-1,313
Aluminum Industry	
This increase will allow the acceleration of activities in the areas of efficient melting and forming. Future R&D applicable to this and other industries will be conducted through the Energy-Intensive Process R&D activity.	+402

	FY 2009 vs. FY 2008 ($000)
Metal Casting Industry	
This increase would accelerate ongoing cost-effective projects currently underway in the area of innovative casting and melting technologies, such as Energy Savings Melting and Revert Reduction Technology which focus on energy efficiency improvements in melting technology and casting processes without major in-plant capital investment.	+781
Chemicals Industry	
The increase will accelerate R&D efforts in the areas of distillation and hybrids and oxidation reactions. ITP will then continue the shift toward more crosscutting and higher impact energy-intensive process R&D activities to dramatically improve the energy efficiency and environmental performance of the energy-intensive industries, consistent with R&D Investment Criteria on incorporating "off-ramps".	+563
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+4
Total Funding Change, Industries of the Future (Specific)	**+147**

Industries of the Future (Crosscutting)

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Industries of the Future (Crosscutting)			
Industrial Materials of the Future	9,882	4,717	4,654
Combustion	2,366	641	583
Sensors and Automation	3,062	1,805	0
Industrial Technical Assistance			
Industrial Assessment Centers	4,035	3,998	4,035
Best Practices	19,833	8,753	15,532
Total, Industrial Technical Assistance	23,868	12,751	19,567
Energy-Intensive Process R&D	0	7,186	14,846
Fuel and Feedstock Flexibility	0	2,805	3,889
Nanomanufacturing and Other Interagency Manufacturing R&D	0	4,823	4,861
Industrial Distributed Energy	0	14,467	1,498
Energy Efficient Information Technologies	0	2,948	0
SBIR/STTR	0	1,020	829
Total, Industries of the Future (Crosscutting)	39,178	53,163	50,727

Description

In the Industries of the Future (Crosscutting) activities, ITP works with industrial partners and suppliers to conduct cost-shared RD&D on technologies that have potential applications across many partner industries. In FY 2008, ITP began a three-year transition to more multi-industry application and transformational R&D activities in the Energy-Intensive Process R&D key activity. Investments in the key activity areas of Robotics, and Sensors and Automation will be completed and merged into this activity by 2008. Industrial Materials of the Future and Combustion R&D will continue, complemented by R&D in the Energy-Intensive Process activity. The Nanomanufacturing and Other Interagency Manufacturing R&D activity will expand this notion of cross-industry and next-generation research to activities conducted with other government agencies with an initial focus on enabling process for the mass production and application of nano-scale materials, structures, devices and systems to transform industrial processes.

Fuel and Feedstock Flexibility activities will lead to the development and deployment of alternative fuel and feedstock technologies to replace natural gas and oil. ITP will seek to displace industrial natural gas use through a targeted, deployment-focused technology development initiative that links industrial users with advanced fuel development activities taking place throughout DOE (e.g., EERE's Biomass Program, the Fossil Energy office, etc.) and the National Laboratories. Deployment activities such as Industrial Assessment Centers and the Best Practices activities will continue to deliver the results of energy-efficiency R&D and energy-saving practices to industrial plants nationwide.

Crosscutting IOF technologies have provided the means for development of broad benefit and enabling technologies that were not within practical developmental reach of an individual industry. These technologies continue to be developed across industries providing economic, energy and environmental benefits nationally. Deployment activities, such as the Industrial Assessment Centers and Best Practices, bring the results of these technological improvements to the plant floor. Activities in these areas are expected to result in carbon savings of 19.5 MMTCE in the year 2020.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Industrial Materials of the Future	**9,882**	**4,717**	**4,654**

In FY 2009, work will continue on the development of nanocomposites and nanocoatings, materials for energy systems and materials for separations, and advanced materials solutions such as membranes for waste energy recovery; refractories for industrial systems. ITP will also Conduct R&D on new high temperature corrosion-resistant materials for energy intensive applications and advanced manufacturing processes such as low cost titanium production. Estimated potential energy savings from these activities in the year 2020 are 103 trillion Btus and carbon savings of 1.5 MMTCE.

	FY 2007	FY 2008	FY 2009
Combustion	**2,366**	**641**	**583**

Work initiated in FY 2005 for a transformational second generation superboiler is expected to continue through FY 2009 with a demonstration of a high efficiency industrial boiler at over 94 percent fuel-to-steam efficiency at 2 ppm NO_x and CO_2 emissions in FY 2009. Estimated potential energy savings from these activities in the year 2020 are almost 13 trillion Btus and carbon savings of 0.2 MMTCE.

	FY 2007	FY 2008	FY 2009
Sensors and Automation	**3,062**	**1,805**	**0**

In FY 2008, this key activity was scaled down to complete existing projects. Beginning in FY 2008, future sensors and automation projects will be undertaken under the crosscutting Energy-Intensive Process R&D activity which will enable ITP to shift toward broader research areas with higher impacts to improve the energy efficiency and environmental performance of energy-intensive industries. Activities in this area such as wireless real-time sensors systems will also be conducted through the Nanomanufacturing and Other Interagency Manufacturing R&D activity.

Industrial Technical Assistance

	FY 2007	FY 2008	FY 2009
▪ **Industrial Assessment Centers (IAC)**	**4,035**	**3,998**	**4,035**

The IAC activity funds a network of universities which send undergraduate and graduate engineering students out to small and medium-sized manufacturers, conducting free energy audits that identify a range of efficiency improvements, including no-cost and low-cost recommendations, providing assistance to U.S. manufacturers struggling to cope with high energy prices. This activity also supports the Administration's goal of training more engineers and scientists in the energy field. IAC alumni are very much in demand by top firms as energy managers with real-world knowledge and experience, ready to work on projects immediately and improve the bottom line.

(dollars in thousands)

Through the end of FY 2005, almost 14,000 audits have been completed, training over 2,300 students, with an estimated cumulative energy savings of almost 1.3 quadrillion Btus for actions actually implemented by the audited companies. An average of about 350 audits is expected to be conducted annually beginning in FY 2007. This activity is expected to yield energy savings of 135 trillion Btus in 2020 and carbon savings of 2 MMTCE.

	FY 2007	FY 2008	FY 2009
▪ **Best Practices**	**19,833**	**8,753**	**15,532**

The Save Energy Now initiative will partner with leading industrial companies, plants, and supply chains to reduce their energy intensity by 25% over a 10 year period as called for in EPACT 2005, Section 106 (reduce energy intensity by 2.5% per year from 2006 to 2016). Save Energy Now will support energy intensive plants and new emerging sectors [such as data centers] to implement cost-effective energy saving and carbon reducing technology solutions through the dissemination of energy assessments, tools, information, and training either directly or through state, utility and local partners. The program will continue to provide plant sites industrial process application tools relevant to major energy systems, such as, steam, pumping, process heating, and compressed air systems emphasizing system-level improvements. Building off the success of 450 completed Energy Savings Assessments (ESAs) in 2006 and 2007 which have identified over $600 million per year in potential energy cost savings, ITP will expand its partnership with leading corporations in energy management and will pilot a new voluntary ANSI-accredited standard to certify a manufacturing facility for energy efficiency through a third party verification process. As part of Save Energy Now, ITP will continue sending energy experts to the Nation's most energy-intensive manufacturing facilities to identify immediate opportunities for saving energy and money. Best Practices activities are estimated to result in energy savings in the year 2020 of 520 trillion BTUs and carbon savings of 7.7 MMTCE.

	FY 2007	FY 2008	FY 2009
Total, Industrial Technical Assistance	**23,868**	**12,751**	**19,567**
Energy-Intensive Process R&D	**0**	**7,186**	**14,846**

In FY 2008, ITP began to transition from predominantly industry-specific R&D to more crosscutting research. Using the convening power of government to form working groups for future industrial cooperation, this key activity will support multi-industry R&D in the four platform areas of: Waste Energy Minimization and Recovery (including high efficiency steam generation and combustion technologies and improved energy recovery technologies), Industrial Reaction and Separation (including oxidation processes and advanced water removal), High-Temperature Processing (including high efficiency calcining and next-generation steelmaking), and Sustainable Manufacturing (including near net shape casting and forming). This shift toward larger targets of energy savings opportunities will lead to the development of advanced, energy-efficient technologies to serve a broad set of industries, including those identified by the National Association of

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

Manufacturers such as the food & beverage, computer and electronic, and fabricated metal products, in the near- to mid-term time horizon (3-10 years). Estimated energy savings in the year 2020 are 328 trillion Btus and carbon savings of 4.8 MMTCE.

Fuel and Feedstock Flexibility	**0**	**2,805**	**3,889**

ITP will seek to displace industrial natural gas use through a targeted, deployment-focused technology development initiative that links industrial users with advanced fuel development activities taking place throughout DOE (e.g., EERE's Biomass Program, the Fossil Energy office, etc.) and the National Laboratories. This activity will assist industry to integrate alternative fuels into manufacturing processes, improving fuel flexibility to reduce the damaging effects of fossil fuel price hikes. Initial efforts will focus on technical analyses of advanced fuel and feedstock flexibility technology platforms and industrial process integration issues. The Fuel and Feedstock Flexibility effort will complete analysis to address the technical, economic, environmental, business, and infrastructure barriers to increase market adoption of emerging energy technologies for the industrial sector. Estimated energy savings in the year 2020 are 86 trillion Btus and carbon savings of 1.3 MMTCE.

Nanomanufacturing and Other Interagency Manufacturing R&D	**0**	**4,823**	**4,861**

The Nanomanufacturing and Other Interagency Manufacturing R&D activity will support the development of next-generation manufacturing processes to reduce the energy intensity of the U.S. manufacturing sector dramatically. A technology roadmap developed in a workshop conducted with industry, and in coordination with the Federal agencies participating in the White House Office of Science and Technology Policy's Interagency Working Group on Manufacturing R&D, will serve as a guide for the initial research focus. Potential for next generation manufacturing concepts will be evaluated, such as nanomanufacturing technology (one of the technology platforms identified in the U.S. Climate Change Technology Program Strategic Plan 2006). The initial work is expected to include development of technologies and techniques and processes needed for nanomanufacturing, enabling the mass production and application of nano-scale materials, structures, devices and systems to transform industrial processes that could provide energy savings and improve economic productivity. Estimated energy savings in the year 2020 are 107 trillion Btus and carbon savings of 1.6 MMTCE.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Industrial Distributed Energy	**0**	**14,467**	**1,498**

In FY 2008, Congress re-established a distributed generation activity within ITP, including CHP. The appropriations were concluded during the final stages of the Administration's deliberations on the proposed FY 2009 budget request, therefore full consideration of the new DG/CHP activity within the context of the FY 2009 request was not possible.

In FY 2009, in collaboration with industry, ITP would support the development and adoption of Industrial Distributed energy to include advanced reciprocating engine system research for clean, efficient and fuel-flexible DG/CHP systems for non-traditional CHP applications, such as untapped markets in the industrial sector, including food processing plants and the growing data center sector. ITP would also pursue the growth opportunity in traditional industry CHP applications below 20 MW, including medium-sized plants that require both power and process heat. Specific activities would include the development of alternative/dual fuel capability for turbines that meet the most stringent NO_x and CO regulations (e.g., those in southern California), development of thermal activities such as absorption cooling/refrigeration to address food processing and data center industry cooling needs, and innovative systems integration to optimize overall CHP system efficiency and reduce capital and O&M costs by 20-30%. Market transformation would be accomplished through a comprehensive public-private strategic partnership for CHP led by ITP, including expansion of the DOE CHP Regional Application Centers, more aggressive use of existing partnerships(and development of new state and local partnerships to address market, regulatory, and policy barriers. These activities are estimated to contribute as much as 11 trillion Btus of displaced energy and 0.2 MMTCE in carbon savings in 2020.

Energy-Efficient Information Technologies	**0**	**2,948**	**0**

ITP will continue to collaborate with the information technology industry to increase the energy efficiency of this emerging high growth industry to improve its energy footprint from chip making to data center application. .

SBIR/STTR	**0**	**1,020**	**829**

In FY 2007, the SBIR/STTR funds were transferred to the Science Appropriation for execution. The FY 2008 and 2009 amounts shown are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Industries of the Future (Crosscutting)	**39,178**	**53,163**	**50,727**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Industrial Materials of the Future	
The decrease reflect some nanotechnology Materials R&D efforts requiring process manufacturing scaleup will be completed under the Nanomanufacturing and Other Interagency Manufacturing R&D activity.	-63
Combustion	
This decrease reflects the completion of the development and preparation for demonstration of a transformational super boiler. Future combustion effort will be continued in the Energy Intensive Process (EIP) activity.	-58
Sensors and Automation	
This decrease reflects the completion of the transition of Sensors and Automation-specific research to broader crosscutting research and development undertaken under the crosscutting Energy-Intensive Process R&D activity.	-1,805
Industrial Technical Assistance	
▪ **Industrial Assessment Centers**	
No significant funding change.	+37
▪ **Best Practices**	
Increased funding will allow ITP to perform additional audits in the Save Energy Now (SEN) activity as well continued expansion of these audits at the corporation and supply chain levels.	+6,779
Energy Intensive Process R&D	
This increase reflects the second phase of the transitioning of Industry-Specific R&D toward higher-impact cross-industry activities.	+7,660
Fuel and Feedstock Flexibility	
After completion of the initial analysis to identify the technical, economic, environmental, business, and infrastructure barriers to increase market adoption of emerging flexible fuel energy technologies for the industrial sector, ITP will expand the deployment initiative linking industrial users with existing DOE activities in the field, as well as funding additional activities.	+1,084

Nanomanufacturing and Other Interagency Manufacturing R&D	
No significant funding changes.	+38
Industrial Distributed Energy	
With this funding, ITP will evaluate efforts initiated in FY 2008 and assess progress of the development of advanced reciprocating engines and energy efficient CHP systems for non-traditional applications, and address the significant growth opportunities in traditional applications below 20 MW (including medium-sized industrial plants).	-12,969
Energy-Efficient Information Technologies	
ITP will complete an evaluation of FY 2008 activities. No new efforts will be initiated.	-2,948
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-191
Total Funding Change, Industries of the Future (Crosscutting)	**-2,436**

Federal Energy Management Program

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments[a]	FY 2008 Current Appropriation	FY 2009 Request
Federal Energy Management Program					
Project Financing	8,509	8,685	-79	8,606	8,000
Technical Guidance and Assistance	6,519	8,228	-75	8,153	4,000
Planning, Reporting and Evaluation	2,473	3,087	-28	3,059	2,000
Departmental Energy Management	1,979	0	0	0	0
Federal Fleet	0	0	0	0	2,000
DOE Specific Investments	0	0	0	0	6,000
Total, Federal Energy Management Program	19,480	20,000	-182	19,818	22,000

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "DOE Organization Act" (1977)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The Federal Energy Management Program (FEMP) strives to enhance energy security, environmental stewardship and cost reduction within the Federal Government by advancing energy efficiency and water conservation; promoting the use of renewable energy, sustainable building design, and distributed energy resources; and improving utility management decisions at Federal facilities.

Accomplishing the mission will benefit both the supply and demand sides of the Department's energy security equation, enabling more productive use of the energy we consume and accelerating the arrival and use of the new fuels and technologies that we need.

[a] Reflects amounts rescinded by General Provision, section 312, of the Consolidated Omnibus Appropriations Act, 2008 (PL-110-161).

The Federal Government is the single largest energy consumer in the United States, proper stewardship of its energy usage is critical for its direct benefits to government and its leadership role. FEMP supports DOE's goal of improving energy security by improving the energy efficiency and sustainability of Federal Government buildings and by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy to Federal facilities and vehicle fleets. These activities fulfill several national energy and environmental priorities as outlined in the President's National Energy Policy (NEP) as well as the statutory requirements of the National Energy Conservation Policy Act (NECPA); Energy Policy Act of 1992 (EPACT); Energy Policy Act of 2005; Energy Independence and Security Act of 2007 (EISA); and provisions of Executive Order 13423. These policy measures call upon Federal agencies to reduce the energy intensity of their operations, increase the use of renewable energy, accelerate the protection and improvement of the environment, and increase our Nation's energy security. The Secretary's Transformational Energy Action Management (TEAM) initiative will establish DOE as a Federal agency leader in strengthening environmental, energy, and alternative fuels management. Because a core mission and responsibility of the Department of Energy is to lead the Nation in promoting and utilizing the best available energy management technologies and practices, binding agreements will be set up throughout DOE program offices that ensure that these offices will meet, exceed and lead in the implementation of Executive Order 13423 goals.

FEMP pursues its mission through integrated activities to improve the energy efficiency of, and renewable energy usage by, the Federal Government. The Department expects these improvements to reduce the energy intensity at Federal facilities, lower their energy bills and provide environmental benefits. Additionally, building energy efficiency technologies provide less easily quantifiable benefits, such as improved lighting quality and building occupant productivity. The benefits estimates reported exclude any expected acceleration in the deployment of the technologies that may result from "spillover" to state or local office buildings.

As of 2006 (the year with the latest available data), FEMP assisted Federal agencies in reducing energy intensity in Federal buildings by 6.4 percent compared to the EPACT 2005 baseline year of 2003. While there is a trend in reducing energy intensity over time, a great many factors combine to affect Federal agency energy consumption in any one year. While FEMP has had a significant effect on reducing Federal energy intensity throughout its program history, other factors such as new Federal building construction; military base closures and greater use of the existing building stock have contributed to this reduction as well. The Federal Fleet Program helps the Federal Government reduce on-road petroleum consumption in Federal vehicles.

Achievement of program goals could result in a reduction in net consumer expenditures of $2 billion by 2030 and nearly $35 billion by 2050. The program's economic, environmental and security benefits that are quantified as expected program outcomes are described in more detail under the "Expected Program Outcomes" sections.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Federal Energy Management Program directly supports the following goal:

Strategic Theme 1, Energy Security

Strategic Goal 1.4, Energy Productivity: Cost-effectively improve the energy efficiency of the U.S. economy.

And concurrently supports:

Strategic Goal 1.1, Energy Diversity: Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs; and Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

FEMP has one GPRA Unit Program goal which contributes to Strategic Goals 1.1, 1.2 and 1.4 in the "goal cascade":

GPRA Unit Program Goal 1.1.07.00: DEMP/FEMP - The Federal Energy Management Program goal is to provide assistance with project financing and technical assistance to Federal agencies to further the use of cost-effective energy efficiency and renewable energy. FEMP's activities enhance energy security, environmental stewardship and cost reduction within the Federal Government.

Contribution to GPRA Unit Program Goal 1.1.07.00 (DEMP/FEMP)

FEMP contributes to the Program Goal by assisting Federal agencies through alternative financing contract support, specific assistance to DOE sites, guidance on Federal vehicle fleet activities and reporting and evaluating agency progress each year. The program facilitates the award of alternative financing contracts between Federal agencies and the private sector to fund energy efficiency improvements through the use of dollar savings on Federal energy bills. FEMP provides technical assistance and other investments at DOE sites to further their attainment of the goals of EO 13423. In addition, FEMP reports to Congress on Federal energy efficiency, renewable electric power and agency compliance with relevant Executive order requirements.

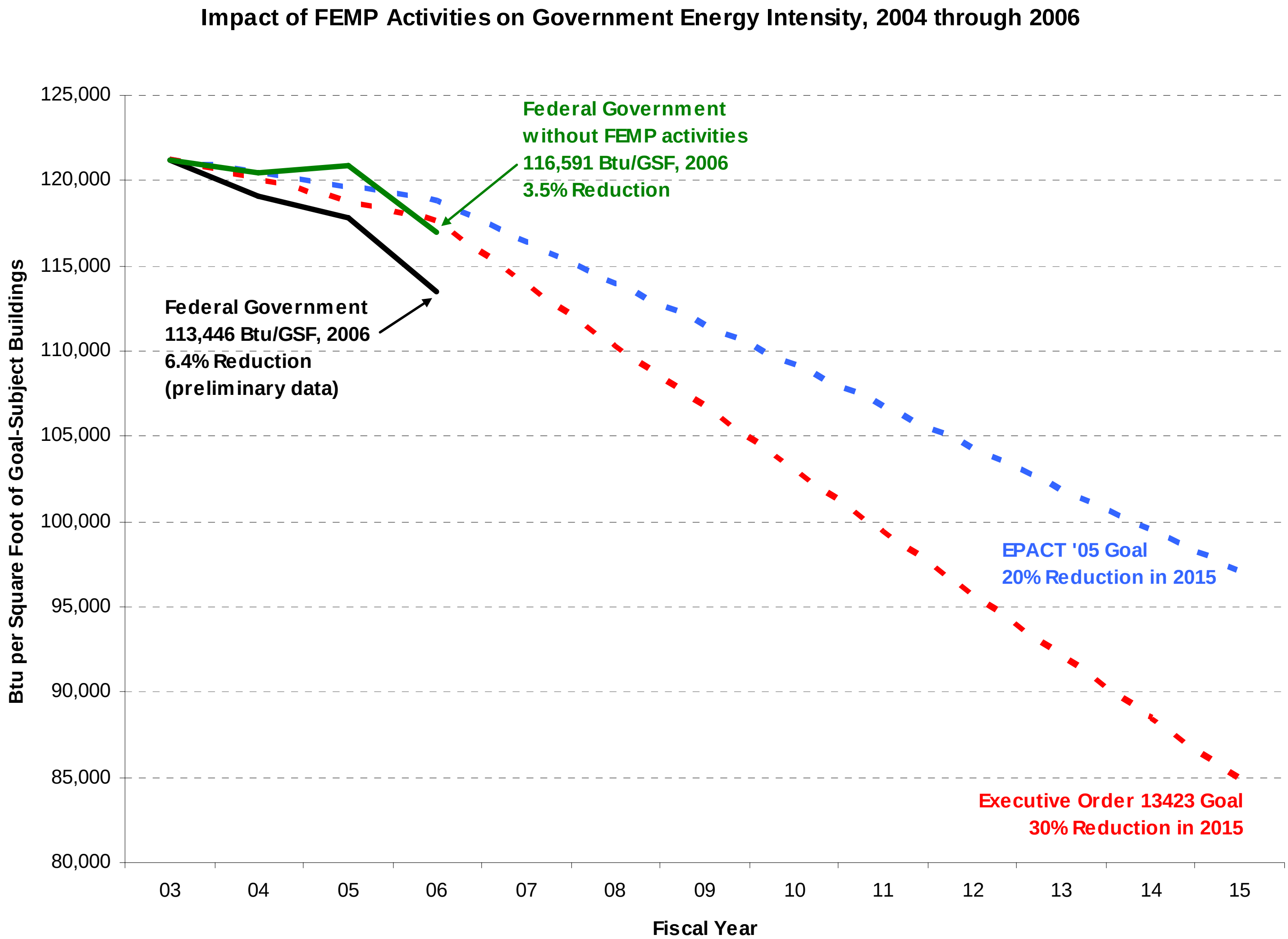
Success occurs when FEMP and its agency and private sector partners enable Federal energy managers to make better energy management choices that result in a more efficient, effective and energy secure government. In FY 2009, FEMP's goal is to complete Energy Savings Performance Contract (ESPC) and Utility Energy Service Contract (UESC) awards and provide assistance to DOE sites that will result in lifecycle Btu savings of 34.4 trillion. These savings should result in about a 1.3 percent annual reduction in energy intensity.

FEMP's assistance will help agencies reach the goals set by Executive Order and legislation. In addition to the FEMP-assisted efforts, agencies make additional energy savings investments without direct FEMP assistance and are expected to continue to do so. Federal agencies will need to make significant investments beyond the projects assisted by FEMP to meet the goals set forth by the Energy Policy Act of 2005 and Executive Order 13423, and EISA. Current government-wide goals include:

- Ensure that at least 3 percent of Federal electricity consumption be generated from renewable sources in the years FY 2007 through FY 2009; 5 percent in the years FY 2010 through FY 2012; and 7.5 percent in FY 2013 and each fiscal year there after.

- Improve energy efficiency and reduce greenhouse gas emissions of the agency, through reduction of energy intensity by 3 percent annually through the end of fiscal year 2015, or 30 percent by the end of fiscal year 2015, relative to the baseline of the agency's energy use in fiscal year 2003;
- Ensure that at least half of the statutorily required renewable energy consumed by the agency in a fiscal year comes from new renewable sources, and to the extent feasible, the agency implements renewable energy generation projects on agency property for agency use; and
- Ensure that, if the agency operates a fleet of at least 20 motor vehicles, the agency, relative to agency baselines for fiscal year 2005, (i) reduces the fleet's total consumption of petroleum products by 2 percent annually through the end of fiscal year 2015, (ii) increases the total fuel consumption that is non-petroleum-based by 10 percent annually, and (iii) uses plug-in hybrid (PIH) vehicles when PIH vehicles are commercially available at a cost reasonably comparable, on the basis of life-cycle cost, to non-PIH vehicles.

Building Energy Intensity



In addition to lifecycle energy savings, another performance measure for FEMP set forth in the Program Assessment Rating Tool (PART) effort was the use of new (since 1999) renewable energy sources as a percentage of Federal facility electricity use. The table below shows the targets and actual values.

(Renewable Energy Sources as a percentage of Federal facility electricity use)

	Historic						Planned		
	2000	2001	2002	2003	2004	2005	2007	2010	2013
Target	Baseline	0.83%	1.25%	1.67%	2.08%	2.50%	3.0%	5.0%	7.0%
Actual	0.15%	0.26%	0.53%	1.60%	2.78%	6.93%	-	-	-

However, these renewable energy targets were revised, because of the Energy Policy Act of 2005. The following new targets have been established:

(Renewable Energy Sources as a percentage of Federal facility electricity use)

	Planned						
	2007	2008	2009	2010	2011	2012	2013
Target	3.0%	3.0%	3.0%	5.0%	5.0%	5.0%	7.5%
Actual	-	-	-	-	-	-	-

Executive Order 13423 placed additional emphasis on new sources so that at least half of the statutorily required renewable energy consumed by the agency in a fiscal year comes from new renewable sources.

Another performance measure for FEMP set forth in the Program Assessment Rating Tool (PART) effort was the percent reduction of energy use per gross square foot in Federal standard buildings.

(Reduction of energy use per gross square foot in Federal standard buildings)

	Historic				Planned
	1985	1995	2000	2005	2010
Target	Baseline	10.0%	20.0%	30.0%	35.0%
Actual	0%	14.9%	23.7%	29.6%	-

These goals were revised in January 2007 with the signing of Executive Order 13423 which set forth the following energy intensity goals for standard and energy intensive buildings.

(Reduction of energy use per gross square foot in Federal standard and energy intensive buildings)

	Historic		Planned		
	2003	2006	2007	2010	2015
Target	Baseline	3.0%	6.0%	15.0%	30.0%
Actual	0%	6.4%	-	-	-

Furthermore, to establish the Department of Energy as a leader in the implementation of Executive Order 13423, the Secretary of Energy established the Transformational Energy Action Management (TEAM) initiative which includes the following key features for DOE facilities and vehicle fleets:

- DOE will have executable plans in place by FY 2008 to achieve no less than 30 percent energy and 16 percent water reductions before 2015;
- DOE will have executable renewable energy agreements in place by the end of FY 2008 at as many sites as needed for on-site renewable energy to meet the Executive Order renewable energy consumption goal of 7.5 percent before the 2013 deadline; and
- DOE will have executable plans in place by the end of FY 2008 to ensure that every alternative fuel vehicle in the DOE fleet will be run on alternative fuels;

Executive Order 13123 set a goal for all Federal agencies to use renewable energy for 2.5 percent of electricity consumption in FY 2005. EPACT 2005 and Executive Order 13423 set a goal for the use of renewable energy to be 3.0 percent in FY 2007. In FY 2005, renewable energy (including purchased renewable energy credits) accounted for 6.9 percent of Federal facility electricity consumption. The Federal Government as a whole exceeded the FEMP goal, although some individual agencies did not. In FY 2006, renewable energy (including purchased renewable energy credits) accounted for 6.9 percent of Federal facility electricity consumption. There was no goal for renewable use in FY 2006, and FY 2007 data is not yet available.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.4, Energy Productivity			
GPRA Unit Program Goal 1.1.07.00, DEMP/FEMP			
Project Financing	8,509	8,606	8,000
Technical Guidance and Assistance	6,519	8,153	4,000
Planning Reporting and Evaluation	2,473	3,059	2,000
Departmental Energy Management	1,979	0	0
Federal Fleet	0	0	2,000
DOE Specific Investments	0	0	6,000
Total, GPRA Unit Program Goal 1.1.07.00 , DEMP/FEMP	19,480	19,818	22,000
Total, Strategic Goal 1.4 (Federal Energy Management Program)	19,480	19,818	22,000

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.4.07.00 (/FEMP)					
Project Financing/Technical Guidance and Assistance/Departmental Energy Management					
			Complete ESPC and UESC contract awards, fund DOE retrofit projects and provide technical assistance that will result in lifecycle Btu savings of 17.1 trillion. [MET]	Estimated lifecycle energy savings expected in Federal agencies' facilities as a result of FEMP activities are 20.2 trillion Btus (TBtu). FEMP's facilitation activities include alternative financing, technical assistance, and directly funded energy efficiency projects within the Department. These savings should result in about a 0.4 percent annual reduction in energy intensity.	Estimated lifecycle energy savings expected in Federal agencies' facilities as a result of FEMP activities are 34.4 trillion Btus (TBtu). FEMP's facilitation activities include alternative financing, technical assistance, and directly funded energy efficiency projects within the Department. These savings should result in about a 1.3 percent annual reduction in energy intensity.
Project Financing					
Achieve between $35 and $55 million in private sector investment through Super ESPCs, contributing to National energy security. [NOT MET: Program not authorized]	Will achieve between $80 and $120 million in private sector investment through Super ESPCs which will result in about a 0.2 percent annual reduction in energy intensity. These projects are cost-effective resulting in a positive net present value gain for the tax payer. [NOT MET. MET reduced goal of $60 million -- $73 million in private sector investment].	Will achieve between $80 and $120 million in private sector investment through Super ESPCs and/or UESCs which we expect to result in about a 0.2 percent annual reduction in energy intensity. These projects are cost-effective resulting in a positive net present value gain for the tax payer. [MET]			
Technical Guidance and Assistance					

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Provide technical and design assistance for 60 energy efficiency, renewable energy, Operations and Management (O&M), distributed Energy Resource (DER)/Combined Heat and Power (CHP), and water conservation projects. [MET: 66 energy efficiency and renewable projects]	Will provide technical and design assistance for 60 Federal projects which include energy efficiency, renewable energy, O&M, Distributed Energy Resources, Combined Heat and Power, SAVEnergy Audits, ALERTS and water conservation projects. These projects are cost-effective, because the technologies applied have been shown to be cost-effective by the supporting EERE programs. [MET: 73 energy efficiency and renewable projects]	Provide technical and design assistance for 27 Federal projects (e.g., energy efficiency, renewable energy, Operations and Maintenance, Distributed Energy Resources, Combined Heat and Power, Assessment of Load and Energy Reduction Techniques (ALERTS) and water conservation projects) which are expected to result in energy savings of about 60 billion Btus. [MET]			
Train 4,000 Federal energy attendees in energy management best practices supporting National Energy Policy education goals. [MET: 4,450 personnel trained]	Train 4,000 Federal energy attendees in energy management best practices supporting National Energy Policy education goals. [MET: 4844 personnel trained]				
Departmental Energy Management					
Complete the selection for funding of 4 to13 energy efficiency projects through a competitive selection process that chooses those projects with the greatest return on investment. [MET: 11 projects selected for a reduction of 35 billion Btus.]	Complete the selection for funding of 4 to 13 energy efficiency projects through a competitive selection process that chooses those projects with the greatest return on investment. [MET: 13 projects selected.]	Complete the selection for funding of 3 energy retrofit projects that will provide the required dollar savings to achieve a 20 percent return on the investment of the DEMP funding. These projects will save over 12 billion Btus per year. [MET]			
Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing annual program uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funds.]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the FEMP/DEMP Program FY 2004 end of year adjusted uncosted baseline ($11,266K) until the target range is met. [NOT MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.

Means and Strategies

In order to establish leadership in the Federal Government, the Secretary has set forth the Transformational Energy Action Management (TEAM) Initiative whereby the Department will meet or exceed the goals for energy efficiency, renewable energy and water usage established in Executive Order 13423.

The Office of Science and other offices in DOE will be establishing binding agreements that ensure the agency will meet, exceed and lead in the implementation of the following goals:

- Increased Energy Efficiency
- Renewable Energy Generation and Use
- Petroleum Reduction/Alternative Fuel Use (vehicle fleets)
- Sustainable Building Standards
- Water Conservation
- Sustainable Environmental Practices in Acquisitions
- Reduction in Toxic and Hazardous Material Use/Solid Waste Diversion/Recycling
- Electronics Stewardship – purchase of highly efficient FEMP-designated products.

In addition, FEMP will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources and information, and "strategies" include program, policy, management and legislative initiatives. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

FEMP helps Federal agencies take advantage of energy management opportunities in building construction, renovation, retrofit, operations and maintenance; energy consuming product and equipment procurement; and utility service acquisition and utility load management.

These activities support the Secretary's Transformational Energy Action Management (TEAM) initiative which will establish DOE as the as the Federal agency leader in strengthening environmental, energy, and transportation management. Because a core mission and responsibility of the Department of Energy is to lead the Nation in promoting and utilizing the best available energy management technologies and practices, binding agreements will be set up throughout the program offices that ensure that DOE will meet, exceed and lead in the implementation of EO 13423 goals. FEMP efforts will include establishing an alternative fuel infrastructure for DOE vehicle fleets and furthering deployment of advanced energy efficiency, renewable energy and water technologies.

FEMP will implement the following means:

- Developing policy and guidance to achieve Executive Order and legislative requirements;
- Providing energy savings performance contracting mechanisms and oversight for the Federal sites;
- Evaluating the potential of new, innovative technologies for use in the Federal sector;
- Reporting progress with respect to energy conservation at the Federal agencies;

- Providing oversight and approval of DOE utility contracts and support utility rate interventions;
- Providing analysis and reporting on Federal vehicle fleet management activities to identify issues and problem areas that present challenges. FEMP works with agencies to develop strategies for addressing those issues and shares the lessons learned with other vehicle fleets;
- Establishing an alternative fuel infrastructure for DOE vehicle fleets and furthering deployment of advanced energy efficiency, renewable energy and water technologies; and
- Supporting the TEAM initiative, by identifying and assessing DOE sites based on greatest opportunities for energy and water reduction.

FEMP will implement the following strategies:

- As part of the Secretary's Transformational Energy Action Management (TEAM) initiative, DOE will lead the Nation in promoting and utilizing the best available energy management technologies and practices through binding agreements that will be set up throughout the program offices that ensure that DOE will meet, exceed and lead in the implementation of EO 13423 goals.
- Identify high impact opportunities across Federal agencies for energy efficiency improvements and to increase the use of renewable energy;
- Identify opportunities for widespread use of energy efficient and renewable energy technologies in the Federal sector and deploy these technologies through coordinated procurement, alternative financing, or other means; and
- Recommend strategies for improved energy security for critical needs at Federal facilities.

These strategies will result in significant cost and energy savings and improved energy security at Federal facilities.

The following external factors could affect FEMP's ability to achieve its strategic goal:

- Mission changes at Federal sites that would change building usage;
- Availability of energy management personnel at Federal sites; and
- Energy price increases that could help focus attention on energy conservation.

The following collaborations help FEMP achieve its goals:

- FEMP collaborates with agency leadership, energy and facility managers from other Federal agencies and state and industry partners to identify key opportunities for enhancing energy efficiency and the use of renewable energy at Federal facilities; and
- FEMP helps DOE program offices develop energy performance plans with their respective "landlord" sites in order to achieve energy management goals and measure progress.

Validation and Verification

To validate and verify programs, FEMP conducts ongoing internal reviews of its program activities each year. In addition, external peer reviews are conducted. FEMP provides a report to Congress every year on the progress of Federal agencies on reaching their energy efficiency and renewable energy goals.

Data Sources: Agencies submit annual reports to the Department of Energy documenting energy use in buildings, cost, gross square footage and exempt facilities and FEMP compiles this information in a report to Congress each year. For the Federal vehicle fleet activity, agencies enter fleet and fuel use data into the Federal Automotive Statistical Tool (FAST) database.

Baselines: The baseline for the energy efficiency goal for Federal facilities of the Energy Policy Act of 2005, the Executive Order 13423 and the TEAM initiative is the FY 2003 energy intensity of standard and energy intensive Federal buildings – 121,227 Btu per square foot. As established by Executive Order 13423 (which also applies to the TEAM initiative), the baseline for the Federal vehicle fleet was the amount of Federal petroleum usage in 2005 – 420 million gallons of gasoline equivalent.

Frequency: Annual.

Evaluation: In carrying out the program's mission, the Federal Energy Management Program uses several forms of evaluation to assess progress and to promote program improvement:

- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal program reviews.
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); PMA (the President's Management Agenda – annual departmental and Program Secretarial Officer (PSO) based goals whose milestones are planned, reported and reviewed quarterly); and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage: FEMP maintains a database of reported information. Agencies maintain their own, more detailed data.

Verification: External audits are conducted each year. Reporting anomalies are identified and resolved during the annual reporting cycle.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The Federal Energy Management Program participated in its first PART review in 2005. This PART review included ratings of 100 percent for program purpose, 100 percent for planning, 86 percent for management and 50 percent for program results and accountability with an overall rating of "Moderately Effective." These ratings reflect the commitment of EERE program management to the basic management and planning principles of the President's Management Agenda, including the criteria scored in the PART and the implementation of the EERE reorganization employing those principles. In response to the PART findings and recommendations, FEMP has taken action to ensure that responsibility for planning and strategy development is assigned to program staff with a reduced dependence on contractors for these activities. In addition, action has been taken to make sure that measures that the program uses internally to assess performance of its various activities are consistent with program's long-term and annual measures.

Expected Program Outcomes

FEMP pursues its mission through integrated activities to improve the energy efficiency (including water efficiency) of, and renewable energy usage by, the Federal Government. We expect these improvements to reduce the energy and water intensity at Federal facilities, lower their energy bills and provide environmental benefits. Additionally, building energy and water efficiency technologies provide less easily quantifiable benefits, such as improved lighting quality and building occupant productivity. The benefits estimates reported exclude any expected acceleration in the deployment of the technologies that may result from "spillover" to state or local office buildings.

Program analysis of benefits was conducted by EERE and resulted in the following estimates for security and economic benefits from 2009 through 2050 that would result from realization of the program's goals.

EERE's FEMP Program Goal Case reflects the program's continuance over time, and the gradual penetration of efficiency measures throughout Federal buildings.

The goals are modeled in contrast to the "baseline" case, in which no DOE R&D or deployment programs exist. The baseline case is identical to those used for all DOE applied energy R&D programs.[a] Further, across EERE, and across all of DOE's applied energy R&D programs, the expected outcome benefits are being calculated using the same fundamental methodology. Finally, the metrics by which

[a] The starting point for the baseline case is the Energy Information Administration's "reference case," as published in the AEO 2007. Program analysts from across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO's technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

expected outcome benefits are measured are identical for all of DOE's applied energy R&D programs.[a] This standardization of methods and metrics has been undertaken as part of the Department's efforts to respond OMB's request to make all programs' outcomes comparable.

The difference between the baseline case and the program goal case results in economic, environmental and security benefits. For example, achievement of program goals results in a reduction in cumulative net consumer expenditures of $2 billion by 2030 and nearly $35 billion by 2050. Finally, the program would also result in carbon emissions reductions of more than 25 metrics tons (MMTCE) by 2030 and nearly 100 MMTCE by 2050. The results are generated by modeling the program goals within two energy-economy models: NEMS-GPRA09 for benefits through 2030, and MARKAL-GPRA09 for benefits through 2050.[b] The full list of modeled benefits is provided below.

In addition to the benefits quantified, improved Federal energy management increases the ability of the Federal Government to manage its energy loads during emergencies and facilitates coordination of Federal energy use with local authorities in the event of local energy supply constraints or emergencies.

The EPACT 2005 goal calls for a 2 percent reduction in Federal building energy intensity each year between 2006 through 2015 measured against a 2003 baseline. The Executive Order 13423 goal calls for a 3 percent reduction in Federal building intensity each year between 2006 and 2015 measured against the same baseline. The following figure shows the goals from EPACT 2005 and the Executive Order along with the actual energy intensity over time for Federal agencies for standard buildings since 2003. More information regarding these goals can be found on FEMP's website: www.eere.energy.gov/femp.

[a] The set of expected outcome metrics being used this year differs in substantial ways to that of most previous years. In addition to the standardization across DOE's applied energy R&D programs, the list is expanded and more comprehensive than in past years. Further, the list maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

[b] Documentation on the analysis and modeling, including all of the methodologies and underlying assumptions is posted on the web at http://www.eere.energy.gov/ba/pba/gpra.html.

Primary Benefits Metrics for FY09 NEMS and MARKAL

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.1
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	NA	NA	NA	N/A
		MARKAL	ns	ns	ns	0.1
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	5	13	27	N/A
		MARKAL	6	16	49	99
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	0	1	2	N/A
		MARKAL	3	7	18	34
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	0	1	3	N/A
		MARKAL	ns	2	4	8
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns

1. “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Project Financing

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Project Financing	8,509	8,606	8,000
Total, Project Financing	8,509	8,606	8,000

Description

FEMP developed its alternative financing effort to help Federal agencies access private sector financing to fund needed energy improvements. It provides guidance, documentation and individual project assistance to Federal agencies which utilize Energy Savings Performance Contracts (ESPCs), public benefit funds, and Utility Energy Service Contracts (UESCs) to finance energy saving improvements. This financing pays for energy improvements at Federal facilities that are in need of significant energy system retrofits. Projects include energy improvements of all types, such as lighting upgrades, new heating and ventilation systems, and improved control systems.

These third party funding mechanisms for energy efficiency and renewable energy projects have and will continue to improve the energy efficiency of Federal facilities. These projects reduce the energy bills of Federal facilities and are implemented with little or no upfront cost to the government. By providing a means for Federal agencies to utilize renewable energy and energy efficiency technologies, these financing mechanisms help reduce the emissions associated with power usage at Federal facilities and promotes the use of clean alternatives to conventional technologies.

FEMP has set a target to facilitate energy investments through project financing that will result in lifecycle Btu savings of 20.0 trillion from FEMP project financing activities in FY 2009. This savings is equivalent to displacing the energy use of about 14,000 households over the lifetime of the investment.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Project Financing	**8,509**	**8,606**	**8,000**

Federal agency use of ESPCs was authorized by Congress to provide an alternative to direct appropriations for the funding of energy-efficient improvements in Federal facilities. Under the ESPC legislation, agencies can take advantage of private sector financing and expertise with little or no upfront cost to the Government. The Government pays back the industry — including interest at private sector rates — through energy cost savings over the life of the projects. ESPC and UESC projects will continue in the areas of energy-efficient improvements, renewable energy technologies, alternative fuel (biomass/landfill), combined heat and power, and reduced water consumption

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

technologies.

The Department of Energy is responsible for ESPC oversight and reporting, and management of a government-wide multiple award contract available to all Federal agencies. FEMP will continue to make improvements in the areas of project facilitation, financing, training, reporting and competition. Project facilitators will continue to provide ESPC and UESC assistance including identifying and screening projects, preparing delivery orders and evaluating proposals. They will provide technical and contracting expertise for issues such as interest rates, competitive financing, and utility rates to support the negotiation process. National Laboratory expertise will continue to be utilized in FY 2009.

Reporting and monitoring of contract performance will continue to ensure data integrity and provide the Federal Government with improved means of quantifying benefits. This will include activities in measurement and verification methodologies and practices related to monitoring ESPCs and UESCs performance. Outreach activities for project financing will be conducted.

Analytical activities will continue in support of reporting requirements for project metrics, milestones and program plans to implement improvements in the ESPC and UESC activities.

Activities supporting the use of state-provided public benefit funds for Federal facilities will continue. Specifically, a website will identify the public benefits funds available for Federal sites.

Project facilitation provided for the ESPC and UESC projects is expected to result in Federal agency reimbursements of about $1,100,000 in FY 2009. Reimbursements are projected to be $1,000,000 in FY 2007 and $1,300,000 in FY 2008. In FY 2009, these funds will be used for technical and financial analyses by project facilitators, the marketing of ESPC projects through alternative financing representatives, Federal employee travel, contractor support, funding a contingency account to reimburse Federal agencies for fees collected on projects that were terminated, and other third party financing activities.

Total, Project Financing	**8,509**	**8,606**	**8,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Project Financing	
The Project Financing activities will be streamlined, because the revisions necessary for guidance, outreach and training for the new ESPC contract will be completed in FY 2008.	-606
Total Funding Change, Project Financing	**-606**

Technical Guidance and Assistance

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Technical Guidance and Assistance			
Direct Technical Assistance	6,519	8,153	4,000
Total, Technical Guidance and Assistance	6,519	8,153	4,000

Description

Technical Guidance and Assistance helps Federal agencies take advantage of innovative technologies, tools, and best practices. FEMP assists Federal energy managers in their efforts to identify, design, and implement new construction and facility improvement projects. FEMP provides unbiased, expert technical assistance in areas such as audits for buildings and new technology deployment, including combined heat and power and distributed energy technologies. FEMP also provides analytic software tools to help agencies choose the most effective energy and water project investments. In addition, FEMP helps agencies acquire the most energy efficient and water conserving products by continuing to update its specifications for highly energy efficient products and providing them to the General Services Administration and Defense Logistics Agency as required by the "federal purchase requirement" set forth in the Energy Policy Act of 2005.

Technical Guidance and Assistance supported FEMP's mission by helping agencies implement projects and practices that reduce energy bills, improve air quality, and promote the use of water conservation, energy efficiency and renewable energy. FEMP's direct project assistance provided the information and means that agencies need to determine cost-saving and energy-saving practices appropriate to their needs as they design new buildings and renovate existing ones. FEMP's technical assistance on energy efficiency and renewable technologies results in accelerated acceptance of these technologies in the Federal sector.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Direct Technical Assistance	**6,519**	**8,153**	**4,000**

FEMP's technical assistance activities support cost-effective investments in energy efficiency and renewable energy technologies. Direct technical assistance provides analytical support and expert assistance to Federal agencies. National Laboratory technical assistance will be utilized in areas where competitively selected private sector experts are not available and to provide unbiased technical review.

Activities will include lighting and renewable energy and Combined Heat and Power (CHP) technologies for energy security, and analytical review of new technologies assess the technical potential for replication in the Federal sector, energy savings potential and cost. Federal Technology Alerts, and web-based technical case studies and guidance documents, which provide summary information on candidate energy-saving technologies will continue to be developed. The Energy Policy Act of 2005 establishes that FEMP is responsible for carrying out a number of activities, including developing product specifications and issuing regulations on vehicle fleets, on metering, new construction, and other energy-related building topics. FEMP will continue to update its specifications for highly energy efficient products and provide them to the General Services Administration and Defense Logistics Agency as required by the Federal purchase requirement set forth in the Energy Policy Act of 2005. Program-specific technical training and information will continue on a limited basis and will rely primarily on web-based training where appropriate.

Total, Technical Guidance and Assistance	**6,519**	**8,153**	**4,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Technical Guidance and Assistance	
In order to fund the high priority activities in DOE Specific Investments, funding for design assistance projects will be reduced and the employment of Energy Efficiency Expert Evaluation teams will be scaled back.	-4,153
Total Funding Change, Technical Guidance and Assistance	**-4,153**

Planning, Reporting and Evaluation

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Planning, Reporting and Evaluation	2,473	3,059	2,000
Total, Planning, Reporting and Evaluation	2,473	3,059	2,000

Description

The Energy Policy Act of 2005 and Executive Order 13423 require the Department to collect, verify and report on progress by the Federal agencies (including the Department of Energy) toward the goals that address energy efficiency in facilities that includes standard buildings, industrial and commercial space, petroleum reduction and water conservation. FEMP will collect and publish data for the Annual Report to Congress and respond to inquiries to help ensure accuracy in reporting and analysis of trends.

Through planning, reporting and evaluation, FEMP meets the reporting requirements set forth by Congress and Executive Order. Tracking, reporting and evaluating are necessary to assess the effectiveness of the government's efforts achieve the greatest possible reductions in energy costs, improvements in air quality, and promotion of water conservation, energy efficiency and renewable energy technologies.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Planning, Reporting and Evaluation	**2,473**	**3,059**	**2,000**

The Energy Policy Act of 2005, Executive Order 13423 and the National Energy Conservation Policy Act require the Department of Energy (DOE) to collect, verify and report to Congress on the progress by the Federal agencies, including DOE, toward the Federal facility energy management goals of reducing energy intensity in buildings, reducing petroleum usage and conservation of water. Data collection, verification and reporting continue to be centralized for the Federal agencies at FEMP with the assistance of technical experts for preparing analysis and verification of data. This also includes maintaining the Department of Energy's facilities information and developing annual plans and

reports. Information will be made available on Federal progress toward the legislative and Executive Order goals on the FEMP website and technical updates to web-based materials will continue for the

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

Federal sector.

Technical analysis will continue as required to respond to analytical reporting requirements involved with the Government Performance and Results Act (GPRA), the Program Assessment and Rating Tool (PART), multi-year planning and peer reviews. Program assistance will continue in preparing and updating the Federal sector plans for meeting the legislative and Executive Order goals as well as recognizing progress through Presidential and Federal awards program.

The Federal Energy Management Advisory Committee (FEMAC) will not be funded in FY 2009. FEMAC was established in October 2000 to provide the Department of Energy with input from Federal and non-Federal sources on a range of issues critical to meeting Federal energy management goals set by Executive Order 13123. This authority for this committee was not included in the new Executive Order 13423 which superceded EO 13123 in January 2007. A new advisory group has been established through EO 13423 which includes only Federal employees and is headed by the Chairman of the Council for Environmental Quality. FEMP is not responsible for funding and coordinating this committee.

Total, Planning, Reporting and Evaluation	**2,473**	**3,059**	**2,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Planning, Reporting and Evaluation	
Reduced funding reflects the transfer of Federal vehicle fleet tracking and reporting activities to the Federal Fleet line item and the redirection of some outreach activities to Project Financing.	-1,059
Total Funding Change, Planning, Reporting and Evaluation	**-1,059**

Departmental Energy Management

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Departmental Energy Management			
Energy Management Project Support	1,979	0	0
Total, Departmental Energy Management	1,979	0	0

Description

In previous years, the Departmental Energy Management Program provided direct funding and leveraged cost sharing for energy retrofit projects and new energy technologies at DOE facilities to increase the energy efficiency of DOE facilities and reduce future utility and maintenance costs. However, DOE government-owned contractor operated (GOCO sites) spend a significant amount of indirect funds for energy efficiency and renewable energy projects and will continue to do so. Therefore, in FY 2008, this activity was closed out, but policy, oversight, coordination and reporting continues within other activities of FEMP.

DOE has already achieved the Executive Order 13123 goal for 2010 to reduce the energy intensity in its standard buildings. The baseline (1985) energy intensity in standard buildings was 473,126 Btu per square foot, whereas the energy intensity in 2005 was 224,043 Btu per square foot, showing a 53 percent reduction in energy intensity in that time period. New aggressive goals for DOE are found in Executive Order 13423 and DOE's Transformational Energy Action Management (TEAM) initiative. FEMP will provide assistance in meeting these goals through funding in the DOE Specific Investments, and collect funding information on all energy efficiency projects and activities at DOE facilities and laboratories. FEMP will also provide guidelines on what investments, or the parts thereof, can be classified and reported as energy efficiency investments.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Energy Management Project Support	**1,979**	**0**	**0**

Prior to FY 2008, DEMP provided support through direct funding and leveraged cost-sharing at various DOE facilities for energy projects to increase the energy efficiency of DOE facilities and reduce future utility and maintenance costs. DOE government-owned contractor operated (GOCO sites) spend a significant amount of indirect funds for energy efficiency and renewable energy projects and will continue to do so.

	FY 2007	FY 2008	FY 2009
Total, Departmental Energy Management	**1,979**	**0**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Departmental Energy Management	
No change.	0
Total Funding Change, Departmental Energy Management	**0**

Federal Fleet

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Federal Fleet	0	0	2,000
Total, Federal Fleet	0	0	2,000

Description

Federal vehicle fleet activities will include the required tracking and reporting activities for the Federal fleet that were previously covered under Planning, Reporting and Evaluation. Additional activities include the promotion of the increased use of alternative fuel for Federal Agency sites. Federal vehicle fleet activities support the integration of buildings, electricity and electric vehicles (EV) or plug-in hybrid electric vehicles (PHEVs). FEMP will demonstrate opportunities for increased petroleum displacement to increase alternative fuel use and its fueling infrastructure.

These activities will support private sector development of alternative fuel stations at Federal sites and demonstrate opportunities for petroleum displacement to increase alternative fuel use and its fueling infrastructure. FEMP will continue reporting and analysis for the Federal vehicle fleet activities and implementation of compliance measures in each agency's vehicle fleet activity in support of the Energy Policy Acts of 1992 and 2005, and Executive Order 13423. The Federal vehicle fleet activities provide guidance and support to each agency toward compliance with legislative and Executive Order requirements to reduce dependence on foreign sources of oil. These activities support the Bioenergy Initiative.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Federal Fleets	**0**	**0**	**2,000**

Activities will include aggregating alternative fuel vehicles (AFVs) to support private sector development of alternative fuel (AF) stations and demonstrating the potential for integration of buildings, electricity and electric vehicles (EV) or plug-in hybrid electric vehicles (PHEVs). FEMP will demonstrate opportunities for increased petroleum displacement to increase alternative fuel and its fueling infrastructure, use of electric vehicles, use of geographic analysis for maximization of use, and will look specifically at issues related to use of renewable electricity generation, utility integration, time-of-day charging, and potential impacts on Federal facilities. These activities will support the Bioenergy Initiative and contribute to the Presidential goal of reducing gasoline consumption by 20 percent in 10 years through efficiency and alternative fuels.

	FY 2007	FY 2008	FY 2009
(dollars in thousands)			

FEMP will develop a comprehensive program to assess opportunities for increased petroleum displacement including innovative strategies to increase alternative fuel and its fueling infrastructure, neighborhood electric vehicles and other EVs, resolution of institutional and policy barriers, and use of geographic analysis for maximization of use.

In activities previously covered under Planning, Reporting and Evaluation, FEMP will continue reporting and analysis for the Federal vehicle fleet activities and to implement compliance measures in each agency's fleet activity in support of the Energy Policy Acts of 1992 and 2005, and Executive Order 13423. The Federal vehicle fleet activities provide guidance and support to each agency toward compliance with legislative and Executive Order requirements to reduce dependence on foreign sources of oil.

	FY 2007	FY 2008	FY 2009
Total, Federal Fleets	**0**	**0**	**2,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Federal Fleet	
This funding will allow FEMP to support private sector development of alternative fuel stations at Federal sites; demonstrate opportunities for petroleum displacement to increase alternative fuel use; and conduct reporting and analysis of the Federal vehicle fleet.	+2,000
Total Funding Change, Federal Fleet	**+2,000**

DOE Specific Investments

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
DOE Specific Investments	0	0	6,000
Total, DOE Specific Investments	0	0	6,000

Description

DOE Specific Investments includes activities designed to implement the Energy Policy Act of 2005, EISA and Executive Order 13423 at DOE sites. These activities support the Secretary's Transformational Energy Action Management (TEAM) initiative which will establish DOE as the as the Federal agency leader in strengthening environmental, energy, and transportation management. Because a core mission and responsibility of the Department of Energy is to lead the Nation in promoting and utilizing the best available energy management technologies and practices, binding agreements will be set up throughout the program offices that ensure that agencies will meet, exceed and lead in the implementation of EO 13423 goals. FEMP efforts will include establishing an alternative fuel infrastructure for DOE vehicle fleets and furthering deployment of advanced energy efficiency, renewable energy and water technologies. As DOE makes progress toward meeting its own goals, it will broaden its efforts to enable other Federal Agencies meet the goals of EO 13423 by employing lessons learned from DOE’s experience.

These activities support the goal of Executive Order 13423, which calls for a reduction of energy intensity by 30 percent by the end of fiscal year 2015. The activities also further the Department of Energy's strategic goal of energy security by increasing the energy productivity and energy diversity and reducing the environmental impacts of energy use at the Department of Energy.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
DOE Specific Investments	**0**	**0**	**6,000**

Activities include establishing alternative fuels infrastructure for DOE vehicle fleets; establishing incentive awards; training DOE senior management and staff on Secretarial initiative, Executive Order and EPACT 2005 and EISA compliance; establishing sustainable principles; identifying and deploying energy efficiency, water and renewable energy technologies; providing information and outreach; assisting with development and implementation of site energy and water plans; supporting ESPC and UESC projects, training, renewable power purchase agreements, project development and

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

implementation assistance; and supporting deployment of smart meters on all DOE buildings.

FEMP will provide assistance to other DOE offices to support the use of third party financing, maximize direct purchases which facilitate new renewable energy projects, maximize use of DOE land for new renewable energy projects and incorporate renewable technologies into new construction where feasible.

Total, DOE Specific Investments	**0**	**0**	**6,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
DOE Specific Investments	
Increase in FY 2009 funding supports the Secretary's "Transformational Energy Action Management Initiative" (TEAM) that establishes DOE as the as the Federal agency leader of all agencies in strengthening environmental, energy, and transportation management.	+6,000
Total Funding Change, DOE Specific Investments	**+6,000**

Facilities and Infrastructure

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments[a]	FY 2008 Appropriation	FY 2009 Request
Facilities and Infrastructure					
National Renewable Energy Laboratory	107,035	76,876	-700	76,176	13,982
Total, Facilities and Infrastructure	107,035	76,876	-700	76,176	13,982

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The National Renewable Energy Laboratory (NREL) is a single-purpose National Laboratory dedicated to the research and development of energy efficiency, renewable energy, and related technologies. NREL is EERE's primary National Laboratory and EERE sponsors NREL as a Federally Funded Research and Development Center (FFRDC). NREL provides EERE, as well as the Office of Science and the Office of Electricity Delivery and Energy Reliability, with world-class research and development, expert advice, and objective programmatic counsel.

This Facilities and Infrastructure budget funds capital investments to support a vibrant world-class research and development program at major participant DOE laboratory sites. Included are funding requests for projects and equipment that are of general benefit to all research activities at NREL, and more productively enable EERE program's achievement of their technology outputs critical to achieving DOE's strategic energy security goals.

Maintaining EERE's state-of-the-art research facilities at NREL is important to EERE's research and development mission. EERE's proposed investment meets DOE's annual reinvestment goal and provides funding to ensure the availability of these capabilities in the future.

[a] Reflects amounts rescinded by General Provision, section 312, of the Omnibus Appropriations Act, 2008.

National Renewable Energy Laboratory

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
National Renewable Energy Laboratory			
Operation and Maintenance			
General Plant Projects	3,957	3,331	3,576
General Capital Equipment	20,078	3,587	6,406
Science and Technology Facility (STF)/Solar Energy Research Facility (SERF)	0	7,927	0
Total, Operation and Maintenance	24,035	14,845	9,982
Construction			
Research Support Facilities	63,000	0	0
Integrated Biorefinery Research Facility	20,000	0	0
South Table Mountain Infrastructure	0	6,831	0
Energy Systems Integration Facility	0	54,500	4,000
Total, Construction	83,000	61,331	4,000
Total, National Renewable Energy Laboratory	107,035	76,176	13,982

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Operation and Maintenance	**24,035**	**14,845**	**9,982**
▪ **General Plant Projects**	**3,957**	**3,331**	**3,576**

The Plant Projects request supports a portion of the annual investment used to maintain the capabilities of EERE's existing real property and related infrastructure at NREL. These projects apply to both the South Table Mountain (STM) and National Wind Technology Center (20 miles away) locations in Golden, CO. Projects may include safety and security improvements; replacements of roofs and other building components; upgrades to utilities and heating ventilation and air conditioning systems; energy efficiency improvements; reconfigurations of existing buildings to accommodate changes or growth in R&D programs or research support needs; upgrades of site-wide utility systems, telecommunications and computer networks; road and parking improvements; and walkways, landscaping, water management, water treatment, and other site improvements to enhance the sustainability, cohesiveness, and pedestrian nature of the site.

▪ **General Capital Equipment**	**20,078**	**3,587**	**6,406**

The Capital Equipment request maintains EERE's general scientific and administrative equipment to a corporate standard of 50 percent (average) remaining portfolio value through maintenance, repair, or replacement. This portfolio includes general scientific equipment with multiple users across NREL, information technology, safety and security equipment, communications equipment, etc.

▪ **(S&T/SERF)Science and Technology/Solar Energy Research Facility**	**0**	**7,927**	**0**

Recapitalizes (i.e. replaces existing equipment essential for ongoing R&D that is at or near lifetime end) at the Solar Energy Research Facility (SERF) and completes post-construction outfitting of the new Science and Technology Facility (STF) in support of the Solar America Initiative (part of the President's Advanced Energy Initiative).

Construction	**83,000**	**61,331**	**4,000**
▪ **Research Support Facility**	**63,000**	**0**	**0**

The RSF will provide 220,000 square feet of office space for approximately 800 employees that are currently occupying leased space off-site. The RSF will use an integrated design approach to achieve its goal producing a high-performance building that will serve as a showcase for the Nation's commercial building sector. The RSF will be designed to achieve a Platinum rating using the U.S. Green Buildings Council's Leadership in Energy and Environmental Design (LEED) system.

▪ **Integrated Biorefinery Research Facility**	**20,000**	**0**	**0**

This facility directly supports the Biomass Program multiyear plan. Biorefineries are expected to develop along two principle conversion pathways – biochemical and thermochemical. The biochemical pathway will use the carbohydrate portion of biomass to produce sugars that can then be converted to fuel ethanol and other products. This research will be conducted in the Integrated Biorefinery Research Facility (IBRF). The IBRF will also be used to produce the non-carbohydrate residue that is the feedstock for the thermochemical pathway, thus supporting the other major conversion pathway funded by the Biomass Program. This facility also supports the mission of the DOE's Vehicle Technologies Program to develop emission and petroleum-free cars and light trucks. In addition, there are synergies with the USDA's efforts to promote agricultural resources for biofuel production.

▪ **South Table Mountain Infrastructure**	**0**	**6,831**	**0**

Starts the supporting infrastructure, such as: roads, walkways, and parking; natural gas, electricity, water, and sewer; and data/telecom connections required to link pending and future facilities construction and/or expansion of the NREL research campus.

▪ **Energy Systems Integration Facility**	**0**	**54,500**	**4,000**

This facility creates the national capability to simulate, model, and create cost-effective renewable electricity generation, storage, and distribution components and systems to reduce the financial, technical, and market risk of wide-scale deployment and commercialization within the Nation's existing grid and emerging distributed energy infrastructure. The facility will integrate the effort of multiple EERE technology programs. The ESIF relies on advanced computational science capability to design, model, simulate, test, and improve solar, wind, hydrogen, buildings systems, and integrated energy systems, including electricity storage systems so that they can meet requirements for integration into specific utility systems. The ESIF will also enable the development of new infrastructure scenarios that might be optimized for greater integration of advanced renewable energy systems.

Total, National Renewable Energy Laboratory	**107,035**	**76,176**	**13,982**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Operation and Maintenance	
▪ **General Plant Projects**	
Category increases slightly to meet the 2 percent corporate reinvestment goal for real property and related assets.	+245
▪ **General Capital Equipment**	
Activity increases to maintain EERE's general scientific and administrative equipment to a corporate standard of 50 percent (average) remaining portfolio value through maintenance, repair, or replacement.	+2,819
▪ **Science and Technology Solar Energy Research Facility (S&T/SERF)**	
Activity decreases due to moving this portion of the request to the Solar Program budget in FY 2009. Program-specific Capital equipment requests are typically included within respective program budgets.	-7,927
Total, Operation and Maintenance	**-4,863**
Construction	
▪ **South Table Mountain**	
As a result of the significant new capital investments at NREL (i.e., the recently completed construction of STF and the approved construction of the RSF, the IBRF, and the ESIF), NREL site infrastructure planning and resulting projects must be re-examined to accommodate the dramatically accelerated site development. In FY 2009, EERE is deferring a follow-up funding request for South Table Mountain infrastructure development while a review and revision of its capital planning for	-6,831

	FY 2009 vs. FY 2008 ($000)
NREL is completed in FY 2008.	
▪ **Energy Systems Integration Facility**	
In FY 2008, Congress provided funding to commence design and construction of the Energy Systems Integration Facility (ESIF) at NREL. The FY 2009 request includes the remaining funds required ($4.0 million) to complete Phase I development of the ESIF.	-50,500
Total, Construction	**-57,331**
Total Funding Change, National Renewable Energy Laboratory	**-62,194**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
General Plant Projects	3,957	3,331	3,576
Capital Equipment	1,978	3,587	6,406
Research Support Facilities	63,000	0	0
Integrated Biorefinery Research Facility	20,000	0	0
Energy Systems Integration Facility	0	54,500	4,000
STM Site Infrastructure Development	0	6,831	0
Process Development and Integration Lab, NREL	16,000	7,927	0
Data Infrastructure Modernization	2,100	0	0
Total, Capital Operating Expenses	107,035	76,176	13,982

Construction Projects

	(dollars in thousands)					
	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2007	FY 2008	FY 2009	Unappropriated Balance
NREL Science and Tech Facility	22,531	22,531	0	0	0	0
Research Support Facility	72,900	9,900	63,000	0	0	0
Integrated Biorefinery Research Facility	20,000	0	20,000	0	0	0
Energy Systems Integration Facility	93,000	0	0	54,500	4,000	34,500
STM Site Infrastructure Development	23,887	0	0	6,831	0	17,056
Total, Construction Projects	232,318	32,431	83,000	61,331	4,000	51,556

Major Items of Equipment

(dollars in thousands)

	Total Project Cost (TPC)	Other Project Cost	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2007	FY 2008	FY 2009	Completion Date
Process Development and Integration Lab, NREL	19,680	0	19,680[a]	3,672	16,000	7,927	0	FY 2008
Total, Major Items of Equipment	19,680	0	19,680	3,672	16,000	7,927	0	

[a]

Item	Cost ($K)	Item	Cost ($K)
CIS PVD Workstation (3 chambers - Se, S based PVD, CdS or other)	$1,200	Spectroscopic Ellipsometry Workstation	$495
Thin-Si iodine transport or other high temperature process	$550	Minority Carrier Lifetime Tool	$860
X-ray and Ultraviolet Photoelectron Spectrometer	$800	PL Imaging Tool	$500
Multi-target Sputtering system (TCO/metallization)	$550	CdS Deposition Tool (Chemical Bath Deposition) - S&TF Essential Capital Equipment Item	$55
A-Si CVD Workstation (Low T processing, 3 chambers p, i, n, all combi)	$1,200	PECVD/Etch Tool	$610
Optical Probe Workstation, phase I, (PL, TRPL, Raman, rf-PCD)	$700	Integrated Plasma Etch Sputtering Tool	$810
Thin-film Analyzer (Auger Electron Spectrometer)	$460	Central Robot	$610
CBD CdS-controlled ambient glove box (CdTe/CIS)	$185	Atomic Force Microscopy Tool	$550
Real Time Spectroscopic Ellipsometer	$370	Scanning Electron Microscopy Tool	$1,000
Optical Probe Workstation, phase II, (FTIR, ATR)	$235	Thin Film CdTe Platform - Phase 1	$1,479
Stationary Universal Sample Transfer Interface Platform	$230	Thin Film CdTe Platform - Phase 2	$1,835
Completion of Si Platform	$1,450	Si Wafer Replacement Platform	$2,820
Polycrystalline Thin-Film Cluster Tool (Base Platform) - S&TF Essential Capital Equipment Item	$126		
		Total	$19,680

Project 06-EE-01, Research Support Facilities (RSF), National Renewable Energy Laboratory, Golden, Colorado

1. Significant Changes

Design, construction, and operation of the Research Support Facilities (RSF) project was initially authorized and appropriated in FY 2006. This submission accelerates and completes the acquisition of the project with FY 2007 appropriations using a design/build strategy. Changes in cost, scope, and schedule in this document from the approved FY 2006 version reflect the acceleration and full acquisition of the project in FY 2007.

Cost and schedule will be revised following completion of conceptual design. In accordance with Design/Build acquisition strategy the Performance Baseline will be approved and Design/Construction authorized with the approval of a combined Critical Decision 2/3 following completion of the Independent Program Review (IPR) to validate project cost, scope, and schedule. The IPR and CD-2/3 approval are anticipated to occur in the 2nd Quarter of FY 2008.

2. Design, Construction, and D&D Schedule

(fiscal quarter)

	Preliminary Design start	Final Design Complete	Physical Construction Start	Physical Construction Complete	D&D Offsetting Facilities Start	D&D Offsetting Facilities Complete
FY 2006	2Q2007	3Q2007	3Q2007	4Q2009	4Q2006	4Q2008
FY 2007	4Q2007	3Q2008	3Q2008	3Q2010	--	--

3. Baseline and Validation Status

(dollars in thousands)

	TEC	OPC, except D&D Costs	Offsetting D&D Costs	Total Project Costs	Validated Performance Baseline	Preliminary Estimate
FY 2006	9,900	2,532	--	12,432	N/A	12,432
FY 2007	72,900	5,283	--	78,183	N/A	78,183

No construction funds will be used until the performance baseline has been validated. The use of private sector funding was evaluated as an option during the selection of alternatives.

4. Project Description, Justification, and Scope

The FY 2007 Research Support Facilities (RSF) project provides for completion of the previously authorized design, engineering, construction, commissioning, and operation of the RSF project at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. At completion the project will allow consolidation of Office of Energy Efficiency and Renewable Energy (EERE) supported Golden-based personnel into federally-owned space on the NREL site, thereby allowing the termination of costly long-term leases and improved operational efficiency.

The National Renewable Energy Laboratory, located in Golden, Colorado, is the EERE National Laboratory for energy efficiency, renewable energy, and related technology research and development. EERE sponsors NREL's designation as a Federally Funded Research and Development Center. NREL is a strategic partner for EERE and is a critical component of EERE's program and project management supply chain. DOE annually provides approximately $200M to NREL, which hosts a contingent of approximately 1,100 scientists, engineers, and support personnel. EERE's Golden Field Office (GO) oversees the management and operating contract at NREL, and manages a research, development, and deployment (RD&D) portfolio valued in excess of $2B (over the life of the projects). This RD&D portfolio of financial assistance projects is managed through the Project Management Center. GO staffing approaches 200 technical and support personnel in FY 2007.

Since NREL's inception in 1978, EERE has diverted in excess of $187M (2007 dollars) from critical research and development activities to fund long-term building leases to house its Golden-based operations. These accumulated lease payments are many times the facilities' original purchase value. EERE lease holdings are physically separated from NREL's research and development complex and from each other by public roads and Interstate 70. This separation imposes additional overhead costs on EERE in the form of operational efficiency penalties; penalties that are estimated at 3% of the combined NREL and GO labor base, or $2M annually. Currently, 50% of NREL's staff and 100% of GO's staff are housed in these leased facilities, totaling 265,000 gross square feet. Replacing lease-holdings through acquisition of the Research Support Facility will net $122M (2007 dollars) in savings over long-term leasing over a 30-year life cycle in accordance with OMB calculation criteria for life cycle costs.

The Mission Need Statement (Critical Decision-0) was approved in 2004 by the DOE Acquisition Executive (AE) following review by DOE's Office of Program Analysis and Evaluation's integrated review team: including the Office of Engineering and Construction Management, and the Office of the Chief Financial Officer. This project fulfills the critical mission need identified in the Mission Need Statement.

The Research Support Facilities project provides for all design, construction, and commissioning activities necessary to vacate EERE's leased space. The project will be designed to fit into the NREL campus arrangement. The project will house 800 employees, which include all Federal and NREL senior management in approximately 220,000 net useable square feet, replacing the aforementioned leased support, meeting, and research space. Final project size, configuration, and cost baselines will be generated through the design process and submitted to the AE for approval through the DOE O 413.3A CD process.

As stipulated by the Congress, the project will be a showcase of sustainable, high-performance design and will incorporate the best in energy efficiency, environmental performance, and advanced controls using a "whole-building" integrated design process. The project will be designed to achieve the Leadership in Energy and Environmental Design (LEED) "Platinum" standard, the highest third-party certification building standard currently defined. Certification of the RSF LEED attainment level will be provided by an independent expert entity. The project will comply with all applicable Energy Star standards and will achieve at least a 50% energy reduction over the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard for commercial buildings, with the potential to achieve 60% to 70% energy reduction. The project will maximize its use of energy generated from renewable sources consistent with life-cycle cost considerations. Finally, the project will serve as a model for cost-competitive, high-performance commercial buildings for the Nation's design, construction, operation, and financing communities, meeting the specific intent of the congressional language.

The integrated design process, led by a Design/Build (Architect & Engineer/Construction Contractor) firm or joint venture selected through a national competition will be highly collaborative and will use design charettes, independent reviews, and external experts in advanced controls, renewable design, and operations to ensure the project's high-performance, sustainable, and cost competitive goals can be achieved.

The project will be conducted in complete accordance with the project management requirements in DOE Order 413.3A and DOE Manual 413.3-1, Program and Project Management for the Acquisition of Capital Assets, which provides for a tailored strategy for Critical Decisions for design/build acquisition strategy. Facility operating costs are included in Item 7, Related Annual Funding Requirements.

Compliance with Project Management Order

- Critical Decision – 0: Approve Mission Need – 11/19/2004
- Critical Decision – 1A: Approve Selected Alternative, Acquisition Strategy, and Cost Range – 3/8/2007
- Critical Decision – 1B/2: Approve Project Performance Baseline[1] – 2nd Qtr FY 2008
- Critical Decision – 3: Approve Construction Start[3] – 3rd Qtr FY 2008
- Critical Decision – 4: Approve Start of Operations – 3rd Qtr FY 2010

5. Financial Schedule

(dollars in thousands)

	Appropriations	Obligations	Costs
Design/Construction by Fiscal Year			
Design, independent cost estimates and review			

[3] This project will be accomplished using a Design/Build approach. Design/Build allows for combined critical decisions in support of a combined CD-1B/2/3.

	(dollars in thousands)		
	Appropriations	Obligations	Costs
2006	1,837	1,837	0
2007	6,079	6,079	4,750
2008	0	0	3,166
2009	0	0	0
Total, Design	7,916	7,916	7,916
Construction			
2006	8,063	8,063	0
2007	56,921	56,921	0
2008	0	0	38,990
2009	0	0	25,994
Total, Construction	64,984	64,984	64,984
Total, TEC	72,900	72,900	72,900

6. Details of Project Cost Estimate

Total Estimated Costs

	(dollars in thousands)	
	Current Estimate ($000)	Previous[4] Estimate ($000)
Preliminary and Final Design	7,916	1,837
Construction Phase		
Site Preparation	500	220
Equipment/FFE	4,851	0
All other construction	0	0
Contingency/Management Reserve	6,182	440
Construction	53,451	7,403
Total, Construction	64,984	8,063
Total, TEC	72,900	9,900

[4] Previous estimate based on FY 2006 $9.9M project. Current estimate reflects FY 2006 $9.9M + FY 2007 $63.0M = $72.9M project.

Other Project Costs

Cost Element	(dollars in thousands) Current Estimate ($000)	Previous Estimate ($000)
Conceptual Planning and Design	1,240	440
NEPA documentation costs	50	50
ES&H costs	70	35
Other Project-Related costs[5]	3,684	2,007
Start-up	--	--
Offsetting D&D Phase[6]	--	--
D&D for removal of the offsetting facility	--	--
Other D&D to comply with "one-for-one" requirements	--	--
D&D contingency	--	--
Total D&D	--	--
Contingency for OPC other than D&D	239	0
Total, OPC	5,283	2,532

7. Schedule of Project Costs

(dollars in thousands)

	Prior Years	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Outyears	Total
TEC (Design)	--	4,750	3,166	--	--	--	--	7,916
TEC (Construction)	--	--	38,990	23,594	2,400	--	--	64,984
OPC Other than D&D........	271	1,390	813	2,809	--	--	--	5,283
Offsetting D&D Costs	--	--	--	--	--	--	--	--
Total Project Costs............	271	6,140	42,969	26,403	2,400	--	--	78,183

[5] Costs include traffic study, geotechnical study, commissioning, Integrated Project Team costs, moving, parking study, utility and telecommunication connection charges, and personnel/equipment moves.
[6] No excess space exists at NREL to satisfy "one-for-one" existing space replacement with new space as stated by Congress in House Report 107-258. See Section 9 "Required D&D Information" for additional information.

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter)	3rd Q2010
Expected Useful Life (number of years)	50
Expected Future start of D&D for new construction (fiscal quarter)	N/A

(Related Funding Requirements)

(dollars in thousands)

	Annual Costs		Life cycle costs[7]	
	Current estimate	Prior Estimate	Current estimate	Prior Estimate
Operations (Utilities Included)	358	--	17,900	--
Maintenance	244	--	12,200	--
Total Related Funding	602	--	30,100	--

9. Required D&D Information

The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that DOE can use to comply with the "one-for-one" space replacement identification stated in House Report 107-258 and as required by DOE Order 413.3-A. No excess space exists at NREL to satisfy direction for replacement on a "one-for-one" basis. Accordingly, the DOE is currently in the process of identifying appropriate space at other DOE sites.

Name(s) and site location(s) of existing facility(s) to be replaced: Lease space will be released as soon as feasible in accordance with lease terms and operational requirements.

D&D Information Being Requested	Square Feet
Area of new construction[8]	220,000
Area of any additional space that will require D&D to meet the "one-for-one" requirement	0

10. Acquisition Approach (formerly Method of Performance)

The Acquisition Strategy will emphasize best value to the government; defined, as the balance between mission need, project performance, financial value, timeliness, and risk mitigation. The majority of the project will be executed under a Design/Build strategy to mitigate government risk and achieve maximum progress in building. Attributes of the strategy include:

[7] Undiscounted costs based on 30 years of operation.
[8] Minimum range of estimate. Project replaces 265,000sf of space currently leased to meet present space requirements.

- Acquisition will be accomplished using a design/build strategy in which design and construction services are performed by an integrated design/construction team. The design/construction team will be selected via competition using best value contracting procedures. A Guaranteed Maximum Price will be negotiated to limit the Government's risk.
- NREL will engage national financial, controls, and systems experts independent of the A/E to review and ensure that the project achieves the highest level of energy, operational, and cost performance reasonably achievable. All first cost decisions will be made against life-cycle cost benefits.
- NREL will engage third-party experts to certify the project's energy and environmental performance.

07-EE-01, Integrated Biorefinery Research Facility (Expansion), National Renewable Energy Laboratory, Golden, Colorado

1. Significant Changes

Other Project Costs (OPC) have been re-evaluated based on current market conditions and expected effort associated with IPT salaries and personnel/equipment moves. Project description has been modified to allow more creativity and options providing for the greatest value to the Government.

2. Design, Construction, and D&D Schedule

(fiscal quarter)

	Preliminary Design start	Final Design Complete	Physical Construction Start	Physical Construction Complete	D&D Offsetting Facilities Start	D&D Offsetting Facilities Complete
FY 2007	2Q 2008	1Q 2009	3Q 2008	4Q 2009	--	--

* Note: See Section 9 "Required D&D Information"

3. Baseline and Validation Status

(dollars in thousands)

	TEC	OPC, except D&D Costs	Offsetting D&D Costs	Total Project Costs	Validated Performance Baseline	Preliminary Estimate
FY 2007	20,000	976	0	20,976	N/A	$20,976

No construction funds will be expended until the performance baseline has been validated.

4. Project Description, Justification, and Scope

The project provides for the design, engineering, construction, and commissioning of the Integrated Biorefinery Research Facility Expansion (IBRF) at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. The project expands the existing Alternative Fuels User Facility (AFUF), thereby expanding capabilities to house new equipment and processes. This will enable current and new technology to be developed and validated to allow large scale cellulosic ethanol technology deployment to occur, an outcome that is critical to the Department of Energy (DOE) being able to successfully meet its Energy Security strategic goals for 2012. Beyond being key to the success of DOE's integrated biorefining RD&D program, having this unique facility co-located at NREL with other DOE Biomass Program expertise and biomass user facilities (e.g., Biomass Surface Characterization Laboratory and

Thermochemical Conversion Process Development Unit) will also foster achievement of the U.S. DOE's strategic goals related to scientific discovery, foundational science, and basic and applied research integration.

Building upon the transportation fuel diversification objectives set forth in the Energy Policy Act of 2005, the Advanced Energy Initiative announced by President George W. Bush in February 2006 and in the Energy Independence and Security Act of 2007 signed by President Bush in December 2007**,** calls for accelerating our Nation's cellulosic ethanol research and development program in order to make this technology cost-competitive with corn-based ethanol by 2012. The "20 in 10" Initiative, included by the President in the State of the Union Address in January of 2007, calls for the increase of ethanol production by 1.2 billion gallons per year, seeking to reduce petroleum consumption by 20 percent in ten years, as well as increases in funding for biomass (particularly for cellulosic ethanol R&D). This biorefinery facility expansion is a major component to meeting that aggressive goal.

Energy Security

Our national security relies on being "energy secure" and "environmentally secure." The importance of decreasing the United States' reliance on foreign sources of energy to improve our energy security has long been recognized. The National Energy Policy of 2001 specifically recommended supporting the research and development of new technologies that will help reduce our Nation's dependence upon imported petroleum. Both the Energy Policy Act of 2005 and the Advanced Energy Initiative of 2006 include sections focused on diversifying transportation fuel options through the acceleration of cellulosic ethanol RD&D. Increased funding for research, development and demonstration activities related to biomass conversion to biofuels and bioproducts in integrated biorefineries would directly benefit from the proposed integrated biorefinery research facility and is authorized in EPACT 2005 Sections 210, 931 and 932. Beyond this, Section 977 of EPACT 2005 authorizes funding for science to advance integrated bioenergy research, which would indirectly also benefit from the proposed facility. While the Advanced Energy Initiative has not yet been appropriated, its accelerated "Biorefinery Initiative" would also greatly benefit from the proposed IBRF. Additionally, the Energy Independence and Security Act of 2007 calls for the total amount of biofuels added to gasoline is required to increase to 36 billion gallons by 2022, from 4.7 billion gallons in 2007. The Energy Act further specifies that 21 billion gallons of the 2022 total must be derived from non-cornstarch products (e.g. sugar or cellulose).

In support of these legislative and new initiatives, and in accordance with our Nation's energy and environmental security objectives, the U.S. Department of Energy's (DOE) 2006 Strategic Plan (Strategic Theme 1, Energy Security) directs the Federal enterprise to:

> "Increase our energy options and reduce dependence on foreign fuel supplies, thereby reducing vulnerability to disruption and increasing the flexibility of the market to meet U.S. needs." (Goal 1.1 Energy Diversity)
>
> "Reduce greenhouse gas emissions and other environmental impacts (water use, land use, criteria pollutants) from our energy production and use." (Goal 1.2 Environmental Impacts of Energy)

"Create a more flexible, secure, reliable, efficient, and higher capacity U.S. energy infrastructure by improving energy services throughout the economy and enabling the use of diverse sources." (Goal 1.3 Energy Infrastructure)

As discussed in the President's Advanced Energy Initiative, first revealed during his State of the Union Address on January 31, 2006, bio-based transportation fuels like cellulosic ethanol are recognized to have the potential to displace up to 30 percent of the Nation's current fuel use and thereby dramatically contribute to improved U.S. energy and environmental security. Accordingly, the President's Advanced Energy Initiative includes a request for increased future funding to spur cellulosic ethanol technology development.

The proposed IBRF expansion is key to successfully conducting an accelerated cellulosic ethanol technology development effort. Such a facility is critically needed to be able to efficiently develop and validate cellulosic ethanol biorefining technology to the point where large-scale deployment can occur, an outcome that is critical to the U.S. Department of Energy being able to successfully meet its Energy Security strategic goals.

Scientific Discovery

Developing and deploying robust biomass refining (biorefining) technologies will be a key to realizing the full potential of biofuels to improve U.S. energy security. Recognizing this, the Advanced Energy Initiative includes a "Biorefinery Initiative" component to accelerate cellulosic ethanol research.

A biorefinery is analogous to a petroleum refinery that refines crude oil into a broad range of industrial and energy products. Examples of existing biorefineries include paper mills and grain (predominantly corn) processing plants that produce ethanol and various food and feed coproducts. The DOE's Office of Energy Efficiency and Renewable Energy (EERE) is partnering with these industries to develop the next generation of biorefineries that will produce fuel, chemical, feed, material, and/or power products from non-conventional, lower-cost fibrous feedstocks such as residues resulting from agricultural and forestry operations and their allied industries. Since beginning pilot-scale research on biomass-to-ethanol in the early 1990s, it has become clear that biorefineries utilizing a combination of biochemical and thermochemical conversion technologies offer the best opportunity to capture the value in biomass in a commercially viable fashion.

The development of biorefineries will logically follow a progression moving from the lowest cost feedstock with the least technology and market risk, through a series of steps where research will be needed to bring an increasing breadth of feedstocks and products under the biorefinery umbrella. This progression is expected to develop along two principle conversion pathways – biochemical and thermochemical. The biochemical pathway will use the carbohydrate portion of biomass to produce intermediate sugars that can then be converted to fuel ethanol and other products. The thermochemical pathway will use intact (raw) biomass or just the non-carbohydrate portion to produce synthesis gas (analogous to natural gas for electricity and heating) and/or heavy oils (analogous to heating oil used for space heating), either of which then can be converted into a wide range of fuels and chemicals products. In time it is likely that a biorefinery will emerge that combines elements of both these pathways in one integrated facility.

The current EERE Biomass Program goal for biochemical and thermochemical conversion is to reduce the estimated cost for biomass-derived ethanol from an estimated $2.75/gal of ethanol today to $1.07/gal by 2020, and the President's Advanced Energy Initiative proposes to accelerate this cost reduction goal to 2012. Reaching these cost goals requires an overall systems-level approach to research and development on both biochemical and thermochemical production pathways, and will necessitate both bench-scale and pilot-scale research. At the pilot-scale, the research goal is to reduce cost through process intensification and integration within each pathway, and ultimately to couple the synergies afforded by combining elements of both pathways in one biorefining facility. Breakthroughs in fundamental science understanding and capabilities will also be needed, in the longer term, to be able to achieve these cost targets on higher cost biomass feedstocks, such as so-called energy crops grown specifically for bioenergy applications.

In terms of advancing science and technology knowledge, capabilities and infrastructure, the U.S. DOE's 2006 Strategic Plan (Strategic Theme 3, Scientific Discovery) directs the Federal research enterprise to:

> "Deliver the scientific facilities, train the next generation of scientists and engineers, and provide the laboratory capabilities and infrastructure required for U.S. scientific primacy." (Goal 3.2, Foundations of Science)
>
> "Integrate basic and applied research to accelerate innovation and to create transformational solutions for energy and other U.S. needs."(Goal 3.3 Research Integration)

Developing new biorefining technologies for the value-added conversion of cellulosic biomass feedstocks is a transformational energy solution offering tremendous opportunities for science and technology innovation and continuation of U.S. scientific and engineering primacy.

The Project provides for the design, engineering, construction, and commissioning of the Integrated Biorefinery Research Facility (IBRF) at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. The project will expand the existing Alternative Fuels User Facility (AFUF) thereby exhancing capabilities to house new equipment and processes. The project will result in the addition of finished laboratory, storage and office space, basement space for feedstock storage and staging, and flexibly configurable open concrete floor industrial high bay space for process equipment. This will enable current and new technology to be developed and validated to the point where large scale cellulosic ethanol technology deployment can occur, an outcome that is critical to the U.S. Department of Energy being able to successfully meet its Energy Security strategic goals for 2012. Beyond being key to the success of DOE's integrated biorefining RD&D program, having such a unique facility co-located at NREL with other DOE Biomass Program expertise and biomass user facilities (e.g., Biomass Surface Characterization Laboratory and Thermochemical Conversion Process Development Unit) will also foster achievement of the U.S. DOE's strategic goals related to scientific discovery, foundational science, and basic and applied research integration.

This project will be managed to the principles of project management outlined in DOE Order 413.3A, Program and Project Management for the Acquisition of Capital Assets.

Compliance with Project Management Order[9]

- Critical Decision – 0: Approve Mission Need – 11/16/2006
- Critical Decision – 1A: Approve Alternative, Acquisition Strategy, and Cost Range – 3/8/2007
- Critical Decision – 1B/2: Approve Project Performance Baseline – 2nd Qtr FY 2008
- Critical Decision – 3: Approve Construction Start[10] – 2nd Qtr FY 2008
- Critical Decision – 4: Approve Start of Operations – 4th Q 2009

5. Financial Schedule

(dollars in thousands)

	Appropriations	Obligations	Costs
Design/Construction by Fiscal Year			
Design			
2007	1,950	1,950	0
2008	0	0	1,950
Total, Design	1,950	1,950	1,950
Construction			
2007	18,050	18,050	0
2008	0	0	10,000
2009	0	0	8,050
Total, Construction	18,050	18,050	18,050
Total, TEC	20,000	20,000	20,000

6. Details of Project Cost Estimate

Total Estimated Costs

(dollars in thousands)

[9] The principles as set forth in DOE Order 413.3A Program and Project Management for the Acquisition of Capital Assets will be utilized for this project. All requirements will be addressed and the approach to meeting the requirements will be tailored consistent with the risk, complexity, visibility, cost, safety, security, and schedule for this project.
[10] This project will be accomplished using a Design/Build approach. Design/Build allows for combined critical decisions such as a combined CD-1B/2/3.

	Current Estimate ($000)	Previous Estimate ($000)
Preliminary and Final Design	1,950	--
Construction Phase		
Site Preparation	350	--
Equipment	6,165	--
Contingency/Management Reserve	2,322	--
Construction	9,213	--
Total, Construction	18,050	--
Total, TEC	20,000	--

Other Project Costs

(dollars in thousands)

	Current Estimate ($000)	Previous Estimate ($000)
Cost Element		
Conceptual Planning and Design	316	300
NEPA documentation costs	--	20
ES&H costs	40	20
Capitalized Experimental equipment (these Equipment costs are part of project)	0	0
Other Project-Related costs[11]	620	495
Start-up	0	0
Offsetting D&D Phase[12]		--
D&D for removal of the offsetting facility	--	--
Other D&D to comply with "one-for-one" requirements	--	--
D&D contingency	--	--
Total, D&D	--	--
Contingency for OPC other than D&D	--	--
Total, OPC	976	835

[11] Integrated Project Team, Independent, and Cost Reviews.
[12] No excess space exists at NREL to satisfy direction to replace “one-for-one” existing space with new space stated in House Report 107-258.

7. Schedule of Project Costs

(dollars in thousands)

	Prior Years	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	Outyears	Total
TEC (Design)	0	0	0	1,950	0	0	0	1,950
TEC (Construction)	0	0	0	10,000	8,050	0	0	18,050
OPC Other than D&D	0	0	200	776	0	0	0	976
Offsetting D&D Costs	0	0	0	0	0	0	0	0
Total, Project Costs	0	0	200	12,726	8,050	0	0	20,976

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter)	4Q 2009
Expected Useful Life (number of years)	25
Expected Future start of D&D for new construction (fiscal quarter)	--

* Note: See Section 9. "Required D&D Information".

(Related Funding Requirements)

(dollars in thousands)

	Annual Costs		Life cycle costs[13]	
	Current estimate	Prior Estimate	Current estimate	Prior Estimate
Operations	191	N/A	4,775	N/A
Maintenance	202	N/A	5,050	N/A
Total, Related Funding	393	N/A	9,825	N/A

9. Required D&D Information

The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that DOE can use to comply with the "one-for-one" space replacement identification stated in House Report 107-258 and as required by DOE Order 413.3-A. No excess space exists at NREL to satisfy direction to replace "one-for-one" existing space with new space as stated by

[13] Life cycle costs as of June 2006.

Congress in Report language. Accordingly, the DOE is currently in the process to identifying appropriate space.

Name(s) and site location(s) of existing facility(s) to be replaced: Lease space will be released as soon as feasible in accordance with lease terms and operational requirements.

D&D Information Being Requested	Square Feet
Area of new construction	21,400
Area of existing facility(ies) being replaced	-3,800
Area of second activity to add new space to the east side of existing northern section	5,500
Area of any additional space that will require D&D to meet the "one-for-one" requirement	23,100

10. Acquisition Approach (formerly Method of Performance)

The acquisition strategy will emphasize best value to the government defined as the balance between mission need, project performance, financial value, timeliness, and risk mitigation. The majority of the project will be executed under a Design/Build procurement. Attributes of the strategy include:

- Acquisition will be accomplished using a design/build strategy where design and construction services are performed by an integrated design/construction team. The design/construction team will be selected via competition using best value contracting procedures. A Guaranteed Maximum Price will be negotiated to limit the Government's risk.

- NREL will engage national financial, controls, and systems experts independent of the A/E to review and ensure that the project achieves the highest level of energy, operational, and cost performance reasonably achievable. All first cost decisions will be made against life-cycle cost benefits.

- NREL will engage third-party experts to certify the project's energy and environmental performance.

08-EE-01, Energy Systems Integration Facility, National Renewable Energy Laboratory, Golden, Colorado

1. Significant Changes

This is the first submission for the Energy Systems Integration Facility (ESIF) project. The Congress has included $55,000,000 [less a 0.91% across-the-board rescission] in FY 2008 appropriations to begin design/construction for this project. The project profile funding of $54.5M in FY 2008, $4.0M in FY 2009 and $34.5M in FY 2010 for a total estimated cost of $93M is required to complete this effort.

2. Design, Construction, and D&D Schedule

(fiscal quarter)

	Preliminary Design start	Final Design Complete	Physical Construction Start	Physical Construction Complete	D&D Offsetting Facilities Start[14]	D&D Offsetting Facilities Complete
FY 2008	2Q2009	1Q2010	1Q2010	2Q2012	--	--

3. Baseline and Validation Status[15]

(dollars in thousands)

	TEC	OPC, except D&D Costs	Offsetting D&D Costs	Total Project Costs	Validated Performance Baseline	Preliminary Estimate
FY 2008	93,000	3,900	--	96,900[16]	2Q2009	96,900

Project Description, Justification, and Scope

The Energy Information Administration forecasts that energy consumption in the U.S. will increase by 34 percent by 2030.[17] The current energy infrastructure and total energy demand cannot be replaced by a single production source. Renewable energy sources including solar, wind, and hydrogen (a carrier) need to be a significant part of the energy supply to accommodate the increased demand. In the U.S., solar and wind resources offer a major opportunity to supply energy for production of electricity and hydrogen; however, their variability, decentralization, and intermittency can make them challenging to integrate into energy production and delivery systems while continuing to ensure low cost and high system reliability. Developing integrated energy systems and testing technologies that include energy

[14] DOE Golden Field Office negotiating with other sites to comply with "One-for-One" requirement.
[15] No baseline has been established at this time.
[16] No construction funds will be used until the performance baseline has been validated.
[17] Annual Energy Outlook 2007; Energy Information Administration

generation, storage, distribution, and utilization are critical to maximize the potential benefits of renewable technologies.

The U.S. Department of Energy (DOE) recognizes the need to develop an integrated energy systems approach that will result in large scale adoption of renewable energy. Inherent variability in power quality and intermittency of renewable generation systems requires full characterization to lower economic and technical risk for maximum deployment acceleration of these carbon-free power systems. The scope defined is technology improvements on the generator systems equipment (Renewable Energy generator plant, inverters, transformers, power conditioning/controls systems, etc.) side of the interconnection point. Activities, therefore, need to include efforts to:

- Develop foundation of advanced renewable resource evaluation and forecasting tools for adoption of renewable technologies at scale;
- Develop and characterize renewable generator performance and power quality (voltage variability, harmonics, etc.);
- Combine renewable resource assessments data with renewable generation project performance data for model validation;
- Test and validate optimized renewable energy generators and associated equipment (e.g., electricity storage for PV systems, etc.) to reduce operability and reliability risks;
- Model, simulate, and evaluate increased market penetration of renewable generation to optimize RE generation portfolios for specific regions, and to identify and mitigate issues related to intermittency and variability;
- Build common platforms for renewable systems integration hardware testing to enable evaluation of many different, novel generator/controller/load scenarios quickly and cheaply;
- Explore a variety of end-user-level systems configurations in a controlled environment allowing for the understanding of fundamental integration and interconnection issues;
- Enable the ability to explore systems configuration optimization at a scale that is cheaply and quickly configured and reconfigured; and
- Fully incorporate technical, economic, and financial analyses with technical validation efforts.

Energy Efficiency and Renewable Energy (EERE) programs support the R&D needed to bring critical new technologies to a point where industry is able to commercialize renewable energy-based energy systems, hydrogen infrastructure, and plug-in hybrid vehicles. To meet programmatic milestones, EERE requires an effective research facility, with appropriate testing, modeling and data management capabilities, to reduce R&D time and enable quicker deployment of cost-effective technologies to the marketplace.

DOE must increase its ability to characterize and test pre-commercial-scale integrated renewable energy systems to maximize the benefit of individual program funding. The ability to test and evaluate integrated systems will help maximize the benefit to each technology program to accomplish the EERE mission in support of the Department’s Strategic Goals. This scale of testing can be done more quickly at less cost than commercial-scale demonstrations, and will allow industry to try a variety of new and advanced component and system combinations before deciding on which paths forward make the best economic sense to commercial deployment with the lowest technological and financial risks.

The capability must be designed for industry collaboration through cost-shared partnerships. A user-oriented facility must be located where it can easily be accessed by researchers and by energy stakeholders from the utility, buildings, hydrogen, electricity, and other key sectors. It will allow industry partners to test their individual technologies and systems in a controlled integrated energy system platform, and optimize the technologies for earlier market penetration. Experience has shown that validating and correcting problems in a laboratory environment enables technologies to go from concept to production more quickly, reduces overall cost, improves reliability, and reduces risks. This, in turn, makes early-stage projects more easily financed at better terms. Establishing this capability will foster information exchanges to help grow these emerging industries.

The Energy Systems Integration Facility (ESIF) will help achieve the goals of the President's Advanced Energy Initiative. It also supports the development and deployment of energy efficiency and renewable technologies expressed in the Energy Policy Act (EPAct) of 2005. DOE builds on the EPAct goals in its Strategic Plan (Fall 2006), which established goals for achieving national energy security that include:

- Increase U.S. energy diversity thus reducing vulnerability to disruption and increasing the flexibility of the market;
- Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts from energy production and use; and,
- Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

A research facility – containing computational support for characterization of solar, wind, hydrogen, buildings systems, and integrated energy systems, including electricity storage– is required that can effectively design, engineer, test, and verify technologies for commercial deployment.

A research facility that tests technology systems will ensure that the technical and financial risks faced by U.S. industry are fewer, making technology readiness less difficult, less costly, and take significantly less time.

The Energy Systems Integration Facility will enable U.S. industry to compete more readily with foreign companies in Europe and Asia, and will help determine technology readiness, allowing the U.S. to overcome vulnerabilities inherent in dependence on foreign oil, and achieving the objectives of energy security in an accelerated way.

High priority mission needs call for accelerated research into the area of energy systems integration and the key issues of interconnectivity and control of resource input and output, which, in turn, calls for strengthening DOE's Research, Development & Demonstration (RD&D) program, facilities, and equipment.

- As DOE's Strategic Plan (Fall 2006) notes: "The United States is heavily dependent upon oil, especially in the transportation sector. Rapid increases in U.S. and world energy demand, combined with regional resource and production constraints, have led to large increases in oil and natural gas prices, changing the industrial and commercial business environment. The Nation's energy infrastructure is not keeping pace with the growth in energy demand, thereby endangering the reliability of the energy system. Finally, there is a need to reduce the environmental impacts associated with energy use."

DOE's visionary initiatives and programs are designed to accelerate the development of technologies to meet milestones for each individual technology. Developing a new electric and fuel infrastructure for the Nation is a complex task requiring a systems-level approach, and many paths can lead to a successful electric and hydrogen future. Today, scientists and engineers are developing more efficient and lower-cost fuel cells; advanced vehicle designs; new methods to produce hydrogen from solar, wind, and biomass resources; gasoline and diesel alternatives from biomass.

To fully realize the benefits of EERE's technology programs and improve the market impact of renewable energy, DOE also needs to strengthen its engineering, design, modeling, simulation, and testing capabilities. Currently, the DOE research, development, and demonstration environment has little capability to accomplish the following critical activities:

- Integrate components into optimized systems from power generation through end use at a building-scale, community-scale, or utility-scale system.
- Test systems using flexible platforms for mixing and matching power generation and use.
- Provide technical and economic data/analyses to foster successful business opportunities.

EERE needs to increase the ability to characterize and test pre-commercial-scale integrated renewable energy and hydrogen systems to maximize the benefit of individual program funding, which is directed at individual technology development. The ability to test and evaluate integrated systems will help maximize the benefit to each technology program to accomplish the EERE mission in support of the Department's Energy Strategic Goals. This scale of testing can be done quicker and for less cost than commercial-scale demonstrations and will allow industry to try a variety of new and advanced component and system combinations quickly before deciding on which paths forward make the best economic sense to commercialize (Figure 2.3.1).

The Federal system currently lacks a facility for designing and testing engineering optimized systems, testing integrated energy technologies, and simulating and or emulating new infrastructure scenarios under the control of DOE and available to all of DOE industry partners. The lack of such a facility represents a key barrier to being able to meet DOE's solar, wind, and hydrogen goals. A new facility would allow DOE to optimize these technologies as part of a total energy system collecting both technical and economic data for business analysis will encourage their integration into energy production and delivery systems at minimum cost and high system reliability.

In addition to supporting EERE Program requirements for the Solar; Wind; Hydrogen, Fuel Cells, and Infrastructure; FreedomCAR and Vehicle Technologies; and Building Technologies, the capabilities of a new facility would also support the interconnection requirements of the Office of Electricity program for distributed power from renewable energy technologies into the electrical grid.

Industry partnership is vital to the success of new energy and transportation technologies. U.S. utilities and private sector companies are interested in partnering with DOE to achieve a successful electric and hydrogen future. However, there is currently no facility in the country that supports cooperative public-private, laboratory-controlled research at the pre-commercial engineering scale, including testing and verification of a wide variety of concepts for advanced hydrogen technologies and integrated energy systems. Also, private facilities are not equally available to all researchers involved in a national effort.

One of the goals of NREL, for which EERE is the principal secretarial office, is to manage the interface between applied R&D and the commercial marketplace to encourage the market penetration of renewable and energy efficiency technologies. Many of the existing individual engineering and testing activities supporting the goals of the Solar, Wind, Hydrogen, Buildings and FreedomCAR programs described above are conducted at NREL. Hydrogen systems development and advanced fuels technology development activities are effectively leveraged to take advantage of NREL's core expertise and capabilities in integrating clean energy technologies such as solar, wind, and biofuels. These activities at NREL, however, have no dedicated facility.

Creating a facility to test the integrated renewable technology systems concept (energy system technology and system design, testing and performance optimization in the context of the larger energy supply, delivery, and end use systems for deployment) forms the center of DOE's energy efficiency renewable energy capability. The Energy Systems Integration Facility will enable DOE and its industrial partners to assess the potential of solar, wind, and hydrogen technology options for buildings, transportation, community, and utility utilization and develop a validated engineering-scale collection and analysis of performance data for the most promising technologies and integrated energy systems. The ESIF will allow U.S. industry members to insert their individual technologies into a controlled integrated energy system platform to test and optimize the technologies for earlier market penetration. It will also help to enable the success of the Hydrogen, Fuel Cell & Infrastructure Technologies Program effort to meet the technology readiness milestones.

The ESIF is envisioned to be a new 130,000-gross-square-foot facility specially designed to accommodate the critical engineering, testing, optimization, and verification research needed for integrated engineering systems development for EERE programs. It is proposed as the "first of its kind" integrated test and validation facility for new technologies being developed by the EERE programs and industry research partners nationwide, including engineering performance and testing of renewable hydrogen systems. The facility will provide support space for approximately 150 researchers, effectively consolidating activities currently in several different locations at NREL, some of which is currently in leased facilities. In addition, outdoor pads will be available for testing larger equipment and systems up to the multi-megawatt scale. The facility itself will be designed to merit at least a "Gold" rating from the U.S. Green Building Council, in support of EERE's goal to demonstrate energy efficient buildings with a lower impact on the environment. Due to the high energy draw for the computational aspect of this facility, a LEED™ Platinum rating is not currently achievable.

<u>Compliance with Project Management Order</u>

- Critical Decision – 0: Approve Mission Need – 8/9/2007
- Critical Decision –1A: Approve Alternative, Acquisition Strategy, and Cost Range – 3rd Q FY 2008
- Critical Decision – 1B/2: Approve Project Performance Baseline[5] – 2nd Q FY 2009
- Critical Decision – 3: Approve Start of Construction[5] – 2nd Q FY 2009

- Critical Decision – 4: Approve Start of Operations – 2nd Q FY 2012

5. Financial Schedule

(dollars in thousands)

	Appropriations	Obligations	Costs
Design/Construction by Fiscal Year			
Design			
2008	7,000	7,000	5,000
2009	0	0	2,000
Total, Design	7,000	7,000	7,000
Construction			
2008	47,500	47,500	0
2009	4,000	4,000	41,500
2010	500	500	10,500
Total, Construction	52,000	52,000	52,000
Equipment			
2010	34,000	34,000	11,000
2011	0	0	23,000
Total, Equipment	34,000	34,000	34,000
Total, TEC	93,000	93,000	93,000

6. Details of Project Cost Estimate

Total Estimated Costs

(dollars in thousands)

	Current Estimate ($000)	Previous Estimate ($000)
Preliminary and Final Design	7,000	--
Construction Phase		
Site Preparation	5,088	--
Equipment	34,000	--

(dollars in thousands)

	Current Estimate ($000)	Previous Estimate ($000)
All other construction	35,912	--
Management Reserve/Contingency (15% of Construction)	11,000	--
Total, Construction	86,000	--
Total, TEC	93,000	--

Other Project Costs

(dollars in thousands)

Cost Element	Current Estimate ($000)	Previous Estimate ($000)
Conceptual Planning	1,500	--
NEPA documentation costs	100	--
ES&H costs	100	--
Other Project-Related costs	2,000	--
Start-up[18]	0	--
Offsetting D&D Phase[19]		
D&D for removal of the offsetting facility	NA	--
Other D&D to comply with "one-for-one" requirements	NA	--
D&D contingency	NA	--
Total D&D	NA	--
Contingency for OPC other than D&D	200	--
Total, OPC	3,900	--

[18] Commissioning costs are charged to construction. Operating Contractor support is planned in other project charges. There are no additional start-up charges.

[19] The DOE Golden Field Office will work with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that NREL can use to comply with the "one-for-one" requirement. No D&D costs are expected.

7. Schedule of Project Costs

(dollars in thousands)

	Prior Years	FY 2008	FY 2009	FY 2010	Outyears	Total
TEC (Design and Construction)	0	5,000	43,500	10,500	0	59,000
Capital Equipment	0	0	0	11,000	23,000	34,000
OPC Other than D&D............	0	1,600	300	1,300	700	3,900
Offsetting D&D Costs	--	--	--	--	--	--
Total Project Costs.................	0	6,600	43,800	22,800	23,700	96,900

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter)	2Q2012
Expected Useful Life (number of years)	25
Expected Future start of D&D for new construction (fiscal quarter) [20]	NA

(Related Funding Requirements)

(dollars in thousands)

	Annual Costs		Life cycle costs	
	Current estimate	Prior Estimate	Current estimate	Prior Estimate
Operations	1,371	NA	34,275	NA
Maintenance	876	NA	21,900	NA
Total Related Funding[21]	2,247	NA	56,175	NA

9. Required D&D Information

The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that can be used to comply with the "one-for-one" requirement.

Name(s) and site location(s) of existing facility(s) to be replaced: Lease space will be released as soon as feasible in accordance with lease terms and operational requirements.

[20] The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that NREL can use to comply with the "one-for-one" requirement. No D&D costs are expected.
[21] Does not include building utilities, i.e., electric, natural gas, sewer or water.

D&D Information Being Requested	Square Feet
Area of new construction	130,000
Area of existing facility(ies) being replaced (Space currently leased from private parties)	TBD
Area of any additional space that will require D&D to meet the “one-for-one” requirement	TBD

10. Acquisition Approach

Design and construction will be performed under a negotiated design/build Maximum Price subcontract awarded on the basis of competitive bidding and best value selection. Construction inspection, independent testing and commissioning will be performed under negotiated fixed price subcontracts awarded on the basis of competitive bidding and best value selection. All subcontracts will be managed by the M&O Contractor with oversight by the Department of Energy.

08-EE-02, STM Site Infrastructure Development, National Renewable Energy Laboratory, Golden, Colorado

1. Significant Changes

This is the first FY 2009 submission for the STM Site Infrastructure Development project. The Congress has included $6,831,000 [$6,894,000 less a 0.91% across-the-board rescission] in FY 2008 appropriations to begin design/construction for this project. Total estimated funding to complete this project is $23,887,000 (+17,056,000).

2. Design, Construction, and D&D Schedule

(fiscal quarter)

	Preliminary Design start	Final Design Complete	Physical Construction Start	Physical Construction Complete	D&D Offsetting Facilities Start[22]	D&D Offsetting Facilities Complete
FY 2008	1Q2009	3Q2009	3Q2009	4Q2011	--	--

3. Baseline and Validation Status[23]

(dollars in thousands)

	TEC	OPC, except D&D Costs	Offsetting D&D Costs	Total Project Costs	Validated Performance Baseline	Preliminary Estimate
FY 2008	23,887	1,350	--	25,237	1Q2009[24]	25,237

Project Description, Justification, and Scope

In January 2006, President Bush announced the Advanced Energy Initiative to reduce our dependence on foreign energy supplies through the accelerated development of energy alternatives that will change the way we power our homes and businesses and the way we power our automobiles. Additionally, he announced the American Competitiveness Initiative that strives to increase investments in research and development, strengthen education, and encourage entrepreneurship. These initiatives, along with Congressional appropriations, places added emphasis on many of the research areas of the National Renewable Energy Laboratory, including solar and wind energy, hydrogen, biomass-derived alternative vehicle fuels, vehicle efficiency technologies, and net-zero-energy buildings, along with the foundational science that will fuel breakthrough innovations in these areas.

[22] Not applicable
[23] No baseline has been established at this time.
[24] No construction funds will be used until the performance baseline has been validated.

Transforming the Nation's energy system is an enormously challenging task, and the trajectory of change will be steep. Meeting this challenge will require a range of technical capabilities and solutions, mobilizing our talent in government, national laboratories, universities, and the private sector. NREL, with its uniquely focused mission and experience in renewable energy and energy efficiency, is poised to provide strong leadership, integrating and mobilizing talent that will yield the innovations required to change the Nation's energy use trajectory. Accomplishing these goals for the future will require strengthening NREL's capabilities in several areas. NREL's current campus is the national focal point for renewable energy development through science and technology and provides a strong foundation for future growth. NREL's facilities meet national needs for renewable energy R&D in many areas, but gaps remain. With its focused mission in energy, NREL must provide a visible leadership example by using the energy efficiency and renewable technologies it works to develop within its own operations. NREL's planned campus expansion is an investment in the energy future of the Nation. The expanded campus will encourage innovation through interdisciplinary research. By actively enhancing the technology development interfaces between basic and applied research and between engineering and the marketplace, we will accelerate the impact of these technologies on the marketplace. Integration will be stressed from science to systems, including energy for entire communities.

Three new facilities (the Research Support Facility and the Integrated Biorefinery Research Facility in FY 2007 and the Energy Systems Integration Facility in FY 2008) have been approved for the NREL South Table Mountain (STM) site that will triple the STM staffing levels and increase the demand for parking, utilities, and computing services by the end of 2010. This project provides supporting infrastructure improvements for these three approved projects. Additionally, plans in the next few years contemplate several more research facilities that would require additional STM infrastructure.

To meet the growing infrastructure needs in the most efficient and effective way, a multi-phase utility upgrade is needed to connect existing and new buildings to required and shared utilities. This project is for the first phase of these upgrades. A utility ring concept is an industry best practice utilized in most progressive urban planning developments, and it has been adopted as NREL's strategy for its campus. The first phase of the infrastructure project will lay the ground work for the comprehensive utility ring and provide essential services to the new RSF and ESIF. The first increment will provide:

- Robust electrical service to provide fault tolerant and dependable capabilities to all new and existing campus structures;
- A distribution system for state-of-the-art fiber optic network and telecommunication services to support future new technologies and support new applications requiring advanced network services. An upgraded scientific computing and data management communication system will also be included to sustain current capabilities and allow for the necessary upgrades to support advanced computing capabilities at NREL;
- Water, sewer, storm water management and natural gas capabilities of sufficient size to support near term building upgrades and the future capacity for all new facilities as planned in the NREL Ten Year Site Plan (TYSP);
- A heating and cooling water underground distribution system that will allow campus-wide sharing of heating and cooling capacity. This sharing of existing and future heating and cooling capacity will minimize the number and expense of future heating and cooling generation

equipment, and minimize operations costs. This design will allow for the maximum use of renewable energy to heat the buildings on the STM campus, and it will provide the required heating and cooling capacity for the Research Support Facility; and

- Roads, parking and personnel walkways, and pedestrian and bicycle paths to support an additional 950 people. The surface parking will be structured to accommodate the new RSF and IBRF facilities in the FY 2010 time frame and will include plug-in capacity for hybrid vehicles. The capability will be expanded in the future to include second level parking structures over a portion of the surface parking that will allow for future NREL growth over the next ten years. Roads and walkways will be ergonomically designed and landscaped to separate vehicle and pedestrian traffic to minimize their interaction and to provide a comfortable campus atmosphere for the researchers and employees at the STM site. Due to the dramatic increase of personnel on the STM site within the next few years, a potential for significant traffic impacts exist in the surrounding communities of the STM site. To mitigate these traffic impacts this project also upgrades the onsite roadways to support a new access road on the south end of the site.

The proposed South Table Mountain Site Infrastructure Development project will extend the roads and utilities into the undeveloped central portions of NREL's primary site, develop stormwater management features necessary to meet environmental requirements, and build parking structures. Because of the limited space for development, and the desire to demonstrate the most sustainable campus design, NREL will require tiered parking structures in the parking zone on the southern edge of campus to support its long term growth. Employees will walk, bicycle, or take a shuttle to get to their workplaces; individual buildings will have parking only for disabled, deliveries, vanpools and visitors. All buildings whose occupants will use the parking structures will be within a five-minute walk of the parking structures.

As of December 2007, NREL had over 1300 occupants overall (including non-payrolled students, subcontractors, and visiting professionals). Of the total 1,300 occupants, approximately 500 were located on the South Table Mountain (STM) site, the primary research campus. In the future, to provide the capabilities needed to meet national goals, current DOE planning shows the need to expand the number of persons working at NREL on the STM site.

<u>Compliance with Project Management Order</u>

- Critical Decision – 0: Approve Mission Need – 2Q FY 2008
- Critical Decision – 1A: Approve Preliminary Baseline Range – 3rd Q FY 2008
- Critical Decision – 1B/2: Approve Performance Baseline – 1st Q FY 2009
- Critical Decision – 3: Approve Start of Construction – 1st Q FY 2009
- Critical Decision – 4: Approve Start of Operations – 4th Q FY 2011

5. Financial Schedule

	(dollars in thousands)		
	Appropriations	Obligations	Costs
Design/Construction by Fiscal Year[25]			
Design			
2008	1,910	1,910	200
2009	0	0	1,710
Total, Design	1,910	1,910	1,910
Construction			
2008	4,921	4,921	0
2009	0	0	4,921
2010	17,056	17,056	5,000
2011	0	0	12,056
Total, Construction	21,977	21,977	21,977
Total, TEC	23,887	23,887	23,887

6. Details of Project Cost Estimate

Total Estimated Costs

	(dollars in thousands)	
	Current Estimate ($000)	Previous Estimate ($000)
Preliminary and Final Design	1,910	--
Construction Phase		
Site Preparation	2,421	--
Equipment	0	--

[25] Design/Build acquisition strategy eliminates the need for separate PED funds.

(dollars in thousands)

	Current Estimate ($000)	Previous Estimate ($000)
All other construction	16,259	--
Management Reserve/Contingency (15% of Construction)	3,297	--
Total, Construction	21,977	--
Total, TEC	23,887	--

Other Project Costs

(dollars in thousands)

Cost Element	Current Estimate ($000)	Previous Estimate ($000)
Conceptual Planning	500	--
NEPA documentation costs	0	--
ES&H costs	50	--
Other Project-Related costs	700	--
Start-up	0	--
Offsetting D&D Phase		
D&D for removal of the offsetting facility	NA	--
Other D&D to comply with "one-for-one" requirements	NA	--
D&D contingency	NA	--
Total D&D	NA	--
Management Reserve/Contingency for OPC other than D&D	100	--
Total, OPC	1,350	--

7. Schedule of Project Costs

(dollars in thousands)

	Prior Years	FY 2008	FY 2009	FY 2010	Outyears	Total
TEC (Design and Construction)	0	200	6,631	5,000	12,056	23,887
Capital Equipment	0	0	0	0	0	0
OPC Other than D&D............	0	200	500	350	300	1,350
Offsetting D&D Costs	--	--	--	--	--	--

Total Project Costs................	0	400	7,131	5,350	12,356	25,237

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter)	4Q2011
Expected Useful Life (number of years)	25
Expected Future start of D&D for new construction (fiscal quarter)	NA

(Related Funding Requirements)

(dollars in thousands)

	Annual Costs		Life cycle costs	
	Current estimate	Prior Estimate	Current estimate	Prior Estimate
Operations	198	NA	9,572	NA
Maintenance	127	NA	6,119	NA
Total Related Funding[26]	325	NA	15,691	NA

9. Required D&D Information

Name(s) and site location(s) of existing facility(s) to be replaced: This project will not replace any facilities.

D&D Information Being Requested	Square Feet
Area of new construction	0
Area of existing facility(ies) being replaced (Space currently leased from private parties)	0
Area of any additional space that will require D&D to meet the “one-for-one” requirement	0

10. Acquisition Approach

Design and construction will be performed under a negotiated design/build Guaranteed Maximum Price subcontract awarded on the basis of competitive bidding and best value selection. Construction inspection, independent testing and commissioning will be performed under negotiated fixed price subcontracts awarded on the basis of competitive bidding and best value selection. All subcontracts will be managed by the M&O Contractor with oversight by the Department of Energy.

[26] Include parking lot electric utilities.

Weatherization and Intergovernmental Activities

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments[a]	FY 2008 Current Appropriation	FY 2009 Request
Weatherization and Intergovernmental Activities					
Weatherization Assistance Program	204,550	229,308	-2,086	227,222	0
State Energy Program	49,457	44,500	-405	44,095	50,000
State Energy Activities	9,348	0	0	0	0
International Renewable Energy Program	9,473	0	0	0	0
Tribal Energy Activities	3,957	6,000	-55	5,945	1,000
Renewable Energy Production Incentive	4,946	5,000	-45	4,955	0
Asia Pacific Partnership	0			0	7,500
Total, Weatherization and Intergovernmental Activities	281,731	284,808	-2,591	282,217	58,500

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Supply and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act" (1978)
P.L. 95-619, "National Energy Supply Policy Act" (NECPA) (1978)
P.L. 95-620, "Power Plant and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Supply Act" (1987)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Weatherization and Intergovernmental Program is develop, promote, and accelerate the adoption of energy efficiency, renewable energy, and oil displacement technologies and practices by a wide range of stakeholders. These include state and local governments, community agencies, companies, foreign and Native American Governments.

[a] Reflects amounts rescinded by General Provision, section 312, of the Omnibus Appropriations Act, 2008.

Accomplishing the mission will benefit both the supply and demand sides of the Department's energy security equation, enabling more productive use of the energy we consume and accelerating the arrival and use of the new fuels and technologies that we need. By 2030 the program could provide cumulative consumer savings of $2.5 billion and roughly the same savings to the electric power industry; consumer savings could grow to more than $200 billion by mid-century. Additionally, carbon savings could be nearly 250 million metric tons (MMTCE) and more than 500 MMTCE respectively. Significant additional detail on benefits is included in the Outcomes section at the end of this budget chapter.

The Weatherization and Intergovernmental Program and its activities benefit the public by improving energy productivity, reducing demand and deploying clean energy technologies. Its key programs all contribute benefits to unique government elements as follows:

- The State Energy Program (SEP) serves as a critical force in reducing energy use and costs, developing environmentally conscious economies, increasing renewable energy generation capacity, and lessening reliance of foreign oil. SEP's initiatives also strengthen national security by funding the development and maintenance of energy emergency planning at the state and local levels.
- Tribal Energy Activities is particularly valuable in building DOE partnerships with tribal governments to assess and meet Native American energy needs for residential, commercial, industrial and technological uses. It also provides technical assistance in energy efficiency and renewable energy project development.
- The Asia Pacific Partnership encourages clean energy technology deployment and meets goals for energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction. Partners include Australia, Canada, China, India, Japan and South Korea.

Program Deliverables and Interdependencies

- Weatherization promotes energy efficiency and the use of renewable energy resources at the state and tribal level enabling and effecting the incorporation of the technologies into government programs
- interdependent with Building Technologies, Wind Energy, and Solar Energy.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Weatherization and Intergovernmental Activities Program supports the following goal:

Strategic Theme 1, Energy Security

Strategic Goal 1.4, Energy Productivity: Cost-effectively improve the energy efficiency of the U.S. economy.

And concurrently supports:

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

The Weatherization and Intergovernmental Program had two program goals which contributed to Strategic Goal 1.4 in the "goal cascade":

Contribution to GPRA Unit Program Goal 1.4.22.00 (State Energy Programs)

The State Energy Program contributes to Strategic Goal 1.4 by influencing state promotion and adoption of affordable energy efficiency and renewable energy technologies.

Contribution from additional Intergovernmental Activities

Intergovernmental activities managed by the WIP contribute to Strategic Goal 1.4 by encouraging energy efficiency and renewable energy investments through incentives and technical assistance.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.4, Energy Productivity			
GPRA Unit Program Goal 1.4.21.00, Weatherization			
Weatherization Assistance Program	204,550	227,222	0
Total, GPRA Unit Program Goal 1.4.21.00, Weatherization	204,550	227,222	0
GPRA Unit Program Goal 1.4.22.00, State Energy Programs			
State Energy Program	49,457	44,095	50,000
State Energy Activities	9,348	0	0
Total, GPRA Unit Program Goal 1.4.22.00, State Energy Programs	58,805	44,095	50,000
All Other			
International Renewable Energy Program	9,473	0	0
Tribal Energy Activities	3,957	5,945	1,000
Renewable Energy Production Incentive	4,946	4,955	0
Asia Pacific Partnership	0	0	7,500
Total, All Other	18,376	10,900	8,500
Total, Strategic Goal 1.4 (Weatherization and Intergovernmental Activities)	281,731	282,217	58,500

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.4.21.00 (Weatherization)					
International Renewable Energy Program					
International Renewable Energy will strengthen and broaden activities supporting priority agreements, e.g., expanded the harmonization of standards to additional countries, ramped up implementation of the Energy Efficiency and Village Energy initiatives. Continue to work with APEC and NAEWG. [MET]	Provide technical analysis and reviews, data access, training and project support for 7 international clean energy projects which includes: developing 2 components for GIS tools to analyze U.S. EERE technology export markets; provide phase 1 technical assistance to secure access for EERE technologies to build 1,000 MW of generation globally over 10 years. [MET]				
Tribal Energy Activities					
Tribal Energy will conduct 6 technical and policy development workshops. [MET]	Tribal Energy will provide direct technical assistance to Tribal nations including: 4 development workshops, 2-3 economic development projects, 8-10 "first steps" efforts, and 6-10 feasibility studies, working toward the goal of 100 MW of generation in Indian country by 2010. [PARTIALLY MET]				
GPRA Unit Program Goal 1.4.21.00 (Weatherization)					
Weatherization Assistance Program					
Weatherize 94,450 homes, with DOE funds. [MET]	Weatherize 92,500 homes, with DOE funds, and support the weatherization of approximately 100,000 additional homes with leveraged funds. [MET]	Weatherize 97,300 homes, with DOE funds. [MET]	Weatherize 70,051 units with DOE funds. [MET]	75,848 low-income family homes weatherized annually with DOE funds, and support the weatherization of 50,000 additional homes with leveraged funds.	

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Cumulative total of 2.8 million homes will be weatherized with DOE funds. [MET] Cumulative total of 5.4 million homes will be weatherized with DOE and leveraged funds. [MET]	Program will update the energy savings benefit-cost ratio and savings per DOE dollar invested as part of a national evaluation of the program. This will allow the program to track an annual performance efficiency of Btus per Federal dollar invested. [MET]	The program will complete planning for and initiate implementation of the new comprehensive national evaluation of the Weatherization Assistance Program. The evaluation is a multi-year task that will provide new, accurate baselines for average energy savings, benefit cost ratios, and Btu energy savings per Federal dollar expended. [PARTIALLY MET]			
GPRA Unit Program Goal 1.4.22.00 (State Energy Program)					
State Energy Program					
Achieve an annual energy savings of 52,406,930 source Btu and $317,772,960 in annual energy cost savings by awarding $43,952,000 in grants to States and Territories. [MET]	Achieve an annual energy savings of 10,250,000 source Btus and $64,780.000 in annual energy cost savings with DOE funds. Achieve an annual energy savings 36,695,000 source Btus and $231,912.400 in annual energy cost savings with leveraged funds. [MET] Program will update Btu to dollar calculation derived from 2003 metrics study to establish new baseline. [MET]	Achieve an average annual energy savings of 8-10 trillion source Btus (an estimated $50-60 million in annual energy cost savings) with DOE funds. Achieve an additional average energy savings of 26-30 trillion source Btus (an estimated $190-$200 million in annual energy cost savings) from leveraged funds. [MET]	Achieve an average annual energy savings of 12-14 trillion source Btus (an estimated $72-78 million in annual energy cost savings) with DOE funds. [MET]	Achieve an average annual energy savings of 10-12 trillion source Btus (an estimated $60-70 million in annual energy cost savings) with DOE funds	Achieve an average annual energy savings of 6-7 trillion source Btus (an estimated $45 million in annual energy cost savings) with DOE funds.

Other Program Goals

WIP Financial Efficiency Measure

Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funding]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($21,257K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent.	Maintain administrative costs at less than 12 percent of total program costs.	Maintain administrative costs at less than 12 percent of total program costs.

Means and Strategies

The Weatherization and Intergovernmental Program will use various means and strategies to achieve its GPRA Unit program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve program goals. Collaborations are integral to the planned investments, means and strategies, and will provide avenues to address external factors.

WIP will implement the following means:

- Coordinate with state governments to target high priority energy needs and expand clean energy choices for citizens and businesses.
- Transform markets with competitive grants to state and local public/private partnerships.
- Conduct feasibility studies and develop of energy efficiency and renewable energy resources on tribal lands.
- Facilitate clean energy technology delivery with existing information tools and increase private sector access to developing markets.

WIP will implement the following strategies:

- Enable state energy offices to tailor energy efficiency programs to state and local needs and to leverage non-Federal resources to supplement Federal assistance.
- DOE will collaborate with national and regional organizations representing key decision-makers (e.g., governors, mayors, state legislators, end users, and product and service providers) to establish market penetration for under-utilized and emerging technologies. Efforts will be funded through competitive grants, technical assistance and the replication of best practices.
- Develop solid partnerships with tribal governments, provide technical support for renewable energy and energy efficiency projects, and increase long range planning capacity for residential, commercial and industrial energy uses.
- Consolidate international efforts in countries affording strategic opportunities. The Asia Pacific Partnership will implement strategies abroad used successfully in EERE Buildings Technologies and Industrial Technologies Programs and renewable energy generation capacity.

The following external factors could affect WIP's ability to achieve its goals:

- Rates of market growth/technology adoption;
- Capital investment requirements;
- Energy supply markets and prices;
- Costs and adoption of technologies;
- Partner cost share and participation rates; and
- Geopolitical changes.

In carrying out the program's mission, WIP collaborates with several groups on its key activities including:

- The State Energy Program works closely with all 50 States, the District of Columbia, and U.S. territories;
- Tribal Energy subprogram maintains a close collaboration with the Bureau of Indian Affairs, Department of Interior, Department of Justice, and the Environmental Protection Agency through the Federal Interagency Working Group on Environmental Justice (IWG).
- The Asia Pacific Partnership will implement strategies to apply EERE Buildings, Industry and Renewable Technologies in APP countries, with efforts particularly focused in China and India.

Validation and Verification

To validate and verify program performance, the Weatherization and Intergovernmental Activities will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review as described below. The table below summarizes validation and verification activities.

Data Sources:	The Energy Information Administration's (EIA) Annual Energy Review (AER), Renewable Energy Annual and Annual Energy Outlook, International Energy Annual, World Energy Outlook, Country Analysis Briefs, Commercial Building Energy Consumption Survey (CBECS), Residential Energy Consumption Survey (RECS); Central Intelligence Agency (CIA) The World Factbook; U.S. Department of Commerce (DOC) Current Industrial Reports (CIR); the Golden Field Office REPI Reimbursement tracking system; NREL and various trade publications; and information collected directly from WIP performers or partners.
Baseline:	▪ The SEP baseline is state energy consumption in 1990. This baseline will be updated as part of the findings from a major national evaluation. ▪ Tribal Energy 2003 baseline is 750 kW of renewable generation capacity on tribal lands. ▪ The key baselines to be used in APP will be determined by its interagency task force.
Frequency:	Annual (complete revalidation of assumptions and results can only take place every 3 to 4 years, due to the reporting cycle of two critical publications, CBECS and RECS. However, updates of most of the baseline forecast and WIP outputs will be undertaken annually).
Evaluation:	In carrying out the program's mission, WIP uses several forms of evaluation to assess progress and to promote program improvement. ▪ Operational field measurement as appropriate; ▪ Peer review by independent outside experts of both the program and

subprogram portfolios;

- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate.
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); PMA (the President's Management Agenda -- annual departmental and Program Secretarial Officer (PSO) based goals whose milestones are planned, reported and reviewed quarterly); and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage:	EIA data sources are available on line. Trade publications are available on a subscription basis. WIP output information is contained in various reports and memoranda. Reviews and analyses conducted by Oak Ridge National Laboratory are available on line at http://www.ornl.gov/info/reports/ORNL_reports.shtml.
Verification:	Calculations are based on assumptions of future market status, equipment or technology performance, and market penetration rates. These assumptions can be verified against actual performance through technical reports, market surveys and product shipments. SEP based results on an assessment of program outcomes conducted by Oak Ridge National Laboratory whose methodology was independently reviewed in FY 2005 by the Board of Directors of the International Energy Program Evaluation Conference. Tribal Energy maintains project information and receives data from individual Tribal Governments. EIA and CIA data undergo regular verification reviews.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The 2003 Weatherization PART resulted in an overall rating of "moderately effective" with the following scores: purpose (100 percent), planning (88 percent) management (78 percent) and results (75 percent). The PART found that the program coordinates effectively with other related government programs in its efforts to meet interrelated Departmental goals and achieves its goals of a favorable benefit-cost ratio and other performance goals, based on internal programmatic assessments. Consistent with PART recommendations, the program is underway with a multi-year national evaluation designed to ensure that its objectives are being met and to validate energy savings, energy bill reductions, program costs, and program benefit estimates.

The 2004 State Energy Program PART (its initial review) resulted in a rating of "results not demonstrated" with the following scores: purpose (100 percent), planning (25 percent), management (89 percent), and results (16 percent). The program's shift from measuring grants processed to measuring energy impacts was not sufficiently in place to substantiate results.

In FY 2006, SEP developed a strategic plan with States which included acceptable performance measures. While noting Oak Ridge National Laboratory's assessment that the program generates significant energy and cost savings, the PART review noted that data was not available from all States and that the study was not prepared by an independent source. Also, in FY 2006, a report by the DOE Inspector General found problems with the methodology and data that the program used to support energy benefit claims. The program is planning future analyses to be conducted by external independent entities. Subsequently, ORNL conducted a second study based on data from 50 States, 5 Territories and DC, which was reviewed by the Board of Directors of the International Energy Program Evaluation Conference, an independent body comprised of many recognized peer experts in the energy efficiency program evaluation field, which found the methodology to be "a good start".

Expected Program Outcomes

Weatherization and Intergovernmental Activities pursues its mission through integrated activities designed to improve the energy efficiency, flexibility, and productivity of our energy economy. The Department expects these improvements to reduce susceptibility to energy price fluctuations; reduce greenhouse gas emissions; reduce EPA criteria and other pollutants; and enhance energy security by enabling the use of technologies that will increase the production and diversity of domestic fuel supplies. Realization of the program goals would provide the potential to reduce conventional energy use. WIP is considered an "enabler" and helps in the realization of efficiency improvements and greenhouse gas reductions from other technologies, such as intermittent renewables.

The goals are modeled in contrast to the "baseline" case, in which no DOE RD&D exists. The baseline case is identical to those used for all DOE applied energy programs.[a] Further, across EERE, and across all of DOE's applied energy programs, the expected outcome benefits are being calculated using the same fundamental methodology. Finally, the metrics by which expected outcome benefits are measured are identical for all of DOE's applied energy programs.[b] This standardization of methods and metrics has been undertaken to address the R&D investment criterion that "Programs and projects must articulate public benefits of the program using uniform benefit indicators across programs and projects with similar goals."[c] By 2030 the program could provide cumulative consumer savings of $2.5 billion and roughly the same savings to the electric power industry; consumer savings could grow to more than

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[a] The starting point for the baseline case is the Energy Information Administration's "reference case," as published in the AEO 2007. Program analysts from across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO's technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

[b] The set of expected outcome metrics being used this year differs in substantial ways to that of previous years. In addition to the standardization across DOE's applied energy R&D programs, the list is expanded and more comprehensive than in past years. Further, the list maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

[c] See OMB-OSTP priorities memo, p. 10. http://www.whitehouse.gov/omb/memoranda/m03-15.pdf.

$200 billion by mid-century. Additionally, carbon savings could be nearly 250 million metric tons (MMTCE) and more than 500 MMTCE respectively.

EERE analysis of benefits associated with the Weatherization and Intergovernmental Activities Programs are provided below.

The expected program outcomes from the Asia Pacific Partnership are not represented by the tools or models utilized by EERE for its benefits calculations. While the Asia Pacific Partnership and its goals are still in the developing stages, pilot demonstration programs have been developed that provide opportunity for partnership countries to replicate U.S. success in reducing energy intensity.

Primary Benefits Metrics for FY09 Target Request – NEMS and MARKAL

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	0.1	0.2
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	NA	NA	NA	N/A
		MARKAL	ns	ns	0.2	2.0
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	65	139	243	N/A
		MARKAL	32	102	308	653
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	6	12	25	N/A
		MARKAL	15	41	115	207
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	7	15	24	N/A
		MARKAL	4	12	30	55
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	10	10	20	N/A
		MARKAL	ns	ns	13	7

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Weatherization Assistance Program

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Weatherization Assistance Program			
Weatherization Assistance Grants	200,000	222,713	0
Training and Technical Assistance	4,550	4,509	0
Total, Weatherization Assistance Program	204,550	227,222	0

Description

The Weatherization Assistance Program (WAP) provided technical assistance and formula grants to state and local weatherization agencies throughout the United States. A network of approximately 970 local agencies provided trained crews to perform weatherization services for eligible low-income households in single-family homes, multifamily dwellings, and mobile homes. Of the homes weatherized annually, 49 percent were occupied by an elderly person with special needs or a person with disabilities. Other priorities were given to families with children, and households that spend a disproportionate amount of their income on energy bills (utility bills make up 16 percent of household expenses for low income families, compared to five percent or less for all other Americans). All homes received a comprehensive energy audit, which is a computerized assessment of a home's energy use and an analysis of which energy conservation measures are best for the home; a combination of those energy-saving measures are then installed.

Weatherization Assistance Program contributed to the WIP goal by reducing the energy cost burden to low-income households that pay a disproportionate amount of household income on energy bills. Since 1976, the Weatherization Assistance Program has helped over five million American families reduce their energy bills and increase the comfort and safety of their homes resulting in average annual cost savings of $358 per household.[a] Weatherization also provided many non-energy benefits to recipient households and their communities. For example, it helped stabilize the housing stock in low-income neighborhoods and supports approximately 8,000 technical jobs in local home energy businesses. Non-Federal funds also are leveraged by States. The table below summarizes the most recent data available.

[a] Oak Ridge National Laboratory. Estimating The National Effects of the U.S. Department of Energy's Weatherization Assistance Program With Sate-Level Data: A Metaevaluation Using Studies From 1993-2005"; October 2005

Weatherization Assistance Funding

(whole dollars)

State	Source of Non-Federal Funds	FY 2008 Federal DOE Funds	FY 2006 Non-Federal Funds [a]
Alabama	N/A	$2,396,413	$275,000
Alaska	Alaska Housing Finance Corp (State)	$1,672,643	$3,000,000
Arizona	Utility funds	$1,352,772	$1,250,000
Arkansas	Utility funds	$2,061,017	$0
California	(Utility funds operated at local level)	$6,265,676	$0
Colorado	Utility funds	$5,454,329	$2,482,000
Connecticut	(Utility funds operated at local level)	$2,495,304	$5,800,000
Delaware	Utility funds	$572,412	$360,000
Dist. Columbia	Utility Funds	$646,384	$1,125,000
Florida	State Funds for WAP Repair Program	$1,948,403	$0
Georgia	Utility funds	$2,914,609	$1,900,000
Hawaii	N/A	$203,581	$0
Idaho	Utility funds and private sources	$1,964,431	$1,642,511
Illinois	State public benefit funds	$13,784,473	$7,800,000
Indiana	(Utility funds operated at local level)	$6,520,687	$2,000,000
Iowa	Utility funds	$4,966,077	$4,814,742
Kansas	N/A	$2,518,837	$0
Kentucky	N/A	$4,498,867	$0
Louisiana	N/A	$1,723,424	$0
Maine	State Public Utility Commission funds	$3,053,961	$0
Maryland	(Utility funds operated at local level)	$2,640,259	$1,850,000
Massachusetts	(Utility funds operated at local level)	$6,517,890	$23,030,692
Michigan	N/A	$15,118,849	$4,215,000
Minnesota	Utility funds and special State funds	$9,809,089	$440,500
Mississippi	N/A	$1,640,948	$0
Missouri	Utility funds	$5,975,410	$2,552,388
Montana	Utility funds	$2,507,786	$1,923,903
Nebraska	N/A	$2,482,462	$0
Nevada	Utility funds	$831,718	$3,300,000
New Hampshire	Utility funds	$1,501,762	$1,417,482

[a] FY 2007 funding data not available until January, 2008

(whole dollars)

State	Source of Non-Federal Funds	FY 2008 Federal DOE Funds	FY 2006 Non-Federal Funds [a]
New Jersey	Utility funds, landlord contributions, other private funds	$5,078,993	$3,723,000
New Mexico	Utility funds	$1,900,941	$3,873,000
New York	Utility funds, landlord contributions, other private funds	$20,075,816	$7,000,000
North Carolina	N/A	$4,139,225	$0
North Dakota	N/A	$2,485,405	$0
Ohio	Utility funds, landlord contributions, other private funds	$13,676,435	$20,000,000
Oklahoma	Landlord contributions, other private funds	$2,579,529	$20,755
Oregon	Utility funds	$2,808,354	$8,256,292
Pennsylvania	(Utility funds operated at local level)	$14,638,184	$0
Rhode Island	Utility funds	$1,150,982	$900,000
South Carolina	N/A	$1,767,384	$150,000
South Dakota	N/A	$1,907,964	$0
Tennessee	N/A	$4,162,066	$0
Texas	Utility funds	$5,549,413	$2,203,235
Utah	Utility funds, TANF	$2,067,579	$351,000
Vermont	VT Weatherization Trust Fund	$1,272,118	$5,991,917
Virginia	Emergency Home Repair funds	$3,997,991	$2,000,000
Washington	Utility funds and State capital funds	$4,519,063	$8,560,000
West Virginia	Utility funds	$3,196,901	$0
Wisconsin	Utility funds	$8,528,669	$41,101,045
Wyoming	N/A	$1,169,217	$495,000
	Headquarters Training and Technical Assistance	$4,508,595	$0
Total, Weatherization Assistance Funding		$227,221,297	$175,804,462

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Weatherization Assistance Grants	**200,000**	**222,713**	**0**

The FY 2008 target was to weatherize 75,848 low income homes. The program saved $1.53 in energy costs for each dollar invested (based on CY 2006 EIA energy price projections).

The majority of the Weatherization Assistance Program funding was allocated to the States as operating funds for this purpose, i.e., for labor, materials, equipment and administrative systems.

A percentage of the total program funding was allocated for state-based training and technical assistance to maintain a high standard of technology application, effectiveness and results. Most training and technical assistance was performed at state and local levels.

Training and Technical Assistance	**4,550**	**4,509**	**0**

DOE conducted analysis, measured and documented program performance, and promoted (e.g., through pilot programs, publications, training programs, workshops and peer exchange) the application of advanced techniques and collaborative strategies to improve program effectiveness.

The Weatherization Assistance Program initiated a national evaluation to assess the overall energy savings and cost-effectiveness of the program, assess the impact of numerous changes made to program policy and procedures, and determine the best methods to improve future program performance.

Total, Weatherization Assistance Program	**204,550**	**227,222**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Weatherization Assistance Grants	
Funds are redirected to R&D programs which deliver greater benefits. EERE's Efficiency portfolio has historically provided approximately 20 to 1 benefit to cost ratio. In comparison, Weatherization has a benefit cost ratio of 1.53 to 1.	-222,713
Training and Technical Assistance	
With the closure of the weatherization Assistance program, no funds for Technical and Training Assistance are needed. Through FY 2008, Technical and Training Assistance supported the implementation of Weatherization Assistance Grants.	-4,509
Total Funding Change, Weatherization Assistance Program	**-227,222**

State Energy Program

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
State Energy Program			
State Energy Program Grants	49,457	34,186	25,000
State Energy Program Special Projects	0	9,909	25,000
Total, State Energy Program	49,457	44,095	50,000

Description

The State Energy Program (SEP) provides financial and technical assistance to States through formula and competitive special project grants, enabling state governments to target their own high priority energy needs and expand clean energy choices for their citizens and businesses.

SEP is the only Federally funded, state-based program administered by DOE that provides resources directly to the States for projects exclusively of their own choosing, so long as they meet program criteria and oversight requirements. With grant funds and leveraged resources, the State and Territory Energy Offices develop and manage a variety of programs designed to increase energy efficiency, reduce energy use and costs, develop alternative energy and renewable energy sources, promote environmentally conscious economic development and reduce reliance on oil produced outside the U.S. State Energy Offices remain instrumental in administering public benefits funds and energy emergency preparedness.

SEP supports EERE's market transformation goals by helping States encourage energy advances in areas of education, government, employment and technology. SEP funds support the development and maintenance of energy emergency planning at the state and local levels, a critical security benefit. The subprogram is quantifying energy benefits of activities, including savings and emissions reductions.

Planned State Energy Program Savings (trillion source Btus)

	2009	2010	2011	2012	2013
Target	6-7	6-7	6-7	6-7	6-7
Actual	-	-	-	-	-

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
State Energy Program Formula Grants	**49,457**	**34,186**	**25,000**

The State Energy Program (SEP) request includes $25 million in formula grants to ensure all States have energy programs and services for citizens, while maintaining the viability of the State Energy Office network.

Fifty States and the District of Columbia and U.S. Territories will receive formula grants for energy efficiency/renewable programs. SEP is conducting a national evaluation to determine the impacts of state energy efficiency and renewable energy programs. The funds requested sponsor information technology systems needed to evaluate and report in compliance with the E-Gov initiative. Additionally, SEP provides planning and technical direction to States to address energy and environmental issues affecting transportation and air quality in neighboring regions.

State Energy Program Special Projects	**0**	**9,909**	**25,000**

In FY 2009 $25 million is requested for SEP Special Projects (competitive), and focus on market transformation and crosscutting solutions targeted at market sectors. (They will not be technology specific independent solicitations, as they were in FY 2005.) The program will pursue state and local innovations that can be replicated, including removing market barriers at the state level as well as crosscutting, holistic solutions, e.g., city/county-wide planning and project development so that EERE technologies can compete with fossil fuel technologies on a level playing field. The program will expand work with States and utilities to improve the liquidity of renewable power as a commodity of high market value to consumers, reduce barriers to utility investment in energy efficiency to meet future electricity demand, scale up the use of energy saving performance contracting in state and local buildings, and expand state/pilot models for residential energy efficiency through green mortgages for all income levels.

Total, State Energy Program	**49,457**	**44,095**	**50,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
State Energy Program Grants	
Decreased to allow for higher yield competitive grants to States. The $25 million request maintains core capabilities of State Energy Offices.	-9,186
State Energy Program Special Projects	
Increased to allow for higher yield competitive grants to States. These projects focus on market transformation and crosscutting solutions targeted at market sectors. These will not be technology specific independent solicitations. The program will pursue state and local innovations that can be replicated, including removing market barriers at the state level as well as crosscutting, holistic solutions, e.g., city/county-wide planning and project development so that EERE technologies can compete with fossil fuel technologies on a level playing field. The program will expand work with States and utilities to improve the liquidity of renewable power as a commodity of high market value to consumers, reduce barriers to utility investment in energy efficiency to meet future electricity demand, scale up the use of energy saving performance contracting in state and local buildings, and expand state/pilot models for residential energy efficiency through green mortgages for all income levels.	+15,091
Total Funding Change, State Energy Program	**+5,905**

State Energy Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
State Energy Activities			
Planning and Evaluation Support for State and Local Grant Programs	9,348	0	0
Total, State Energy Activities	9,348	0	0

Description

State Energy Activities complemented the State Energy Program. Former activities, such as metrics evaluation, program communication and oversight, are included as part of the State Energy Program request. In FY 2007, the subprogram implemented EPACT 2005 provisions relating to energy efficiency pilots, utility reform and renewable energy certificate trading.

State Energy Activities contributed to WIP deployment goals by supporting State Energy Program grant activities. This funding provided assistance to States to implement planning and analysis for policies, programs and projects that increased market penetration of energy efficiency and renewable energy technologies and policies.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Planning and Evaluation Support for State and Local Grant Programs	**9,348**	**0**	**0**

No change. Activities, including program evaluation, planning, and analysis, State Energy Advisory Board support, EPACT 2005 requirements, and State training and technical assistance are included in the State Energy Program Request.

Total, State Energy Activities	**9,348**	**0**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
State Energy Activities	
No Change.	0
Total Funding Change, State Energy Activities	**0**

International Renewable Energy Program

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
International Renewable Energy Program			
International Renewable Energy Program	9,473	0	0
Total, International Renewable Energy Program	9,473	0	0

Description

The International Renewable Energy Program (IREP) generated market transformation in international energy markets to increase the installation of domestically developed (i.e., U.S.-manufactured) technologies. Specific activities included evaluating local energy needs, raising awareness of renewable energy opportunities, delivering training and technical assistance to foreign energy decision-makers, and apprising them of opportunities related to their domestic energy markets.

The IREP provided technical assistance through National Laboratories and outside experts, helping meet specific commitments contained in bilateral and multilateral agreements.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
International Renewable Energy Program	**9,473**	**0**	**0**
International Renewable Energy (IREP) activities focused on technical assistance to foreign governments and companies that design and install renewable energy technologies. Additionally, in FY 2007 the Asia Pacific Partnership activities were funded within this subprogram. In FY 2009, these efforts are requested within a separate subprogram.			
Total, International Renewable Energy Program	**9,473**	**0**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
International Renewable Energy Program	
No funds are requested in order to focus resources on high priority advanced R&D initiatives within EERE. Additionally, in FY 2007 the Asia Pacific Partnership activities were funded within this subprogram. In FY 2009, these efforts are requested within a separate subprogram.	0
Total Funding Change, International Renewable Energy Program	**0**

Tribal Energy Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Tribal Energy Activities	3,957	5,945	1,000
Total, Tribal Energy Activities	3,957	5,945	1,000

Description

Tribal Energy Activities builds partnerships with Tribal Governments to address Native American energy needs for residential, commercial and industrial uses. It develops, implements, and manages technical assistance projects promoting energy, environmental and economic development policy objectives for Native Americans. The activities provide means for Tribal leaders to make knowledgeable choices regarding their Tribes' energy future, through resource assessments, workshops, training, and energy plan development assistance.

Tribal Energy Activities contribute to WIP's mission by employing EERE technologies and developing strong partnerships with Tribal Governments to meet Native American energy needs. Between FY 2002 and FY 2006, 76 tribal energy projects totaling $12.4 million, leveraged by $3.3 million cost shared by the Tribes, have been competitively selected for awards. Included among these are the installation of the first utility-scale wind turbine (750 kW) on the Rosebud Sioux Reservation (FY 2003) and the installation of a substation at the Colville Indian Power and Veneer plant in Washington State, which is projected to reduce line losses and save $160,000 to $260,000 per year.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Tribal Energy Activities	**3,957**	**5,945**	**1,000**

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

The Tribal Energy projects support the developmental capacity of 565 Federally recognized Native American Tribes to assess and meet energy needs both for residential and economic development. Tribal Energy Activities provide financial (prior to FY 2009) and technical assistance to Tribes for: strategic planning, energy options analysis, organizational development, capacity building, and feasibility studies.

Tribal Energy Activities helps Tribes address clean energy needs collaboratively with the Department of Interior and the Department of Housing and Urban Development. Low income Tribal members need greatly the benefits of low-cost energy efficiency technologies to reduce their energy costs. The Tribal Energy Activities continues to address the unique project development concerns of Tribal Governments.

Tribal leaders face persistent challenges with economic development and energy accessibility. Because of their remote locations and distance from, or access to, transmission and distribution systems, many Tribes have an inadequate energy service. This situation inhibits economic development efforts and programs to promote rural education, public health, and safety. In many ways, the energy problems faced by the Tribes resemble the energy problems faced by developing nations and remote populations around the world.

Total, Tribal Energy Activities	**3,957**	**5,945**	**1,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Tribal Energy Activities	
Funding reduction maintains core tribal energy assessment and technical assistance contributions. In FY 2008, program restructuring was initiated to develop finance mechanisms that streamline project development and increase access to private developers, thereby reducing the need for direct financial assistance to Tribes. Redirected funds enable EERE to accelerate critical national research priorities that benefit the Nation.	-4,945
Total Funding Change, Tribal Energy Activities	**-4,945**

Renewable Energy Production Incentive (REPI)

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Renewable Energy Production Incentive	4,946	4,955	0
Total, Renewable Energy Production Incentive	4,946	4,955	0

Description

The Renewable Energy Production Incentive (REPI) subprogram provided financial incentive payments to publicly owned utilities, not-for-profit electric cooperatives, and Tribal governments and native corporations that own and operate qualifying facilities generating renewable electricity.

REPI supported the WIP goal to promote increases in the generation and utilization of electricity from renewable energy sources and to further the advances of renewable energy technologies.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Renewable Energy Production Incentive	**4,946**	**4,955**	**0**
Through FY 2008, REPI provided financial incentive payments to publicly owned utilities, not-for-profit electric cooperatives, and Tribal Governments and native corporations that own and operate qualifying facilities generating renewable electricity.			
Total, Renewable Energy Production Incentive	**4,946**	**4,955**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Renewable Energy Production Incentive	
The incentive value of REPI has diminished over time as renewable energy technologies have reduced in cost and become more competitive. Other factors, such as state initiatives and policies, like Renewable Portfolio Standards, have further reduced the value of this program. Finally, the steadily growing pool of eligible applicants has resulted in increasingly smaller amounts which can be paid out, given the limited availability of funds to distribute.	-4,955
Total Funding Change, Renewable Energy Production Incentive	**-4,955**

Asia Pacific Partnership

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Asia Pacific Partnership	0	0	7,500
Total, Asia Pacific Partnership	0	0	7,500

Description

The Asia Pacific Partnership (APP) pursues project development, implementation assistance, and capacity building with foreign governments and private sector entities. These partnerships establish investment strategies for marketable energy technologies and improve governance practices in emerging markets around the world. The State Department is the lead agency for the APP. In addition to DOE, other participating agencies include the Department of Commerce and the Environmental Protection Agency. DOE's Office of Fossil Energy also requests $7.5 million for APP.

The Asia Pacific Partnership activities meet goals for energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction. U.S. Federal Government efforts, in collaboration with APP partner countries (Australia, Canada, China, India, Japan, and South Korea), are working to install new renewable power generating capacity, transfer/demonstrate best manufacturing practices for targeted industries; transfer/demonstrate best design and construction practices for buildings; and encourage the adoption of efficient appliances standards.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Asia Pacific Partnership	**0**	**0**	**7,500**

In FY 2009, APP will support DOE task force commitments in the areas of new renewable energy generation, best manufacturing practices for targeted industries, and best design and construction practices for buildings and efficient appliance standards. The FY 2009 request funds the following:

New Renewable Power Generating Capacity – Consistent with the APP Charter, EERE will provide technical assistance and collaborate with the other partners to promote and create an enabling environment for the development, diffusion, deployment and transfer of existing and emerging cost-effective, new renewable power generating technologies and practices. Initial focus will be on lower-cost clean power to areas without access to modern energy services.

Best Manufacturing Practices for Targeted Industries – Focus on identifying and addressing energy losses that when remedied will reduce the energy requirements of industry while stimulating economic productivity and growth. The initial industries examined with the assistance of EERE's Industrial Technologies Program developed tools are likely to be aluminum, steel, and cement. As illustration of the potential -- Industrial energy consumes over 60% of China's primary energy consumption. Successful industrial strategies in the US targeting highest energy users are being applied in China. The related benefit will be the establishment of an infrastructure (training industrial organizations and universities) capable of taking on their own industrial assessments in China.

Best Design and Construction Practices for Buildings; and Efficient Appliances Standards – The most cost-effective energy savings policy is adoption and enforcement of appliance standards and energy efficient building codes. Each country has or is developing energy efficient building codes and APP is increasing the effectiveness and exploring practices to ensure code compliance. The Agenda 21 building, an APP Flagship project will demonstrate these technologies and practices. Tools and codes developed in EERE's Buildings Technologies Program will be used.

Total, Asia Pacific Partnership	**0**	**0**	**7,500**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Asia Pacific Partnership	
EERE participation in APP will greatly accelerate deployment of cleaner energy supply and efficiency technologies. The seven partner countries -- Australia, Canada, China, India, Japan, South Korea, and the United States – account for about half of the world's economy, population, and energy use. The economies of China and India, the two largest energy consuming nations, are experiencing explosive growth. Increased adoption of clean energy technologies in APP member countries improves U.S. and international energy security and environmental quality.	+7,500
Total Funding Change, Asia Pacific Partnership	**+7,500**

Program Direction

Funding Profile by Category

	(dollars in thousands/whole FTEs)		
	FY 2007	FY 2008	FY 2009
Headquarters			
Salaries and Benefits	42,212	47,110	50,394
Travel	2,139	2,354	2,426
Support Services	11,609	8,496	19,534
Other Related Expenses	7,611	8,856	8,717
Total, Headquarters	63,571	66,816	81,071
HQ Full Time Equivalents	319	338	359
Golden Field Office (Project Management Center)			
Salaries and Benefits	15,057	17,425	20,515
Travel	1,235	678	780
Support Services	3,872	3,655	2,807
Other Related Expenses	3,319	2,550	2,442
Total, Golden Field Office	23,483	24,308	26,544
GO Full Time Equivalents	132	141	150
National Energy Technology Laboratory (Project Management Center)			
Salaries and Benefits	10,430	11,089	12,091
Travel	240	282	366
Support Services	1,540	1,562	1,774
Other Related Expenses	0	0	0
Total, National Energy Technology Laboratory	12,210	12,933	14,231
NETL Reimbursable Full Time Equivalents [a]	(61)	(61)	(64)
Total Program Direction			
Salaries and Benefits	67,699	75,624	83,000
Travel	3,614	3,314	3,572
Support Services	17,021	13,713	24,115

[a] Fossil Energy Employees

	(dollars in thousands/whole FTEs)		
	FY 2007	FY 2008	FY 2009
Other Related Expenses	10,930	11,406	11,159
Total, Program Direction	99,264	104,057	121,846
Total, EERE Full Time Equivalents	451	479	509
Total, NETL Reimbursable Full Time Equivalents[a]	(61)	(61)	(64)

Mission

Program Direction funding allows EERE to advance the Department's energy efficiency and renewable energy goals and objectives as well as implement the President's Management Agenda. Program Direction provides for Federal staffing resources that provide management and oversight of the complex network of National Laboratories, industrial partners, state and local governments, universities, and private companies. It funds staffing, travel, policy review and coordination, infrastructure and construction management, contracts for security and administrative support at the Golden Field Office (GO) and the National Energy Technology Laboratory (NETL). The budget includes funding for human capital resources management, contract support services for budget formulation, execution, and analysis, the development, operations and maintenance of mission-critical corporate management information technology (IT) systems, acquisition of IT hardware, equipment, and general office supplies.

Headquarters

Program personnel are responsible for the following functions:

- Defining the program goals and policies;
- Developing Strategic, Multi-year, and Annual Operating Plans to achieve the goals;
- Formulating and defending the budget requests;
- Executing and implementing appropriated budgets; and
- Overseeing the technical progress of the program and providing feedback on lessons learned to improve program activities.

The EERE Technology Development Programs are supported by the Deputy Assistant Secretary for Business Administration, whose organization consists of three line offices: Program Execution Support; Planning, Budget and Analysis; and Information and Business Management Systems. Together with the EERE Project Management Center (PMC), these offices provide centralized business management services to execute the programs activities. These organizations also lead the EERE President's Management Agenda initiatives for Human Capital Management, E-Government, Budget and Performance Integration, Improved Financial Management, Research & Development (R&D) Investment Criteria, and Competitive Outsourcing.

[a] Fossil Energy Employees

EERE PMC

The FY 2009 budget provides for the fully developed EERE PMC. The PMC consists of administrative, finance, and project management staff at two sites, the Golden Field Office (GO) and the Office of Fossil Energy's (FE) National Energy Technology Laboratory (NETL).

The PMC personnel are responsible for providing an integrated, multi-disciplinary project management oversight function which ensures that all program implementation activities are thoroughly defined, promptly initiated, and carried out successfully in pursuit of EERE program goals and objectives. As a PMC, GO and NETL provide dedicated Contracting Officers (COs) and Contracting Officer Representatives (CORs) to perform field project management of R&D partnerships.

GO/PMC

The GO staff of COs and CORs is supported by technical monitors hired under a support-services contract. GO also supports EERE efforts through the administration of the National Renewable Energy Laboratory (NREL) management and operating (M&O) contract, and serves as field coordinator and Federal Project Managers of facility planning and construction. GO staff also provide direct support to numerous HQ elements in accordance with the Secretary's direction on Functional Reporting. Functional support is provided in Financial Management, Human Capital, Information Technology, Legal, Procurement, and Public Affairs.

GO provides management support for the following programs: Hydrogen Technology; Biomass; Solar Energy; Federal Energy Management Program (FEMP); Water Power; Weatherization and Intergovernmental Activities; Clean Cities; Geothermal; Industrial Technologies; and Wind Energy.

Key activities include:

- Administering the M&O contract for NREL;
- Facilities and Infrastructure planning and coordination;
- Managing the FEMP Super Energy Savings Performance Contracts and serving as the focal point for FEMP finance and procurement activities;
- Partnering with industry and academia in joint R&D projects to further develop and facilitate delivery of applied R&D, including work with Hydrogen Technology;
- Implementing Inter-Agency Agreements between DOE and other Federal agencies, such as the Environmental Protection Agency, General Services Administration, Federal Emergency Management Agency, and the Department of the Interior, to implement joint projects where EERE technologies are relevant;
- Providing EERE's national program managers at Headquarters with customer feedback on how to make their programs more effective and efficient;
- Supporting and helping deliver special initiatives of the President, Secretary, Assistant Secretary, and other senior DOE Officials.
- Performing as Project Manager for formula grant activities.
- Managing Congressionally-directed projects.

NETL/PMC

Serves as the other PMC site for EERE. In FY 2009, EERE budgets for 64 reimbursable employees at NETL. While NETL is an FE laboratory, it provides project management and financial services to other elements of DOE on a reimbursable basis. In FY 2004, EERE and FE signed a Memorandum of Agreement that formalized this partnership.

Provides procurement, financial assistance, and project management services to the following programs: Vehicle Technologies (including Clean Cities); Weatherization and Intergovernmental (formula grant) Activities; Building Technologies; FEMP; Industrial Technologies; and Wind Powering America.

Provides dedicated COs and CORs to perform field project management of R&D, and deployment partnerships. The staff of COs and CORs is supported by in-house procurement and legal specialists, along with other administrative services as needed.

The table below shows the funds programmed in FY 2007 and the budget requests allocations in FY 2008 and FY 2009.

	(dollars in thousands)		
Programs	FY 2007	FY 2008	FY 2009
Project Management Center (PMC)	5,284	5,588	6,551
Building Technologies	2,935	3,138	3,276
Federal Energy Management	272	233	255
Vehicle Technologies	2,153	2,301	2,402
Weatherization and Intergovernmental Activities	1,566	1,673	1,747
Total, NETL funding from Program Direction	12,210	12,933	14,231
Total, Full Time Equivalents[a]	61	61	64

Below are the consolidated Regional Office functions that are now performed at both PMC locations (GO and NETL):

- Administering EERE's principal technology deployment grant programs, including the Weatherization Assistance Program and the State Energy Program;
- Delivering EERE's principal technical assistance programs, including Clean Cities, Rebuild America, and the FEMP;
- Serving as EERE's liaison to state energy offices, other state agencies, regional organizations of the National Governors Association, and other stakeholders involved in energy and environmental quality issues;

[a] Fossil Energy Employees

- Creating local, state, and regional partnerships and leveraging local, state, and regional resources to maximize the impact of EERE's technologies and programs; and
- Helping EERE's end use sectors deliver their programs to state and local stakeholders.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Salaries and Benefits	**67,699**	**75,624**	**83,000**

The DOE Headquarters component, consisting of 359 FTEs, is responsible for the development of policies, strategic plans and related guidance to energy efficiency and renewable energy program offices; the evaluation of program performance; the formulation, defense and execution of renewable energy and energy efficiency budgets; as well as technology advancement and outreach with the public and stakeholders regarding policies, funding, program performance, and related issues.

EERE Program Direction supports a GO personnel level of 150 FTEs. This maintains a centralized PMC at GO, with a particular emphasis on increasing the program execution support for the President's Advanced Energy Initiative. Program Direction also funds a NETL personnel level of 64 reimbursable (Fossil Energy) FTEs who support the EERE mission.

Current and future staff performance is measured by responsiveness to National Energy Policy goals and objectives; implementation of the President’s R&D Investment Criteria for priority decision making; continued improvement in the utilization of Federal personnel, travel, space and support service activities; increases in competitive and cost-sharing procurement awards; extending the use of more efficient electronic government information systems; improving financial performance, particularly in reducing uncosted balances; and further integration of program metrics into the budget resource allocation process.

Travel	**3,614**	**3,314**	**3,572**

The FY 2009 request provides travel funds for 573 FTEs, including the enhanced staff of project managers at the EERE PMC to support mission-critical activities and improve project management and oversight per IG recommendations made in their report entitled “Management Controls over the State Energy Program’s Formula Grants,” Office of Inspector General, Office of Audit Services, April 2006 OAS-M-06-05. The additional funds requested in FY 2009 reflect higher projected travel costs and also respond to the IG’s finding that project oversight should be improved.

Support Services	**17,021**	**13,713**	**24,115**

The FY 2009 Support Services Request includes funding for support service contractors, including IT (Local Area Network and Personal Computers) support, e-mail service, and the Assistant Secretary's energy initiatives. By Congressional direction, general management support services are funded within this line-item. Support for program-specific technical analyses, road-mapping, market studies, etc., are funded within each individual R&D programs. The request provides support services needed for business management systems development and support for I-MANAGE, ePMA, the department's Standard Budget System, safety and health support; facility safeguards and security; and computer hardware and software installation, configuration, and maintenance activities.

The FY 2009 funds include landlord services at the GO and for IT services and local-area network operations. The funding level also supports our goal to move program and project management activities to GO contractors, rather than having the work subcontracted through the National Laboratories. Support service assistance will be utilized in activities that are not inherently Federal, such as: preparation of draft administrative paperwork, technical editing of contract and technical review documents and summary reports to GO and HQ management; funding of outside technical reviewers; and routine status tracking of contracts, outreach and communications, procurement, and financial and human capital resources management. Within the context of supporting the E-Government initiatives, EERE will be providing funding for the Integrated Acquisition Environment, IAE Dunn and Bradstreet, and Grants.gov. These preliminary funding requirements may increase upon receipt of the final FY 2009 list of E-Government initiatives from the Office of Management and Budget (OMB).

Support Services funding will provide administrative support for technical symposia, and data-entry and analytical graphics services, and staff training. These funds also include the estimated portion of the reimbursable work at NETL that will be applied to support services for administrative and editorial assistance to the NETL project managers.

Other Related Expenses	**10,930**	**11,406**	**11,159**

This activity encompasses the Headquarters Working Capital Fund (WCF), IT equipment purchases and maintenance (such as a 3-year replacement cycle for desk-top PCs) at both Headquarters and the GO, contractual services associated with landlord support of the GO, and software purchases and licenses. Within the WCF, rent is the largest component, but the WCF also includes telephones, copying, headquarters network operations, payroll and other employee services, printing, etc. Beginning in FY 2009, the following items will be added to the WCF: Forrestal Safe Havens, Downtown/Germantown Shuttlebus, Logistics Support services contract, courier/messenger service, STRIPES procurement operations, On-line learning Center, and the DOE accounting system, STARS.

The FY 2009 request will support:

- $8,258 for Headquarters WCF activities such as administrative services, rent, automated office support, contract close out, telephone services, postage, printing, graphics, and similar services, plus the Forrestal Safe Havens, Downtown/Germantown Shuttlebus, Logistics Support services contract, courier/messenger service, STRIPES Operations, On-line learning Center and STARS;

- $1,220 for rent at the GO PMC unit;
- $1,681 for miscellaneous other related expenses, including computer equipment and support, utilities, postage, printing, graphics, administrative expenses, and security at GO, plus Workers Compensation, software licenses, publications, and conferences, plus directly reimbursable Other Related Expenses at NETL.

Subtotal, Program Direction	**99,264**	**104,057**	**121,846**

Explanation of Funding Changes

	FY 09 vs. FY 08 ($000)
Salaries and Benefits	
FY 2009 request for salary reflects cost of living increases $3,327 and provides an additional 30 FTEs compared to the FY 2008 appropriation. These new hires will fill critical skill gaps and are commensurate with the technical workload increases to programs.	+7,376
Travel	
Request an increase in the travel budget, as air-travel ticket prices are expected to be higher and travel distances are increased since the consolidation of the six ROs into two PMCs, and to support additional mission-related work and improve project oversight per IG recommendations "Management controls over the State Energy Program's Formula Grants," Office of Inspector General, Office of Audit Services, April 2006 OAS-M-06-05.	+258
Support Services	
$5M of the Support Services increase is in part to fund EERE crosscutting requirements such as the Corporate Planning System (CPS), and the Executive Information System (EIS) from the Program Direction account; EERE Technical Programs previously funded these costs. Support services funding also increases due to increasing service costs, training, and information technology. Support services funds the continued enhancement of business information and planning systems and the associated training thereon, and continues the implementation of additional system security enhancements.	+10,402
Other Related Expenses	
Reduction is due to more conservative management of Working Capital Fund costs, as well as communications, utilities, and miscellaneous, operations and maintenance of equipment, and supplies and materials.	-247

	FY 09 vs. FY 08 ($000)
Total Funding Change, Program Direction	**+17,789**

Support Services by Category

	(dollars in thousands)		
Support Services	FY 2007	FY 2008	FY 2009
Technical Support			
Economic and Environmental Analyses	50	50	70
Surveys or Reviews of Technical Operations	40	40	60
Total, Technical Support	90	90	130
Management Support			
Directives/Management Studies	125	125	250
Automated Data Processing/IT	6,749	4,721	6,197
Corporate Planning Systems / Executive Information Systems	0	0	7,877
Preparation of Program Plans	175	175	350
Training and Education	500	600	807
Analyses of DOE Management Processes	95	150	300
Reports and Analyses Mgt & Gen Admin Services	9,287	7,852	8,204
Total, Management Support	16,931	13,623	23,985
Total, Support Services	17,021	13,713	24,115

Other Related Expenses by Category

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Other Related Expenses			
Rent to GSA	1,100	1,141	1,220
Communications, Utilities, Miscellaneous	280	428	435
Printing and Reproduction	229	219	225
Other Services	90	194	198
Operation and Maintenance of Equipment	140	256	262
Supplies and Materials	151	275	285
Equipment	238	268	276
Working Capital Fund	7,985	8,625	8,258
Total, Other Related Expenses	10,213	11,406	11,159

Congressionally Directed Projects

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007	FY 2008[a]	FY 2009
Congressionally Directed Projects	0	185,921	0

Description

The FY 2008 Omnibus Act included 183 congressionally directed projects within the Office of Energy Efficiency and Renewable Energy. Funding for these projects was appropriated as a separate funding line although specific projects may relate to ongoing work in a specific programmatic area. There were no earmarks in FY 2007.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008[b]	FY 2009
Congressionally Directed Projects			
Hydrogen/Fuel Cell Technology			
▪ Alternate Fuel Cell Membranes for Energy Independence at USM (MS)	0	984	0
▪ Center for Renewable Energy, Science, and Technology (TX)	0	984	0
▪ City of Chula Vista, Alternative Fuels Pilot Project (CA)	0	738	0
▪ CU-ICAR Hydrogen Infrastructure (SC)	0	836	0
▪ Fuel Cells for High Altitude Airship (OH)	0	787	0
▪ Hydrogen Energy Production and Storage Phase IV (OH)	0	984	0
▪ Hydrogen Fuel Cell Development in Columbia (SC)	0	1,476	0
▪ Martin County Fuel Cell Development (NC)	0	492	0
▪ Michigan Tech. Nanostructured Materials (MI)	0	1,230	0
▪ Modular Energy Storage System for Fuel Cells (MI)	0	1,181	0

[a] Amount presented reflects $743,000 redirected from prior year earmark as directed by the FY 2008 Omnibus.
[b] Appropriation after rescission.

▪ Nano-structured Fuel Cell Membrane Electrode Assembly (CA)	0	984	0
▪ NaSi and Na-SG Powder Hydrogen Fuel Cells (NJ)	0	1,476	0
▪ One Kilowatt Biogas Fueled Solid Oxide Fuel Cell Stack (NY)	0	984	0
▪ Purdue Hydrogen Technologies Program (IN)	0	984	0
▪ Renewable & Logistic Fuels for Fuel Cells at the Colorado School of Mines (CO)	0	1,476	0
▪ RIT Integrated Power Microsystems (NY)	0	984	0
▪ Safe Detector Systems for Hydrogen Leaks (CA)	0	984	0
▪ Silicon Based Solid Oxide Fuel Cell Chip (MA)	0	492	0
▪ Solid Acid Fuel Cell Research (CA)	0	492	0
▪ Solid Oxide Fuel Cell Systems Development (OH)	0	984	0
▪ Tanadgusix Foundation Hydrogen Project (AK)	0	246	0
▪ Texas Hydrogen Highway (TX)	0	383	0
▪ University of Akron Carbon Based Fuel Cell (OH)	0	1,181	0

Biomass and Biorefinery Systems R&D

▪ Advancing Texas Biofuel Production	0	492	0
▪ Alternative Biofuel Infrastructure in Central Georgia (GA)	0	344	0
▪ Alternative Fuel for Cement Processing at Auburn University (AL)	0	1,476	0
▪ Appalachian State University Biofuels and Biomass Research Initiative	0	295	0
▪ Arkansas State University Ethanol Fuel Development	0	1,476	0
▪ Auburn Regional Bioenergy Enterprise (NY)	0	492	0
▪ Biodiesel Injection Blending Facilities	0	738	0
▪ Bioenergy Cooperative Ethanol Biomass Fuel Plant	0	1,476	0
▪ BioEthanol Collaborative (SC)	0	984	0
▪ Biofuel Production Initiative Claflin (SC)	0	492	0
▪ Biofuels Development at Texas A&M (TX)	0	984	0
▪ Biorefining for Energy Security at Ohio University (OH)	0	984	0
▪ Center for Producer-Owned Energy (MN)	0	984	0
▪ Chariton Valley R.C.&D., Chariton Valley Biomass for Rural Development	0	492	0

▪ Chautauqua County - Methane Gas Utilization Project from Landfill at Ellery (NY)	0	492	0
▪ Closed Loop Short Rotation Woody biomass (NY)	0	492	0
▪ Compact Membrane Systems, Inc. - Applied Membrane Technology for Processing Ethanol for Biomass (DE)	0	492	0
▪ Connecticut Biodiesel Power Generator (CT)	0	738	0
▪ Consortium for Plant Biotechnology Research (GA)	0	3,936	0
▪ Costilla County Economic Development Council, Inc., Biodiesel Project (CO)	0	271	0
▪ Dakota Gold Research Association Sioux Falls (SD) Biomass	0	1,476	0
▪ DBS Energy Inc., Glastonbury, CT Biofuels Technology Project in Suffield (CT)	0	984	0
▪ Driftless Area Initiative (IL, IA, MN, WI)	0	608	0
▪ Foster-Glocester Regional School District, Ponaganet Alternative Energy Lab and Biomass Facilities Project (RI)	0	984	0
▪ Florida Renewable Energy Program (FL)	0	738	0
▪ Illinois State University Biomass Research (IL)	0	492	0
▪ Integrated Biomass Refining Institute at North Carolina State University (NC)	0	984	0
▪ Intermediary Biochemicals (MI)	0	246	0
▪ Jefferson County Bioenergy Initiative Plant (CO)	0	492	0
▪ Kentucky Rural Energy Consortium at the University of Louisville, (KY)	0	1,968	0
▪ King County Biogas and Nutrient Reduction Project (WA)	0	492	0
▪ Koochiching County, Renewable Energy Clean Air Project (RECAP), Plasma Gasification Waste-to-Energy Project (MN)	0	394	0
▪ Laurentian Energy Authority (MN)	0	984	0
▪ Louisiana State University Alternative Energy Research (LA)	0	984	0
▪ MBI International Biomass Research (MI)	0	492	0
▪ Messiah College Biodiesel Fuel Generation Project (PA)	0	492	0
▪ MidSouth/Southeast Bioenergy Consortium (GA)	0	1,968	0
▪ Mill Seat Landfill Bioreactor Renewable Green Power (NY)	0	738	0
▪ Minnesota Center for Renewable Energy (MN)	0	492	0
▪ Northeast Texas Community College Biodiesel (TX)	0	492	0

▪ Pierce County, Landfill Gas-to-Clean Fuel Project, Biomass (WA)	0	3,739	0
▪ Placer County Biomass Utilization Pilot Project (CA)	0	492	0
▪ Port of Umatilla Biodiesel Refining Plant (OR)	0	492	0
▪ Raceland Raw Sugar Corporation, Bio-Renewable Ethanol and Co-Generation Plant, Biomass (LA)	0	1,476	0
▪ Renewable Energy Biomass Utilization Program (AK)	0	492	0
▪ Snohomish County, Biodiesel Project (WA)	0	344	0
▪ Sorghum to Ethanol Research (CO)	0	984	0
▪ South Dakota State University, Sun Grant Initiative, Regional Biomass Feedstock Development Partnership (SD)	0	3,936	0
▪ Southeast Bioenergy Initiative (AL)	0	492	0
▪ Southern Illinois University, Carbondale, Biofuels Research (IL)	0	492	0
▪ Stamford Waste-to-Energy Project (CT)	0	1,476	0
▪ Strategic Biomass Initiative (MS)	0	492	0
▪ SUNY Cobleskill Bio-Waste to Bio-Energy Project (NY)	0	1,279	0
▪ Sustainable Energy Center Biodiesel from Algae (MI)	0	984	0
▪ Sustainable Energy Research Center at MSU (MS)	0	10,824	0
▪ Trenton Fuel Works Biofuels Plant Re-Construction (NJ)	0	1,476	0
▪ U. of Florida, Gainesville, With the Earth University Foundation Biofuel Project	0	984	0
▪ University of Georgia Biorefinery and Fuel Cell Research (GA)	0	1,230	0
▪ University of Hawaii, College of Tropical Agriculture and Human Resources, Development of High Yield Tropical Feedstock (HI)	0	492	0
▪ University of Kentucky Biofuels Research Laboratory (KY)	0	492	0
▪ University of Nebraska, Lincoln, Bioenergy Demonstration Project: Value-Added Products from Renewable Fuels (NE)	0	1,968	0
▪ University of North Dakota, Grand Forks, Center for Biomass Utilization	0	1,968	0
▪ University of Northern Iowa, National Agriculture-Based Industrial Lubricants (IO)	0	984	0
▪ University of Oklahoma Biofuels Refining (OK)	0	738	0
▪ University of Rhode Island, Research and Technology Development for Genetic Improvement of Switchgrass	0	1,476	0
▪ Vermont Biomass Energy Resources Center (VT)	0	984	0

▪ Vermont Public Power Supply Authority, Renewable Energy from Animal (VT)	0	492	0
▪ Vermont Sustainable Jobs Fund, Central Vermont Recovered Biomass Facility (VT)	0	492	0
▪ Vermont Sustainable Jobs Fund, Vermont Biofuels Initiative (VT)	0	984	0
▪ Waste-to-Energy Cogeneration Project, Munster (IN)	0	1,968	0
▪ Woody Biomass Project at SUNY-ESF (NY)	0	738	0

Solar Energy

▪ Conductive, Transparent Coatings Solar Cell Research Project (MA)	0	1,968	0
▪ Green Energy, Arts & Education Center (NY)	0	492	0
▪ Greenfield Community College - Sustainable Energy Model	0	394	0
▪ High Efficiency Cascade Solar Cells (NM)	0	984	0
▪ MARET Center (MO)	0	984	0
▪ Nanostructured Solar Cells (AR)	0	1,181	0
▪ North Dakota State University, Center for Nanoscale Energy	0	5,904	0
▪ Photovoltaic Demonstration Project (CT)	0	492	0
▪ San Francisco MUNI Solar Energy Facility (CA)	0	610	0
▪ Sandia National Lab Concentrating Solar (NM)	0	2,952	0
▪ Solar Consortium of New York Photovoltaic Research and Development Center (NY)	0	1,476	0
▪ Sustainable Buildings Project at the University of Louisville (KY)	0	394	0
▪ University of Arizona Photovoltaic Concentrator Development (AZ)	0	984	0
▪ University of Nebraska, CIBS Solar Cell Development (NE)	0	935	0
▪ University of Nevada, Solar Cell Nanotechnology (NV)	0	738	0
▪ Wisdom Way Solar Village - Rural Development Incs (MA)	0	394	0

Wind Energy

▪ Casper College Renewable Energy Program (WY)	0	295	0
▪ Cloud County Community College Wind Turbine (KS)	0	984	0
▪ Coastal Wind Ohio (OH)	0	590	0

▪ Great Plains Wind Power Test Facility (TX)	0	1,968	0
▪ Kotzebue Electric Wind Power System (AK)	0	148	0
▪ Renewable Energy for Rural Economic Development Program (UT)	0	984	0
▪ White Earth Tribal Nation Wind Energy (MN)	0	984	0
▪ Wichita State University Sustainable Energy Solutions (KS)	0	984	0
▪ Wind Spires as an Alternative Energy Source (OH)	0	1,083	0
▪ Wyandotte Green Windpower on Brownfields Project (MI)	0	984	0
Water Power			
▪ Hydro Partners in Brazil (OH)	0	984	0
▪ Wave Power Demonstration Project, Reedsport (OR)	0	1,968	0
Geothermal Technology			
▪ Alternative Energy Geothermal Technology Demonstration Program	0	295	0
▪ Notre Dame Geothermal Ionic Liquids Research (IN)	0	984	0
▪ Oregon Institute of Technology Geo-Heat Center (OR)	0	984	0
Vehicle Technologies			
▪ Biopolar Water Cell NIMH Ion Battery (CT)	0	984	0
▪ Center for Advanced Vehicular Systems (CAVS) at MSU (MS)	0	3,936	0
▪ Clean and Efficient Diesel Locomotive (PA)	0	984	0
▪ Energy Efficient Press and Sinter of Titanium Powder (IL)	0	492	0
▪ High Energy Batteries for Hybrid Buses (IN)	0	984	0
▪ Hybrid Hydraulic Drivetrain Demonstration (OH)	0	1,968	0
▪ Iowa Central Community College Renewable Fuels Testing Lab (IA)	0	984	0
▪ Juniata Ultra Low Emission Locomotive Demonstrator (PA)	0	590	0
▪ Kansas City Area Transportation Authority, Demonstration of Plug-In Vehicles, (KS)	0	984	0
▪ Michigan State University, Advanced Hybrid Vehicle Technology, Hybrid Electric Vehicle Group	0	394	0

▪ National Center for Manufacturing Sciences, Lightweight Automotive Materials for Increased Fuel Efficiency (MI)	0	1,968	0
▪ Plug-in Hybrid Electric Vehicle Demonstration (CA)	0	984	0
▪ West Virginia University, Lightweight Composite Material for Heavy Duty Vehicles (WV)	0	492	0
▪ West Virginia University, Transportable Emissions Testing Laboratory for Alternative Vehicles Emissions Testing (WV)	0	984	0

Building Technologies

▪ Advanced Green Design for Museum of National History	0	787	0
▪ Affordable, Energy Efficient, Self Help Housing (MS)	0	295	0
▪ Building Materials Reclamation Program (NC)	0	492	0
▪ Building-Integrated Photovoltaic Solar Energy System (PA)	0	295	0
▪ Center for Energy Efficient Design (VA)	0	197	0
▪ First Responder "Green" House (NY)	0	98	0
▪ Green Roof Project Southwest Brooklyn (NY)	0	246	0
▪ Green Visitor Center, Brooklyn Botanic Green (NY)	0	591	0
▪ Jackson Park Hospital Green Medical Office Building (IL)	0	984	0
▪ NCCR "Green" Building	0	738	0
▪ NYIT Building Efficiency Demonstration Project (NY)	0	492	0
▪ Miami Museum of Science Renewable Energy Project (FL)	0	738	0
▪ Sustainable Energy Research Facility Construction (MD)	0	738	0
▪ Sustainable Fluorescent Light Replacement Technology (MI)	0	590	0
▪ Texas A&M Green Campus Research Initiative (TX)	0	492	0
▪ University of Nevada, Las Vegas, Lighting Emitting Diode Display Engineering (NV)	0	590	0
▪ University of Nevada, Las Vegas, National Center on Energy Management (NV)	0	492	0
▪ University of North Alabama Green Campus Initiative (AL)	0	984	0
▪ Vermont Independent Colleges Zero-Energy Campaign (VT)	0	1,476	0
▪ Western North Carolina Clean Energy Business Incubator (NC)	0	354	0
▪ York College National Energy Resource Center (SC)	0	197	0

Industrial Technologies

▪ Alternative Energy Workforce Applications Training Program	0	819	0
▪ Alternative Fuel for Cement Processing at Auburn University (AL)	0	1,476	0
▪ Clean Power Energy Research Consortium - Nicholls State University	0	984	0
▪ Cooling, Heating, and Power (CHP) at MSU (MS)	0	1,968	0
▪ Energy Efficient Press and Sinter of Titanium Powder (IL)	0	492	0
▪ Great Lakes Energy Research Park (MI)	0	492	0
▪ Nanostructural Materials for Safe Alternative Energy (NC)	0	984	0
▪ Northwest Regional Planning Commission, Manufacturing Conversion for Energy Efficiency (WI)	0	4,920	0
▪ The Greenville Steam Efficiency Project (ME)	0	886	0
▪ Tools for Nanotechnology Education (OR)	0	984	0
▪ Truckee Meadow Water Reclamation Facility (NV)	0	984	0

Weatherization and Intergovernmental Activities

▪ Council of Energy Resource Tribes, (CO)	0	492	0
▪ Department of Energy's Clean Energy Technology Export Program to Export U.S. Clean Energy Technologies (CETE)	0	590	0
▪ Navaho Hopi Land Commission Renewable Development (NM)	0	295	0

Crosscut

▪ Energy and Sustainability Institute, Illinois Institute of Technology (IL)	0	246	0
▪ Hawaii Natural Energy Institute, Hawaii-New Mexico Sustainable Energy Security Partnership (HA)	0	1,968	0
▪ Nevada Institute for Renewable Energy Commercialization, (NV)	0	1,476	0
▪ Nye County Renewable Energy Feasibility Study (NV)	0	492	0
▪ Pacific International Center for High Technology Research, Renewable Energy Development Venture (HI)	0	1,230	0
▪ Risk-Based Data Management System (OK)	0	492	0
▪ SUNY-Oswego Energy Independence	0	295	0
▪ U. of Maryland Energy Research Center (MD)	0	743	0
▪ UMass Renewable Energy Economy Expansion Project (MA)	0	197	0

Subtotal, Congressionally Directed Projects	**0**	**186,664**	**0**
Less Use of Prior Year Balances	**0**	**-743**	**0**
Total, Congressionally Directed Projects	**0**	**185,921**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Congressionally Directed Projects	
No funding requested.	-185,921
Total Funding Change, Congressionally Directed Projects	**-185,921**

Program Support

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments[a]	FY 2008 Current Appropriation	FY 2009 Request
Program Support					
Planning, Analysis and Evaluation	7,418	7,400	-67	7,333	11,000
Technology Advancement and Outreach	3,512	3,500	-32	3,468	9,000
Total, Program Support	10,930	10,900	-99	10,801	20,000

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the program support function is to enable EERE management at all levels to achieve program goals and contribute to Departmental goals. This is done by providing corporate and integrated information to inform decisions for portfolio investment and market adoption of EERE based processes, individual technologies, and energy systems. The EERE offices use that information to guide and provide direct support to satisfy both corporate and program needs resulting in best-in-class strategic management system products which enable EERE to meet the requirements of the President's Management Agenda and to effectively achieve its goals. Program support also enables regular, consistent outreach mechanisms and products that keep EERE stakeholders advised of corporate management issues affecting EERE operations.

The Planning, Analysis, and Evaluation subprogram establishes and maintains the methods, information base, and standards for planning and policy analysis, budget formulation, and performance management and evaluation. The subprogram provides direct expertise and funds contracts that provide technical, economic, and policy analyses and support for strategic and multi-year planning, performance and budget integration, Government Performance and Results Act (GPRA) benefit estimation for all DOE Renewable and Energy Efficiency programs, and foundational understanding of current and future energy and technology markets. Each of these activities is central to achieving the goals of the President's

[a] Reflects amounts rescinded by General Provision, Section 312, of the Omnibus Appropriations Act, 2008.

Management Agenda (PMA), each implements the requirements of GPRA, and each is also key to effective management of DOE; Energy, Science, and Environment (ESE); the EERE programs; and to informing decisions on the optimal allocation of resources among the programs. Each provides key information that enables senior management and the technology programs to select portfolios and pathways that will best advance the Department's goals.

The Technology Advancement and Outreach subprogram manages and creates outreach mechanisms and products that keep EERE stakeholders advised of corporate management issues affecting EERE operations. The TAO also coordinates and manages efforts to make all of the other programs' work – their results and their potential – known to the public. This contributes both to the EERE programs' deployment goals and to Administration E-government initiatives to make government more transparent and accessible to the public. To accomplish these objectives, TAO maintains resources that provide information on request to the general public and other stakeholders through web based and toll free telephone services. Forming partnerships with industry, state and local governments, and non-government organizations (NGOs), the Office produces and disseminates documents in both English and Spanish to educate homeowners on energy saving techniques and technologies.

Planning, Analysis and Evaluation

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Planning, Analysis and Evaluation	7,418	7,333	11,000
Total, Planning, Analysis and Evaluation	7,418	7,333	11,000

Description

Planning, Analysis, and Evaluation (PAE) provides senior management with timely, high quality, independent, credible, and usable information to inform their decisions. PAE also manages EERE-wide requests and requirements, including the Government Performance and Results Act, the President's Management Agenda, Energy Policy Act of 2005 and other Departmental requirements. Finally, PAE develops corporate approaches to planning, analysis, and evaluation that help improve the EERE portfolio and enable effective implementation of the departmental Strategic Management System which enables EERE to best advance the Department's goals.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Planning, Analysis and Evaluation	**7,418**	**7,333**	**11,000**

PAE delivers its management support through planning, analysis and evaluation activities and by responding to requirements external to EERE, such as the EPACT 2005 and Departmental requirements.

PAE's planning efforts focus on improving program planning and developing EERE-wide approaches to strategic planning and portfolio analysis. A key component of PAE's efforts is to work with the programs to develop multi-year plans that link DOE's Strategic Plan to a program's PART, Joule and activity targets. PAE's strategic planning activities seek to improve the treatment of risk and uncertainty and to help advance Budget-Performance Integration as required by the President's Management Agenda.

PAE's activities focus on providing cross-cutting, multi-program, and integrated technical and market analysis to inform EERE corporate and program budget decisions and to meet the requirements of the Government Performance and Results Act. PAE's approach to integrated analysis includes a focus on developing open, transparent, well-documented, and peer-reviewed assumptions and analysis methods for estimating the expected energy, economic, and environmental benefits of the EERE portfolio.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

EERE is working with other applied R&D offices to provide increasingly comparable estimates of the potential impacts of each program's investment and to move effectively and practically to incorporate the Benefits Analysis framework recommendations developed by the National Academy of Sciences (NAS).

PAE also develops and maintains independent, objective analytical capabilities to assess externalities, to answer senior management questions, to better account for technical risk and uncertainty, and to examine how benefits change under different future scenarios. Finally, as required by the President's Management Agenda, OMB PART (Performance Assessment Rating Tool), and Research Development Investment Criteria, PAE is working with the other ESE applied energy R&D programs to prepare benefits projections using common baselines, assumptions, and methods.

PAE's evaluation component works with the programs to proactively address performance management requirements and to prepare EERE's submissions for integrated performance reporting, including PART. PAE's evaluation team also provides a full range of evaluation technical assistance, processes, and tools to help senior management and programs monitor and measure success, increase program effectiveness, and meet OMB requirements for objective and independent assessment.

Total, Planning, Analysis and Evaluation	**7,418**	**7,333**	**11,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Funding increase will enable PAE to: 1) add critical policy options and market analysis; 2) add critical capacity and knowledge management; and 3) expand direct expertise and technical, economic, and policy analyses and support. This expertise will enable more informed strategic and multi-year planning, performance, budget decision making, strategic integration, and Government Performance and Results Act benefit estimation for all DOE Renewable and Energy Efficiency programs, as well as much needed information for foundational understanding of current and rapidly evolving future energy and technology markets. Continuation and improvements in these activities are central to achieving the goals of the President's Management Agenda, implementing the requirements of GPRA, and key to effective strategic management of DOE; Applied Energy programs; the EERE programs; and to informing decisions on the optimal allocation of resources among the programs. Each provides key information that enables senior management and the technology programs to apply next generation insights (e.g., uncertainty, risk and market transformation) to select portfolios and pathways that will best advance the Department's goals.	+3,667

Total Funding Change, Planning, Analysis and Evaluation	**+3,667**

Technology Advancement and Outreach

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Technology Advancement and Outreach	3,512	3,468	9,000
Total, Technology Advancement and Outreach	3,512	3,468	9,000

Description

Public information and technology awareness and outreach activities in EERE are carried out by the Office of Technology Advancement and Outreach (TAO). TAO communicates the EERE mission, program plans, accomplishments, and technology capabilities to a variety of stakeholder audiences including Congress, the public, educational institutions, industry, and other government and non-government organizations.

The Technology Advancement and Outreach subprogram coordinates and manages efforts to make all of the other programs' work – and their results – known to the public and provides a regular, consistent outreach mechanism that keeps EERE stakeholders advised of corporate issues and technology opportunities. This contributes both to the EERE programs' deployment goals and to Administration E-government initiatives to make Government more transparent and accessible to the public.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Technology Advancement and Outreach	**3,512**	**3,468**	**9,000**

Increasing at a rate of 5.4 million a year, the number of web pages viewed by users in 2006 reached 39.8 million, up from 34.4 million in the 2005. Increased demand for website information requires us to increase web-server operations and maintenance and to enhance and accelerate content creation and updates.

TAO will continue its support of the corporate EERE webpage and the consumer guide on that web-page and will operate the EERE Information Center which answers requests from consumers and users of technology submitted via toll free telephone or computer. TAO maintains a catalogue of all EERE information products, including publications, CDs, and analytic tools, and makes that information

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
TAO will continue to create outreach mechanisms and products that keep EERE stakeholders advised of corporate management issues affecting EERE operations. The TAO will coordinate and manages efforts to make all of the other programs' work – their results and their potential – known to the public which contributes both to the EERE programs' deployment goals and to Administration E-government initiatives to make government more transparent and accessible to the public. TAO will maintain resources that provide information on request to the general public and other stakeholders through web based and toll free telephone services and partnerships with industry, state and local governments, and non-government organizations (NGOs) that leverage replication and use of energy saving techniques and technologies. The increase will support the provisions of Section 134 of EPACT (Energy Efficiency Public Information Initiative) and the President's Advanced Energy Initiative to promote clean energy technologies and alternative fuels. Growing public awareness increases demands from the public for information on how they can save energy or use alternatives. Distributing more material and providing more information through the web and its toll free telephone service is required to address the anticipated increase in information demands. TAO will update the design of the EERE website with more interactive components, streaming video and more user-friendly capabilities. Additionally, new technologies such as podcasts, webinars, and webcasts will be added and maintained.	+5,532
Total Funding Change, Technology Advancement and Outreach	**+5,532**

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

available on-line. Working with five-year strategic outreach plan, TAO will leverage the resources of other agencies by promoting collaboratives between state, Federal and local entities to promote alternative energy sources and energy efficiency and provide interactive technology on-line to train consumers in the use of these technologies. TAO will implement programs to disseminate information through new technology avenues such as streaming video, podcasting and on-line analysis and training tools. The growing volume of calls to the information center and requests for printed documents are raising the printing budget and increasing costs for the operation of the center.

TAO will continue to operate the "one-stop", centralized information center that provides information on request to the general public and other stakeholders through web-based and toll-free telephone services. Under ever-growing demand for these services, the Office produces and disseminates documents in both English and Spanish to educate homeowners on energy savings techniques and technologies. TAO will continue efforts to accelerate information dissemination, broaden access, and leverage resources to form partnerships with industry, state and local governments, and non-government organizations (NGOs).

In FY 2009, TAO will also continue to seek partnerships with Industry and NGOs. Supporting EPACT through the dissemination of information energy efficiency and renewable energy technologies, TAO seeks additional partnerships with corporations, trade associations and other government agencies to promote EERE technologies and leverage resources of partners to deploy EERE technologies. Additional funding will leverage the additional partners.

During FY 2009, TAO will redesign the EERE website and enhance its electronic and Internet outreach. The upgraded EERE website redesign will include more interactive components, streaming video, and user friendly capabilities. Additional new approaches will be pursued by developing, maintaining and utilizing a podcast, webinar and webcast program to proactively promote EERE technologies through internet technology.

Total, Technology Advancement and Outreach	**3,512**	**3,468**	**9,000**

Electricity Delivery and Energy Reliability

Electricity Delivery and Energy Reliability

Table of Contents

Electricity Delivery and Energy Reliability

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for electricity delivery and energy reliability activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion [$140,000,000] *$134,000,000*, to remain available until expended. *(Energy and Water Development and Related Agencies Appropriations Act, 2008.)*

Office of Electricity Delivery and Energy Reliability

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Electricity Delivery and Energy Reliability					
Research and Development	96,506	100,679	-1,177[a]	109,502	100,200
Operations and Analysis	20,500	11,556	-105[b]	11,451	14,122
Program Direction	17,357	17,765	-162[c]	17,603	19,678
Total, Electricity Delivery and Energy Reliability	134,363	140,000	-1,444	138,556	134,000

Preface

Our Nation's ability to meet the growing demand for reliable electricity is challenged by an aging electricity transmission and distribution system and by vulnerabilities in our energy supply chain. Despite increasing demand, we have experienced a long period of underinvestment in power transmission and infrastructure maintenance. The majority of the power delivery system was built on technology developed in the 1960s, 70s and 80s and is limited by the speed with which it can respond to disturbances. This limitation increases the vulnerability of the power system to a greater number of outages that can spread quickly and have regional effects.

Major hurricanes, reliability events, and increased congestion in major transmission corridors are costing taxpayers billions of dollars each year and jeopardize the safety and well-being of millions of Americans and U.S. industry. The electric grid is also becoming increasingly vulnerable to cyber attacks against control systems. Since electricity is vital to nearly every aspect of life, from powering our electronics and heating our homes to supporting commerce, transportation, finance, food and water systems, and ensuring national security, any disruption can have major consequences to the economy and public health and safety.

New infrastructure improvements and vulnerability assessments are needed to maintain reliability, to ensure security, and to drive down costs to consumers. Roadblocks to investing more in our grid infrastructure have allowed the existing infrastructure to age and become more constrained, which will result in higher costs to consumers. First, regulatory uncertainty has prevented the private sector from investing in some projects. Second, siting and permitting concerns slow or prevent new electricity infrastructure, such as transmission lines, from being built. Both these roadblocks drive up the costs of new infrastructure, which is ultimately passed on to consumers.

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[a] Includes a rescission of $1,777,505.54 in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.
[b] Includes a rescission of $105,159.60 in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.
[c] Includes a rescission of $161,661.50 in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.

The Office of Electricity Delivery and Energy Reliability (OE) is the focal point for securing energy supplies (oil, gas, and electricity) both nationally and internationally and providing leadership in developing the "next generation" electric delivery infrastructure that enables clean energy choices, automated grid operations, and flourishing markets.

Within the Electricity Delivery and Energy Reliability Appropriation, the OE has three programs: Research and Development (4 subprograms); Operations and Analysis (2 subprograms); and Program Direction.

Mission

The mission of the Office of Electricity Delivery and Energy Reliability is to lead national efforts to modernize the electric grid, to enhance the security and reliability of the energy infrastructure, and to facilitate recovery from disruptions to the energy supply.

Benefits

The benefits of the Office of Electricity Delivery and Energy Reliability stem from improving the reliability, security and efficiency (operations) of the electric system. Disruption of energy supplies can be the result of security/reliability concerns stemming from physical/cyber attack, change in generation/spike in demand, technical/operational failures, market manipulation, or natural disasters. As a result, the Office focuses on long-term system requirements through our research investments in the electricity delivery system and near-term energy vulnerability assessments/disaster recovery.

Benefits of the research activities include:

- Strengthened stability and hardening of the electric grid and reduced frequency/duration of operational disturbances (reliability);
- Increased efficiency of the electric delivery system through reduced energy losses (energy efficiency); and
- Reduced peak price and price volatility of electricity through increased asset utilization (capacity factor of transmission and distribution), and improved accessibility to a variety of energy sources that generate electricity (reliability and system efficiency).

Benefits of the operational activities include:

- A hardened energy infrastructure that detects, prevents, and mitigates external disruptions to the energy sector (reliability);
- Competitively priced and environmentally responsible electricity through cross-border trade (system efficiency);
- Facilitated activities with the States to develop energy security and reliability plans, energy efficiency plans (grid), and generation/demand response investment strategies (system efficiency); and
- Coordinated response for energy emergencies (reliability).

The electric transmission and distribution (T&D) system plays a pivotal role in realizing reductions in greenhouse gas (GHG) emissions, and in implementing carbon management strategies for the electricity sector. This role has two aspects: (1) improvements in the energy efficiency of the electric T&D system itself, with resulting reductions in power delivery losses and GHG emissions; and (2) enabling the installation of renewable and other clean power systems; energy efficient buildings, appliances, and industrial equipment; and potentially low-carbon transportation alternatives such as electric vehicles.

Reductions in power line and other power delivery losses is the primary mechanism for reducing GHG emissions from improvements in the energy efficiency of electric T&D. For example, high temperature superconducting (HTS) power cables, transformers, motors, generators, and fault current limiters generally operate with significantly lower energy losses than conventional equipment (near zero, in some applications). Research, development, and demonstration (RD&D) priorities for HTS cables and equipment include development of lower cost HTS wires with greater current carrying capacity that can be manufactured in longer lengths ("2nd generation wires"), and demonstrating the performance of cables and equipment made from this wire in electric system applications at utilities across the country. Significant reductions in GHG emissions are possible from using HTS cable and other types of HTS equipment, including transformers, motors, generators, and fault-current limiters, when compared with their conventional counterparts.

Energy losses from power delivery are greatest during peak load periods, when electric T&D equipment is often being used at or near thermal limits. As a result, technologies, tools, and techniques that reduce peak loads will also reduce thermal loadings on electric delivery equipment and energy losses, thus increasing the energy efficiency of electric T&D, and providing the opportunity for GHG reductions. Development of sensors, control systems, and communications strategies that provide real-time information to grid operators for "visualizing" power flows across the T&D system are being designed to enable greater use of demand response, energy storage, advanced metering infrastructure, and other peak load reducing strategies. RD&D priorities include development and testing of lower cost sensors, communications and control systems, and energy storage systems, and testing of devices, software, and analysis tools at utilities across the country. Full deployment of these "smart grid systems" has the potential to enable cost-effective peak load reductions of 10-20 percent. Such reductions will reduce the thermal loadings on power lines and transformers thus reducing energy losses and emission of GHGs.

These same smart grid systems, along with power electronics devices such as switches and inverters, will make it easier, and more cost-effective, to install and operate renewable energy and energy efficiency technologies such as wind, photovoltaics, and combined heat and power, and to interconnect them with the electric grid, in a reliable and safe manner. In addition, energy efficient buildings, appliances, and equipment will benefit from having an electric distribution system that includes real-time controls, distributed generation and storage, and advanced metering infrastructure. Finally, the future of electric vehicles (including plug-in hybrids) will depend, in part, on an electric distribution system that is capable of providing charging services to consumers cost effectively, and in a manner that doesn't exacerbate peak demand, or result in other possibly deleterious effects on the grid. RD&D priorities include lower cost and more widely deployed sensors and communications and control systems, and demonstrating their performance at utilities across the country.

Strategic Themes and Goals and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. Within the Electricity Delivery and Energy Reliability Appropriation, the Office supports the following goals:

Strategic Theme 1, Energy Security: Promoting America's energy security through reliable, clean, and affordable energy.

Strategic Goal 1.3, Energy Infrastructure: Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

The programs funded within the Electricity Delivery and Energy Reliability Appropriation have one GPRA Unit Program Goal that contributes to the Strategic Goals in the "goal cascade." This goal is:

GPRA Unit Program Goal 1.2.16.00 Electricity Delivery and Energy Reliability: Lead national efforts to modernize the electric grid, enhance security and reliability of the energy infrastructure, and facilitate recovery from disruptions to the energy supply.

Contribution to Strategic Goal

Both the Research and Development and the Operations and Analysis programs contribute to Strategic Goal 1.3, Energy Infrastructure as follows:

The Research and Development program contributes to this goal by pursuing advancements in renewables integration, transmission, distribution, and storage technologies.

The Operations and Analysis program contributes to this goal by providing policy guidance to regions and States, by modeling and tracking weather-related potential for disruptions, by assisting other agencies in recovery efforts, and by providing expert analysis of energy infrastructure security requirements.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.3, Energy Infrastructure			
GPRA Unit Program Goal 1.3.16.00 Electricity Delivery and Energy Reliability	105,732	96,662	114,322
Subtotal, Strategic Goals 1.3 (Energy Supply and Conservation)	105,732	96,662	114,322
All Other			
Program Direction	17,357	17,603	19,678
Research and Development/High Temperature Superconductivity/Load Control System Reliability (MT)	150	0	0
Research and Development/High Temperature Superconductivity/National Center for Reliable Electric Power Transmission (AR)	150	0	0
Research and Development/High Temperature Superconductivity/Energy Grid Modernization Project at Florida State University (FL)	304	0	0
Congressionally Directed Research and Development/High Temperature Superconductivity/Optimization of High Voltage Lines at Tennessee Tech (TN)	500	0	0
Research and Development/High Temperature Superconductivity/ Utility Transformation Program (WA)	300	0	0
Research and Development/High Temperature Superconductivity/ Power Technologies Project (CT)	200	0	0
Research and Development/Visualization and Controls/System Control and Data Acquisition (SCADA) (ID, NM)	8,000	0	0

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Research and Development/Visualization and Controls/Energy Research and Development Center at the University of Missouri-Rolla (MO)	300	0	0
Research and Development/Visualization and Controls/Energy Grid Modernization Project at Florida State University (FL)	96	0	0
Research and Development/Renewable and Distributed Systems Integration/Hawaii/New Mexico Sustainable Energy Project (HI, NM)	400	0	0
Research and Development/Renewable and Distributed Systems Integration/ Electric Advanced Technology Center (IL)	250	0	0
Research and Development/Modern Grid Initiative/ (WV)	624	0	0
Congressionally Directed Project, Chenga Bay Generator Replacement (AK)	0	379	0
Congressionally Directed Project, Alabama Power Project, Integrated Distribution Management System (AL)	0	1,968	0
Congressionally Directed Project, National Center for Reliable Electric Power Transmission (AR)	0	492	0
Congressionally Directed Project, Dine Power Authority (AZ)	0	492	0
Congressionally Directed Project, Navajo Tribal Utility Authority, Fort Defiance (AZ)	0	1,968	0
Congressionally Directed Project, Utility Integration of Distribution Generation (CA)	0	590	0
Congressionally Directed Project, Connecticut Energy Savings Technology Project (CT)	0	738	0
Congressionally Directed Project, Vehicle to Grid Demonstration Project (DE)	0	738	0
Congressionally Directed Project, Florida State University Electric Grid System Study (FL)	0	984	0
Congressionally Directed Project, Wauchula Municipal Electric Substation Rehab (FL)	0	984	0
Congressionally Directed Project, Iowa Stored Energy Plant (IA)	0	1,476	0
Congressionally Directed Project, Pilot Energy Cost Control Evaluation (WV, PA, & IN)	0	1,476	0
Congressionally Directed Project, Willimar Municipal Utilities Power Generation Study (MN)	0	295	0
Congressionally Directed Project, University of Missouri-Rolla Distributed Energy Research Center (MO)	0	492	0
Congressionally Directed Project, New Albany Electrical Substation (MS)	0	886	0
Congressionally Directed Project, Bismarck State College Center of Excellence (ND)	0	5,116	0
Congressionally Directed Project, Energy Surety Research Center at New Mexico Tech University (NM)	0	1,968	0

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Congressionally Directed Project, Electric Transmission Line Improvements (NY)	0	1,476	0
Congressionally Directed Project, Rolls-Royce Fuel Cell Systems (US), Inc., Stark State College of Tech., Fuel Cell Prototyping Center, Canton, OH, Solid Oxide Fuel Cell (OH)	0	492	0
Congressionally Directed Project, High Voltage Transmission Lines Phase II (TN)	0	492	0
Congressionally Directed Project, Electric Utility Transmission Program (WA)	0	787	0
Total, All Other	28,631	41,893	19,678
Total, Strategic Goal 1.3 (Energy Supply and Conservation)	134,363	138,556	134,000

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Strategic Goal 1.3, Energy Infrastructure					
Research and Development/High Temperature Superconductivity					
Completed testing of 10 MVA superconducting transformer in operation on the Wisconsin Electric Power Company grid. (NOT MET)	Completed the manufacture of a 200m superconducting power cable for American Electric Power (AEP). (MET GOAL)	Operated a first-of-a-kind superconducting power cable on the electric grid for 240 hours. (MET GOAL)	Completed six months operation of superconducting cable operating on the grid at greater than 10 kilovolts. (MET GOAL)	By 2020, develop prototype wire achieving 1,000,000 length-critical current (A-m) for second generation wire (2008 - 50,000 A-m)	Maintain progress in achieving increasingly powerful coils for electric power applications such as transformers and motors: magnetic field (Tesla) produced by test coil at 65K (2009 - 2.0 Tesla)
Research and Development/Visualization and Controls					
Installed and operated a prototype wide area measurement system in the Nation's Eastern Interconnection with real-time synchronized measuring instruments that feed data into two data archiving and analysis locations. (MET GOAL)	Installed four additional data concentrators at four different data archiving and analysis locations, achieving a prototype wide area measurement system in the Nation's Eastern Interconnection consisting of six fully functioning data archiving and analysis locations installed at six different utilities. (MET GOAL) Completed field hardware installation at a cumulative total of at least 100 commercial, industrial, and/or municipal customers participating in the demand response and load conservation network in Connecticut, and reduce peak demand (kilowatt hours) in real-time by 5-8% on average (as compared to non-curtailed kilowatt hour consumption) for all participating customers, thereby improving the energy efficiency of electricity usage. (MET GOAL)	Facilitated the installation and operation of 30 additional measurement units and 2 additional archiving and analysis locations in a real-time measurement network, for a cumulative total of 80 measuring units and 8 archiving and analysis locations. (MET GOAL)	Developed a plan for the transfer of leadership from DOE to the Electric Reliability Organization (ERO) for the deployment of a synchronized measurement network in North America, and released the Real Time Dynamic Monitoring System (RTDMS) prototype visualization tool to industry for comment and recommendations. (MET GOAL)	By 2014, develop tools and algorithms to enable an automatic, smart, real-time switchable network for transmission system operations that enables secure and reliable grid operations for major regions of the grid that is hardened against cyber attacks. Definitions for Target: PMUs - phasor measurement unit; dv - distribution voltage (2008 – Area Interchange Error Tool)	By 2014, develop tools and algorithms to enable an automatic, smart, real-time switchable network for transmission system operations that enables secure and reliable grid operations for major regions of the grid that is hardened against cyber attacks. Definitions for Target: PMUs - phasor measurement unit; dv - distribution voltage (2009 - Prototype Angle Stability Alarming Tool) Complete cyber security assessments of 6 SCADA systems in test bed environment.

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Research and Development/Energy Storage and Power Electronics					
Tested and evaluated the performance of a 500kW/750kWh sodium sulfur battery (first in U.S.) installed at an American Electric Power site for six months to determine technical and economic performance. (MET GOAL)	Completed the manufacture of and factory testing of a 2MW/2MWh zinc-bromine battery system (consisting of four 500kW/500kWh units) for supplying extra power during peak load conditions at a utility substation. (MET GOAL)	Commissioned three pioneering energy storage systems in collaboration with the California Energy Commission and collect preliminary technical and economic data. (MET GOAL)	Commissioned two major pioneering energy storage systems in collaboration with the CEC and NYSERDA, and complete data collection and monitoring of three systems commissioned in FY 2006. (MET GOAL).	Test three ionic liquids for possible use as electrolytes in batteries or electrochemical capacitors with the potential for doubling the energy and increasing the power by at least 50% for capacitors or doubling the lifetime and improving safety of rechargeable non-aqueous batteries.	
					Design a prototype ETO-based STATCOM in collaboration with Utility Company.
Research and Development/Renewable and Distributed Systems Integration					
Completed final design and initiated field testing of low emission technology with less than 7 ppm NO_x. (MET GOAL)	Demonstrated emission levels of 0.25 lbs/MWh from a turbine combustion system. (MET GOAL				
Completed and demonstrated heating coefficient of performance of 1.4 for commercial introduction of a thermally activated system (approximately 40 percent more efficient than a conventional heating system). (MET GOAL)					
Demonstrated 6 percentage point increase in efficiency for an advanced reciprocating engine. (MET GOAL)					

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Completed final design and initiated field testing and evaluation of a complete, fully functional integrated CHP system consisting of a turbine, absorption chiller and control system. (MET GOAL)	Completed a case study on a CHP installation that uses heat from microturbine to provide plate tank heating and sludge drying at an industrial facility, contributing to the PART long-term measure of developing a 70 percent efficient CHP integrated system. (MET GOAL)	Developed one packaged CHP system which operates at 70+% efficiency. (MET GOAL)	Developed second packaged CHP system which operates at 70+% efficiency. (MET GOAL)	Demonstrate peak load reduction on distribution feeders with the implementation of Distributed Energy (DE) and Energy Management (EMS) at a cost competitive with a system/capacity upgrade (i.e. cost not to exceed $1,600 per kW in 2001 dollars). Measured in Percent (%) Reduction in Peak Load and Number of Feeders Analyzed/Demonstrated. (2008 - 0%, 0 -- award contracts)	Demonstrate peak load reduction on distribution feeders with the implementation of Distributed Energy (DE) and Energy Management (EMS) at a cost competitive with a system/capacity upgrade (i.e. cost not to exceed $1,600 per kW in 2001 dollars). Measured in Percent (%) Reduction in Peak Load and Number of Feeders Analyzed/Demonstrated. (2009 - 5%, 1)
	Completed and documented two DE/CHP demonstration projects within the high tech industry, contributing to the PART long-term measure of developing a 70 percent efficient CHP integrated system. (MET GOAL)				
Operations and Analysis/Permitting, Siting, and Analysis					
					Complete DOE's Second Study of National Electric Transmission Congestion.
Operations and Analysis/Infrastructure Security and Energy Restoration					
					Conduct 6 domestic Comprehensive Reviews (vulnerability assessments) and/or energy preparedness exercises. Provide between 2 to 4 technical staff to conduct intl. energy assessments for a detail of 2-4 months.
					Maintain total R&D administrative overhead costs relative to total R&D program costs of less than 12%. Baseline for administrative overhead rate currently being validated.

Means and Strategies

The Office uses various means and strategies to achieve its GPRA Unit Program goal. These means and strategies are designed to maximize the probability of success in an environment that is influenced by many externalities. Collaborative activities with stakeholders are an essential element of the Office's implementation strategy.

The Office's strategies to increase market penetration of electric transmission and distribution systems is achieved through 1) decreased cost and increased technological performance; and (2) the implementation of national industry consensus standards for interconnection, communications, and controls. Technology advances include development of second-generation superconducting wire, development of real-time monitoring and control software tools, and development of system operating models to improve grid reliability and energy efficiency. Modernization and expansion of the electricity infrastructure is achieved by improving the reliability, energy efficiency, and cost-effectiveness of the system using the following methods: (1) improving the efficiency and production of high temperature superconducting wires and power equipment; (2) developing real-time information and control technologies and systems; (3) developing distributed intelligence sensing and control technologies; (4) reducing the cost and increasing the energy density of energy storage systems; (5) providing technical assistance and analysis that supports State and regional wholesale electric market improvements; and (6) developing an integrated portfolio of these advanced technologies and distributed energy systems that achieves commercial viability and addresses the crucial needs of the entire electric system.

In carrying out the Office's mission, the following collaborative activities are performed:

- Planning, reviewing, partnering, and cost-sharing with leading U.S. companies to pursue research and development of electric transmission technologies;
- Consulting with utilities, Regional Transmission Organizations, and Independent System Operators on regional policies, market assessments, planning, and regulations;
- Collaborating with other DOE offices and related entities, including:
    - The Office of Fossil Energy and the Office of Energy Efficiency and Renewable Energy on how to best ensure energy security (DOE's Strategic Theme 1) with a diverse supply of reliable, affordable, and environmentally responsible energy;
    - The Energy Information Administration on market analysis;
    - The Power Marketing Administrations and the Tennessee Valley Authority (TVA) on evaluating transmission-related technologies that enhance reliability and lower costs to consumers;
    - DOE laboratories on planning, managing, reviewing, and completing R&D technical work with industry;
- Working with other Federal agencies, such as the Federal Energy Regulatory Commission, Department of Interior, and Department of Agriculture, to develop policies, market mechanisms, regulations, laws, and programs that facilitate the modernizing and expanding the Nation's electricity grid; as well as the Department of Homeland Security, the Department of State and the Department of Defense to develop and test technologies, coordinate vulnerability issues and provide assessments;
- Collaborating with organizations such as the North American Electric Reliability Corporation and the Electric Power Research Institute to analyze market mechanisms and develop improved approaches to grid modernization and expansion;
- Working with States and regional entities, such as regional governors' associations, the National Association of Regulatory Utility Commissioners, and the National Council of State Legislators to

develop policies, market mechanisms, regulations, State laws, and programs to improve the electric grid at the local, State, and regional levels; and
- Partnering with universities to develop plans and reviews, and to further research and development efforts.

Validation and Verification

To validate and verify performance, the Office conducts internal and external reviews and audits. The Office's programmatic activities are subject to continuing review by the Office of Management and Budget (OMB), the Congress, the Government Accountability Office, and the Department's Inspector General. Senior management invites external reviews of office-wide planning, design, management, and programmatic results in order to improve efficiencies. Each program activity manager conducts annual peer reviews by committees comprised of independent subject-area experts to review the management and technical achievements of both programs and projects. Program activity managers maintain long-term goals, annual targets, and milestones, which are tracked by OMB and by the Department's program management reporting system. In FY 2008, the Office will build on previous budget and performance integration progress, and more rigorously apply its integrated project reporting system, including the monitoring of milestones, performance, cost and schedule, and the implementation of corrective actions as needed.

For example, in August 2007, the program achieved a significant milestone for the High Temperature Superconductivity activity. A 200 meter (660 feet) HTS cable in service at American Electric Power's Bixby Substation has been operating reliably for over one year at 13.2 kV/3000 Amps. The cable serves approximately 8,600 residential, commercial and light industrial customers, with an associated electrical load of more than 55 megawatts (MW), in Columbus, Ohio. The new Triax HTS cable design being demonstrated at Bixby cuts the costs of HTS by reducing the quantity of HTS wire needed for the cable and also requires less extreme cooling. Because this new cable design can also transmit larger amounts of current at lower voltages over long distances, it can reduce the impact that power cables have on their surroundings by making a smaller footprint in the ground and by allowing substations to be pushed out to less-crowded areas of a city. Partners in the Bixby demonstration of the cable include Southwire, NKT cables, AEP, American Superconductor, Praxair, and Oak Ridge National Laboratory.

To validate and verify performance, the Infrastructure Security and Energy Restoration subprogram (ISER) participates in the Federal Emergency Management Agency's (FEMA) Regional Interagency Security Committee exercises in all ten FEMA-designated regions. Additionally, ISER participates in national level annual exercises, such as TOPOFF and Ardent Sentry. Direct feedback from industry during symposia and information exchanges provide valuable insight into shortfalls and areas for improvement.

Interagency collaboration with the Department of Homeland Security, the National Guard, the Coast Guard, and FEMA provide opportunity for review and discussion of policies and plans, as well as corrective actions resulting from interagency exercises. Emergency response efforts, such as deployments in response to hurricane damage to the energy infrastructure, are routinely critiqued by FEMA, and generally subject to other reviews by the Inspector General, Government Accountability Office, or special commissions. ISER efforts are tracked and recorded for later self-evaluation and outside review.

Program Assessment Rating Tool (PART)

The Department has implemented a government-wide tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of PART provides a means through which programs can assess their activities differently than through traditional peer reviews. The Office's Research and Development program was assessed in 2006 in preparation of the 2008 Budget Request.

The 2006 PART review of the Research and Development program found that the program has a clear purpose, strong planning and management, with an overall assessment rating of Moderately Effective. OMB rated the program at 80 percent for Program Purpose and Design, 80 percent for strategic planning, 82 percent for Program Management, and 74 percent for Program Results/Accountability.

A common recommendation to all of the Department's applied R&D programs are addressing a PART recommendation that DOE develop guidance that specifies a consistent framework for analyzing the cost and benefits of research and development investments, and use this information to guide budget decisions. The Department has specified common scenarios, methodologies, and standardized benefits measures to allow analyses of costs and benefits of R&D investments. The Department continues to work on implementation of common assumptions and a consistent approach to incorporation of risk. The Office continues to seek how to incorporate unique program benefits (improved reliability of the transmission and delivery system) currently not represented in models used to assess departmental applied R&D programs.

Basic and Applied R&D Coordination

The Office of Electricity Delivery and Energy Reliability proposes $13,403,000 for research in energy storage and power electronics. The energy storage focus area was the subject of a joint BES/OE workshop held in April 2007. The workshop report noted that revolutionary breakthroughs in energy storage have been singled out as perhaps the most crucial need for this Nation's secure energy future. The report concluded that the breakthroughs required for tomorrow's energy storage needs will be realized with a fundamental and applied research partnership to understand and develop advanced energy storage materials and systems. Breakthroughs in such areas as nano-engineered materials for electrodes, asymmetric electrochemical capacitor management, and ionic liquid electrolytes for capacitor storage are required for tomorrow's energy storage needs. Such research will help facilitate successful utilization and integration of renewable, intermittent power sources into the utility sector, making these energy sources base load competitive. It will also help to develop novel battery concepts for hybrid and electric cars, lessening our dependence on oil.

Other offices within the Department that could benefit from this research integration effort include: the Office of Basic Energy Sciences; the Office of Energy Efficiency and Renewable Energy FreedomCAR and Vehicle Technologies program (for research on batteries for vehicles technologies); and the Office of Energy Efficiency and Renewable Energy Solar Energy Technologies program (for research on energy storage for solar energy utilization).

	(dollars in thousands)		
	FY 2007	*FY 2008*	*FY 2009*
Electrical Storage			
Energy Storage and Power Electronics	*0*	*0*	*13,403*
Total, Electrical Storage	*0*	*0*	*13,403*
Total, Basic and Applied R&D Coordination	*0*	*0*	*13,403*

Office of Electricity Delivery and Energy Reliability

Funding by Site by Program

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Argonne National Laboratory			
Research and Development	2,067	1,525	1,000
Operations and Analysis	1,457	700	1,457
Total, Argonne National Laboratory	3,524	2,225	2,457
Brookhaven National Laboratory			
Research and Development	300	400	300
Chicago Operations Office			
Research and Development	6,839	8,905	1,500
Operations and Analysis	405	2,035	405
Program Direction	226	704	397
Total, Chicago Operations Office	7,470	11,664	2,302
Golden Field Office			
Research and Development	11,575	0	0
Operations and Analysis	25	0	25
Program Direction	5	0	0
Total, Golden Field Office	11,605	0	25
Idaho Operations Office			
Research and Development	2,890	2,025	0
Program Direction	10	0	0
Total, Idaho Operations Office	2,900	2,025	0
Idaho National Laboratory			
Research and Development	0	2,905	2,000

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Lawrence Berkley National Laboratory			
Research and Development	2,135	1,409	2,200
Operations and Analysis	5,030	2,200	4,030
Total, Lawrence Berkley National Laboratory	7,165	3,609	6,230
Los Alamos National Laboratory			
Research and Development	5,700	5,730	5,700
Operations and Analysis	11	0	0
Total, Los Alamos National Laboratory	5,711	5,730	5,700
National Energy Technology Laboratory			
Research and Development	26,112	29,888	34,980
Congressionally Directed Projects	0	22,323	0
Operations and Analysis	7,204	6,501	4,417
Program Direction	4,414	4,441	2,905
Total, National Energy Technology Laboratory	37,730	63,153	42,302
National Renewable Energy Laboratory			
Research and Development	1,525	5,415	6,700
Oak Ridge National Laboratory			
Research and Development	22,499	14,433	17,600
Congressionally Directed Projects	0	492	0
Operations and Analysis	310	0	310
Total, Oak Ridge National Laboratory	22,809	14,925	17,910
Pacific Northwest National Laboratory			
Research and Development	5,775	2,040	8,100
Operations and Analysis	100	15	100
Total, Pacific Northwest National Laboratory	5,875	2,055	8,200
Richland Operations Office			
Operations and Analysis	600	0	300
Total, Pacific Northwest National Laboratory	600	0	300

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		
Sandia National Laboratory			
Research and Development	6,771	10,520	16,120
Congressionally Directed Projects	0	1,476	0
Operations and Analysis	4,950	0	2,322
Total, Sandia National Laboratory	11,721	11,996	18,442
Scientific and Technical Info Office			
Research and Development	0	16	0
Washington Headquarters			
Research and Development	2,318	0	4,000
Operations and Analysis	408	0	756
Program Direction	12,702	12,458	16,376
Total, Washington Headquarters	15,428	12,458	21,132
Total, Energy Supply and Conservation	134,363	138,556	134,000

Major Changes or Shifts by Site

Chicago Operations Office (COO)
Research and Development

- In FY 2009, many of the financial assistance agreements awarded through the solicitations "Cooperative Research and Development for Advanced Communication and Control" and "Cooperative Research and Development for Electric Transmission and Distribution" have been or will be completed. Funds have been reduced to appropriate levels to fund the remaining agreements.

Idaho Operations Office (IDO)
Research and Development

- The IDO administered University Cooperative Projects for the High Temperature Superconductivity R&D activity has been completed.

National Energy Technology Laboratory (NETL)
Research and Development

- NETL will provide strategic planning, technical support, and project management support to the Research and Development Program. Additional funds will be used for solicitations and agreements in Energy Storage and Renewable and Distributed Systems Integration activities.

National Renewable Energy Laboratory (NREL)
Research and Development

- NREL's additional funds will include renewable energy grid integration activities to fully integrate transmission and distribution system level renewable energy technologies into the electric grid.

Oak Ridge National Laboratory (ORNL)
Research and Development

- ORNL's additional funds will include enhanced efforts on power electronics activities. Increases will also be used for renewable energy grid integration activities to fully integrate transmission and distribution system level renewable energy technologies into the electric grid.

Pacific Northwest National Laboratory (PNNL)
Research and Development

- PNNL's additional funds will include analysis of the effects and benefits of plug-in hybrid electric vehicles on the grid. It will also include work on renewable energy grid integration and smart grid development and implementation.

Sandia National Laboratories (SNL)
Research and Development

- SNL's additional funds will support enhanced efforts in energy storage and power electronics.

Washington Headquarters
Research and Development

- Activities will only consist of management and administration of the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, I-Manage, and communications.

Site Description

Argonne National Laboratory (ANL)

Research and Development
ANL performs research and development for the High Temperature Superconductivity R&D (HTS) activity. Argonne uses unique expertise in superconducting materials science and in developing characterization tools to help improve the understanding of current flow in HTS materials. Unique facilities such as the Intense Pulsed Neutron Source (IPNS) and the Advanced Photon Source are used for measurement and characterization in ANL's research. Argonne also provides support to cyber security activities.

Operations and Analysis
One of the five key components of the DOE national laboratory Visualization, Modeling, and Analysis working group, ANL supports leads in the analysis of oil and natural gas modeling and impact analysis which contribute to energy situational awareness during major emergencies.

Brookhaven National Laboratory (BNL)

Research and Development
BNL supports the High Temperature Superconductivity R&D activity by working with national laboratory/industry teams and universities to undertake research on fundamental wire properties and processing issues.

Chicago Operations Office (COO)

Research and Development
The Chicago Operations Office commissioned the solicitations for "Cooperative Research and Development for Advanced Communication and Control" and "Cooperative Research and Development for Electric Transmission and Distribution" and provides project management support to the financial assistance agreements awarded through the solicitations.

Operations and Analysis
COO is used to issue grants to national and regional State-based non-profit organizations that have developed expertise in providing technical assistance in electric markets to States and regions. These groups include the National Association of Regulatory Utility Commissioners (NARUC), the National Governors Association, and the National Conference of State Legislatures.

Idaho Operations Office (IDO)

Research and Development
IDO administered the University Cooperative Projects for the High Temperature Superconductivity R&D activity. The University projects were in cooperation with the National Laboratories and consisted of seven projects to transfer new technologies developed at the universities to individual National Laboratories that would benefit from these new technologies. All University projects have been completed.

Idaho National Laboratory (INL)

Research and Development
The Idaho Laboratory provides a Supervisory Control and Data Acquisition (SCADA) test bed to support the Visualization and Controls activity.

Lawrence Berkeley National Laboratory (LBNL)

Research and Development
LBNL has the lead for a national laboratory/industry/university consortium that was formed to support research in Visualization and Controls. This consortium is assisting in implementing the DOE Visualization and Controls activity.

Operations and Analysis
LBNL provides DOE with nationally recognized expert technical assistance to individual State public utility commissions and energy offices, regional transmission organizations/independent system operators and regional State groups. Also, LBNL provides transmission policy analysis support to DOE

on subjects such as the identification of National Interest Electric Transmission Corridors and supporting work required to implement related requirements under EPAct. LBNL will perform analytical tasks to quantify benefits of distributed generation technologies to the customer, the system and the Nation. In addition, LBNL assists DOE in its work monitoring the implementation of increased grid reliability standards and other recommendations from the August 2003 blackout investigation. LBNL supports the Infrastructure Security and Energy Restoration subprogram (ISER) through the development of metrics and data related to energy infrastructure reliability, required to support the GPRA reporting requirements.

Los Alamos National Laboratory (LANL)

Research and Development

LANL works with industry to develop second generation HTS wires based on the ion beam assisted deposition (IBAD) process pioneered by LANL. LANL's expertise in film deposition processes and materials science is used to improve the performance of IBAD wires. Commercial versions are expected to carry 1,000 amperes of current through a centimeter wide metal strip coated with a film the thickness of only a few human hairs - a revolutionary change. LANL is also working with industry to develop superconducting transmission cables and superconducting fault current limiters. Finally, LANL provides support to energy assurance visualization activities.

Operations and Analysis

As a key component of the Department's national Visualization, Modeling, and Analysis working group, LANL supports these efforts by providing damage models, electric grid simulations and the identification of critical facilities based upon a library of past energy events which they maintain. As one of the two Department of Homeland (DHS) Security National Infrastructure Simulation and Analysis Centers (along with SNL) LANL supports closer modeling and analysis cooperation with the DHS during energy emergencies.

National Energy Technology Laboratory (NETL)

Research and Development

NETL will provide strategic planning, technical support, benefits analysis, and project management support to the Research and Development Program. Project management support includes commissioning solicitations and management support for financial assistance agreements awarded through these solicitations. NETL provides this support to the High Temperature Superconductivity, Visualization and Controls, Energy Storage, and Renewable and Distributed Systems Integration activities. NETL will also provide intra- and inter-departmental coordination support with other Federal Programs.

Operations and Analysis

NETL is the coordinating lead laboratory for the visualization and modeling working group (VMWG), to integrate analysis from the VMWG laboratories. NETL also produces a 1-hour analysis of energy related situations showing major energy assets. In addition, NETL provides analysis for special projects that emerge from various sources and incidents, such as a Gulf of Mexico oil and gas production analysis in the post-Katrina environment. Further, NETL develops Energy Information Library documents which profile key energy assets for use during emergencies as reference documents.

National Renewable Energy Laboratory (NREL)

Research and Development

NREL works with industry to develop a uniform national standard for interconnection of distributed power resources with the electric grid and performs research to develop related test and certification procedures. NREL performs analysis addressing regulatory and institutional barriers to distributed power and provides technical assistance to State agencies and others on these issues. Activities will also include renewable energy grid integration to fully integrate transmission and distribution system level renewable energy technologies into the electric grid. NREL also supports the High Temperature Superconductivity R&D activity by working with national laboratory/industry teams and universities to research fundamental wire properties and processing issues.

Oak Ridge National Laboratory (ORNL)

Research and Development

ORNL is part of a national laboratory/industry/university consortium that was formed to support research in Visualization and Controls activities. ORNL operates the National Transmission Technology Research Center for testing transmission technologies. ORNL is one of the primary labs for renewable and distributed systems integration research including plug-in hybrid electric vehicles' effects on the grid and renewable energy grid integration. ORNL is developing second generation HTS wires based on the rolling-assisted, biaxially textured substrate process (RABiTS) patented by ORNL. ORNL is applying its expertise in cryogenic systems and power system technology in projects to develop superconducting fault current limiters, transformers and transmission cables. ORNL also has expertise in power electronics in support of the grid and energy storage.

Operations and Analysis

As a key component of the Department's national Visualization, Modeling, and Analysis working group, ORNL provides expertise, modeling and analysis relating to demographic impacts, energy commodity flows and transportation during energy emergencies. ORNL also supports the Department's real-time electricity grid visualization in a program with TVA in the OE R&D program.

Pacific Northwest National Laboratory (PNNL)

Research and Development

PNNL is supporting development of communication and control architectures and technologies, situational awareness, and visualization tools. PNNL supports development of technologies for improved load/demand management while responding to market prices and electricity supply/demand conditions. PNNL is one of the lead labs in analyzing the effects of plug-in hybrid electric vehicles on the grid. They are also supporting work in renewable energy grid integration. PNNL is part of a national laboratory/industry/university consortium that was formed to support research on Visualization and Controls. PNNL conducts evaluations of the technological and institutional aspects of recent reliability events on the Nation's electric power system, and is the lead for research activities in real-time monitoring and control for the power grid.

Operations and Analysis

As a key component of the Department's national Visualization, Modeling, and Analysis working group PNNL provides expertise relating to the electricity sector and coordination and cooperation with the North American Electric Reliability Corporation during major electricity related emergencies.

Sandia National Laboratories (SNL)

Research and Development

SNL is a national leader in energy storage systems. SNL is developing improved energy storage system components including power conversion electronics and modular multi-functional energy storage systems and manages joint DOE Storage Initiatives with the California Energy Commission and the New York State Energy Research and Development Authority. SNL is part of a national laboratory/industry/university consortium that was formed to support research on Visualization and Controls. SNL also works to develop advanced superconductors based on the sol-gel chemical deposition process.

Operations and Analysis

As a key component of the DOE national Visualization, Modeling, and Analysis working group, SNL provides expertise regarding infrastructure interdependencies and economic modeling and impact analysis. Additionally, SNL provides subject matter expertise in physical security and vulnerability assessments for the ISER International program. This is in the form of the conduct of assessments, as well as training for foreign countries in methodologies and concepts. As one of the two Department of Homeland (DHS) Security National Infrastructure Simulation and Analysis Centers (along with LANL) SNL supports closer modeling and analysis cooperation with the DHS during energy emergencies.

Washington Headquarters

Research and Development

Activities include program management and administration of the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, I-Manage, and communications.

Operations and Analysis

DOE Headquarters also issues grants to national and regional State-based non-profit organizations that have developed expertise in providing technical assistance in electric markets to States and regions, such as the Western Governors Association. DOE Headquarters staff constantly analyzes the regional and national effects of the loss of crude oil, natural gas, refined petroleum products, and electricity. In addition, during energy disruptions, Headquarters staff issues both periodic and special reports on the real-time status of the particular energy situation, timetables for restoration of energy supplies, and other factors, as well as responds to special information requests from senior officials throughout the Executive Branch.

Research and Development

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Research and Development					
High Temperature Superconductivity	45,750	28,186	-256[a]	27,930	28,186
Visualization and Controls	24,388	25,305	-230[b]	25,075	25,305
Energy Storage and Power Electronics	2,823	6,803	-62[c]	6,741	13,403
Renewable and Distributed Systems Integration	23,545	25,700	-234[d]	25,466	33,306
Congressionally Directed Activities	0	24,685	-395[e]	24,290	0
Total, Research and Development	96,506	110,679	-1,177	109,502	100,200

Public Law Authorizations:
P.L. 110-5, Revised Continuing Appropriations Resolution, 2007
P.L. 110-161, Consolidated Appropriations Act, 2008

Mission

The mission of the Research and Development subprogram is to advance technology, in partnership with industry, government, and the public, to meet America's need for a reliable, efficient, and resilient electric power grid.

The Office's Research and Development subprogram will lead to technologies that can improve the reliability, energy efficiency, system efficiency, and security of the Nation's electricity delivery system. The activities will: (1) strengthen electricity grid stability and reduce the frequency and duration of operational disturbances; (2) increase efficiency of the electric delivery system through reduced energy losses; (3) reduced peak price of electricity, increase asset utilization (capacity factor for transmission and distribution), and improve accessibility to a variety of energy sources for generation; and (4) harden energy infrastructure so it can detect, prevent, and mitigate external disruptions to the energy sector.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. Research and Development program supports the following goals:

[a] Includes reductions of $256,493 rescinded in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.
[b] Includes reductions of $230,276 rescinded in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.
[c] Includes reductions of $61,907 rescinded in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.
[d] Includes reductions of $233,870 rescinded in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.
[e] Includes reductions of $394,960 rescinded in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.

Strategic Theme 1, Energy Security: Promoting America's energy security through reliable, clean, and affordable energy.
Strategic Goal 1.3, Energy Infrastructure: Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

The Operations and Analysis program has one GPRA Unit Program goal which contributes to Strategic Goal 1.3 in the 'goal cascade."

GPRA Unit Program Goal 1.2.16.00 Electricity Delivery and Energy Reliability: Lead national efforts to modernize the electric grid, enhance security and reliability of the energy infrastructure, and facilitate recovery from disruptions to the energy supply.

Contribution to GPRA Unit Program Goal 1.3.16.00 Electricity Delivery and Energy Reliability
The Research and Development program contributes to this goal by improving the reliability and efficiency of the electricity grid.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.3, Energy Infrastructure GPRA Unit Program Goal 1.3.16.00 Electricity Delivery and Energy Reliability			
High Temperature Superconductivity	45,750	27,930	28,186
Visualization and Controls	24,388	25,075	25,305
Energy Storage and Power Electronics	2,823	6,741	13,403
Renewable and Distributed Systems Integration	23,545	25,466	33,306
Congressionally Directed Activities	0	24,290	0
Total, GPRA Unit Program Goal 1.3.16.00 Electricity Delivery and Energy Reliability	96,506	109,502	100,200
Total, Strategic Goal 1.3 (Research and Development)	96,506	109,502	100,200

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Strategic Goal 1.3, Energy Infrastructure					
Research and Development/High Temperature Superconductivity					
Completed testing of 10 MVA superconducting transformer in operation on the Wisconsin Electric Power Company grid. (NOT MET)	Completed the manufacture of a 200m superconducting power cable for American Electric Power (AEP). (MET GOAL)	Operated a first-of-a-kind superconducting power cable on the electric grid for 240 hours. (MET GOAL)	Completed six months operation of superconducting cable operating on the grid at greater than 10 kilovolts. (MET GOAL)	By 2020, develop prototype wire achieving 1,000,000 length-critical current (A-m) for second generation wire (2008 - 50,000 A-m)	Maintain progress in achieving increasingly powerful coils for electric power applications such as transformers and motors: magnetic field (Tesla) produced by test coil at 65K (2009 - 2.0 Tesla)
Research and Development/Visualization and Controls					
Installed and operated a prototype wide area measurement system in the Nation's Eastern Interconnection with real-time synchronized measuring instruments that feed data into two data archiving and analysis locations. (MET GOAL)	Installed four additional data concentrators at four different data archiving and analysis locations, achieving a prototype wide area measurement system in the Nation's Eastern Interconnection consisting of six fully functioning data archiving and analysis locations installed at six different utilities. (MET GOAL) Completed field hardware installation at a cumulative total of at least 100 commercial, industrial, and/or municipal customers participating in the demand response and load conservation network in Connecticut, and reduce peak demand (kilowatt hours) in real-time by 5-8% on average (as compared to non-curtailed kilowatt hour consumption) for all participating customers, thereby improving the energy efficiency of electricity usage. (MET GOAL)	Facilitated the installation and operation of 30 additional measurement units and 2 additional archiving and analysis locations in a real-time measurement network, for a cumulative total of 80 measuring units and 8 archiving and analysis locations. (MET GOAL)	Developed a plan for the transfer of leadership from DOE to the Electric Reliability Organization (ERO) for the deployment of a synchronized measurement network in North America, and released the Real Time Dynamic Monitoring System (RTDMS) prototype visualization tool to industry for comment and recommendations. (MET GOAL)	By 2014, develop tools and algorithms to enable an automatic, smart, real-time switchable network for transmission system operations that enables secure and reliable grid operations for major regions of the grid that is hardened against cyber attacks. Definitions for Target: PMUs - phasor measurement unit; dv - distribution voltage (2008 – Area Interchange Error Tool)	By 2014, develop tools and algorithms to enable an automatic, smart, real-time switchable network for transmission system operations that enables secure and reliable grid operations for major regions of the grid that is hardened against cyber attacks. Definitions for Target: PMUs - phasor measurement unit; dv - distribution voltage (2009 - Prototype Angle Stability Alarming Tool) Complete cyber security assessments of 6 SCADA systems in test bed environment.

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Research and Development/Energy Storage and Power Electronics					
Tested and evaluated the performance of a 500kW/750kWh sodium sulfur battery (first in U.S.) installed at an American Electric Power site for six months to determine technical and economic performance. (MET GOAL)	Completed the manufacture of and factory testing of a 2MW/2MWh zinc-bromine battery system (consisting of four 500kW/500kWh units) for supplying extra power during peak load conditions at a utility substation. (MET GOAL)	Commissioned three pioneering energy storage systems in collaboration with the California Energy Commission and collect preliminary technical and economic data. (MET GOAL)	Commissioned two major pioneering energy storage systems in collaboration with the CEC and NYSERDA, and complete data collection and monitoring of three systems commissioned in FY 2006. (MET GOAL).	Test three ionic liquids for possible use as electrolytes in batteries or electrochemical capacitors with the potential for doubling the energy and increasing the power by at least 50% for capacitors or doubling the lifetime and improving safety of rechargeable non-aqueous batteries.	
					Design a prototype ETO-based STATCOM in collaboration with Utility Company.
Research and Development/Renewable and Distributed Systems Integration					
Completed final design and initiated field testing of low emission technology with less than 7 ppm NO_x. (MET GOAL)	Demonstrated emission levels of 0.25 lbs/MWh from a turbine combustion system. (MET GOAL				
Completed and demonstrated heating coefficient of performance of 1.4 for commercial introduction of a thermally activated system (approximately 40 percent more efficient than a conventional heating system). (MET GOAL)					
Demonstrated 6 percentage point increase in efficiency for an advanced reciprocating engine. (MET GOAL)					

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Completed final design and initiated field testing and evaluation of a complete, fully functional integrated CHP system consisting of a turbine, absorption chiller and control system. (MET GOAL)	Completed a case study on a CHP installation that uses heat from microturbine to provide plate tank heating and sludge drying at an industrial facility, contributing to the PART long-term measure of developing a 70 percent efficient CHP integrated system. (MET GOAL)	Developed one packaged CHP system which operates at 70+% efficiency. (MET GOAL)	Developed second packaged CHP system which operates at 70+% efficiency. (MET GOAL)	Demonstrate peak load reduction on distribution feeders with the implementation of Distributed Energy (DE) and Energy Management (EMS) at a cost competitive with a system/capacity upgrade (i.e. cost not to exceed $1,600 per kW in 2001 dollars). Measured in Percent (%) Reduction in Peak Load and Number of Feeders Analyzed/Demonstrated. (2008 - 0%, 0 -- award contracts)	Demonstrate peak load reduction on distribution feeders with the implementation of Distributed Energy (DE) and Energy Management (EMS) at a cost competitive with a system/capacity upgrade (i.e. cost not to exceed $1,600 per kW in 2001 dollars). Measured in Percent (%) Reduction in Peak Load and Number of Feeders Analyzed/Demonstrated. (2009 - 5%, 1)
	Completed and documented two DE/CHP demonstration projects within the high tech industry, contributing to the PART long-term measure of developing a 70 percent efficient CHP integrated system. (MET GOAL)				

High Temperature Superconductivity

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
High Temperature Superconductivity			
High Temperature Superconductivity	47,000	27,930	28,186
SBIR/STTR	-1,250	0	0
Total, High Temperature Superconductivity	45,750	27,930	28,186

Description

The High Temperature Superconductivity subprogram (HTS) focuses on applying high temperature superconductivity technology to the national effort to modernize and expand America's electricity delivery system. High-Temperature Superconducting power equipment has the potential to become a key twenty-first century technology for improving the capacity, efficiency, and reliability of the electric delivery system. For example, higher-capacity HTS power lines could provide a new approach to building transmission and distribution systems that will reduce the footprint and allow additional capacity to be placed in service within existing rights-of-way.

Core activities focus on researching and developing viable second generation (2G) coated conductor HTS wires that promise high performance at significantly lower cost than today's HTS wire. Additionally, development activities focus on use of the HTS wire in electric power equipment such as cable systems and fault current limiters and demonstration in utility systems. The long-term goal is that by 2016, the use of HTS 2G wire will reduce the footprint for new transmission and distribution infrastructure and reduce energy losses. By 2020, HTS 2G wire will achieve the performance level of 1 million amp-meters (i.e., the capability of carrying 1,000 amps per centimeter width over a 1,000 meter long wire). Achieving this long-term goal for HTS power applications requires 1) solving the difficult problem of manufacturing electrical wires from HTS materials – that require special processing before realizing their ability to carry large currents, and 2) designing super-efficient electrical systems that use these wires for transmission cables, fault current limiters, generators, transformers, and motors.

The subprogram also continues to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the Internet.

The opportunity now exists to modernize and expand the Nation's electricity delivery system with equipment using HTS wires that have 100 times the capacity of conventional copper wires without energy loss due to electrical resistance. This breakthrough enables a new generation of reliable grid equipment with typically twice the capacity of same-sized conventional equipment with only half the energy losses. HTS technologies offer new attributes (high capacity, low impedance, ultra-compact footprint, and reduced environmental impacts) and entirely new functionalities (fault current limiting and overload protection). They will make the electricity delivery system more reliable, flexible, controllable, and self protecting. Superconducting cables, operating at extremely low temperatures, eliminate virtually all resistance to the flow of electric current. HTS cables can deliver up to five times more electricity than traditional conventional copper or aluminum cables and have the potential to address the challenge of providing sufficient electricity to densely populated areas.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
High Temperature Superconductivity (HTS)	**44,146**	**27,930**	**28,186**

In FY 2009, the activity will continue to support core research in second-generation (2G) HTS wire development, as well as research on dielectrics, cryogenics, and cable systems (including fault current limiters).

To maximize the wire performance, research efforts will continue to improve processing to nanoscale engineer the superconductor to behave like an infinitely long single crystal instead of the unprocessed granular structure. It will also develop cost effective processes to produce the wire in long lengths. These activities support research to better understand relationships between the microstructure of HTS materials and their ability to carry large electric currents over long lengths. Technical challenges include reducing the multilayer process cost while also achieving end-to-end uniformity, where long-length currents are comparable to results in short lengths. A key objective is to enable the current to scale with superconductor thicknesses above 2 microns. Processing improvements need to be made in both coating and preparation of the underlying metal substrate. Coating improvements include faster processes, thicker films with higher current densities, and improved uniformity in long lengths. Also, work on enabling technologies such as joining HTS conductors to normal conductors will be supported, as well as additional research to minimize electrical losses due to alternating currents.

The activity will continue to fund the projects competitively awarded under the Superconducting Power Equipment Funding Opportunity. The goal of these projects is to build upon the lessons learned from previous work and to expand the electric power applications base to include greater use of 2G wire that is currently becoming available in significant quantities. Realizing the full potential of HTS equipment will require the capability to operate, as the electricity system does, over a wide range of voltage and power. This includes continued funding of the two cable demonstrations and three superconducting fault current limiter phase one proof of concept studies. Since HTS technologies depend on high-performance, ultra-reliable refrigeration systems, activities will be pursued to improve cryogenic refrigeration systems and long cable cryostats to achieve cost, efficiency, and reliability targets. The cryogenic environment is harsh for dielectric materials that will experience thermal and mechanical stresses and high-voltage partial discharge conditions. Cryogenic dielectric research will fully characterize existing materials in AC and DC applications and then research, develop, and characterize new dielectric materials that have improved electrical and mechanical properties at cryogenic temperatures.

The activity also continues to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the Internet.

Control System Reliability (MT)	**150**	**0**	**0**

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		
National Center for Reliable Electric Power Transmission (AR)	**150**	**0**	**0**
Energy Grid Modernization Project at Florida State University (FL)	**304**	**0**	**0**
Optimization of High Voltage Lines at Tennessee Tech (TN)	**500**	**0**	**0**
Utility Transformation Program (WA)	**300**	**0**	**0**
Power Technologies Project (CT)	**200**	**0**	**0**
SBIR/STTR	**-1,250**	**0**	**0**
In FY 2007, $1,116,000 and $134,000 were transferred to the SBIR and STTR programs respectively.			
Total, High Temperature Superconductivity	**45,750**	**27,930**	**28,186**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
High Temperature Superconductivity There are no substantive changes in this ongoing activity.	+256
Total Funding Change, High Temperature Superconductivity	**+256**

Visualization and Controls

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Visualization and Controls			
Visualization and Controls	25,054	25,075	25,305
SBIR/STTR	-666	0	0
Total, Visualization and Controls	24,388	25,075	25,305

Description

The Visualization and Controls (V&C) subprogram supports grid modernization through the development of advanced visualization and control technologies to improve grid reliability, efficiency and security. Advanced V&C technologies will enhance situational awareness, enhance the cyber security of control systems, and help create a resilient National transmission infrastructure that can automatically detect disturbances and prevent widespread outages.

The Visualization and Controls subprogram will develop tools/algorithms that will:

- Improve the response time of the transmission system to system disturbances to reduce the number and spread of outages;
- Reduce the operating margins by allowing the system to operate closer to its loading limits by sensing deterioration of system conditions and enabling faster response;
- Harden the transmission system's digital control, communications and computing systems.

The long-term goal (by 2014) is to develop tools and algorithms to enable an automatic, smart, real-time switchable network for transmission system operations that enables secure and reliable grid operations, controls major regions of the grid, and is hardened against cyber attacks. OE will maintain the capability to test three SCADA systems per year.

The subprogram also continues to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the Internet.

The V&C subprogram supports modernization of the Nation's electric transmission system through the development of advanced technologies, tools, and techniques to create an electric transmission infrastructure that is more reliable and efficient and can better withstand cyber and physical disturbances without loss of critical services. The V&C subprogram is developing a North American wide-area monitoring system (WAMS) featuring geographically-dispersed, GPS time-synchronized sensors distributed across North America to provide real-time situational awareness. The subprogram is also developing advanced technologies to enhance the cyber security of control systems including more secure supervisory control and data acquisition (SCADA) and energy management systems, secure data communications protocols, intrusion detection/prevention systems, and a virtual control systems environment to evaluate the risk and consequences of cyber attacks on the energy infrastructure.
The expected benefits include:

- Better situational awareness to detect system disturbances and prevent widespread outages,
- Better utilization of existing transmission lines by allowing the transmission system to operate closer to its design limits (thereby reducing the growing need for more lines), and
- Improved reliability through the development of advanced digital control, communications and computing systems that are more resilient to malicious cyber attack.

The technologies, tools, and techniques being developed by the V&C program will significantly improve electricity reliability by reducing outages, improving power quality, and reducing transmission congestion.

There are many T&D technologies that can improve efficiency and reduce GHG emissions. In the near-term, these include high-voltage DC (HVDC) transmission, high-strength composite overhead conductors, solid-state transmission controls such as Flexible AC Transmission System (FACTS) devices that include fault current limiters, switches and converters, and information technologies coupled with automated controls (i.e., a "Smart Grid"). High efficiency conventional transformers—commercially available although not widely used—also could have impacts on distribution system losses. Advanced conductors integrate new materials with existing materials and other components and subsystems to achieve better technical, environmental, and financial performance—e.g., higher current carrying capacity, more lightweight, greater durability, lower line losses, and lower installation and operations and maintenance costs. Improved sensors and controls, as part of the next-generation electricity T&D system, could significantly increase the efficiency of electricity generation and delivery, thereby reducing the GHG emissions intensity associated with the electric grid. Outfitting the system with digital sensors, information technologies, and controls could further increase system efficiency, and allow greater use of more efficient and low-GHG end-use and other distributed technologies. Digital sensors, information technologies, and controls may eventually enable real-time responses to system loads.

Early research is likely to focus on ensuring reliability, e.g., establishing "self-healing" capabilities for the grid, including intelligent, autonomous device interactions, and advanced communication capabilities. Additional technologies would be needed for wide-area sensing and control, including sensors, secure communication and data management; and for improved grid-state estimation and simulation. Simulation linked to intelligent controllers can lead to improved protection and discrete-event control. Digitally enabled load-management technologies, wireless communications architecture and algorithms for system automation, and advanced power storage technologies will allow intermittent and distributed energy resources to be efficiently integrated.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Visualization and Controls	**16,658**	**25,075**	**25,305**

Market restructuring, greenhouse gas reductions, and new end-use technologies have redefined the way we use electricity. As the need for more and higher quality electricity continues to grow, as well as the need to better integrate distributed and renewable resources, more sophisticated and secure control technologies will be required to assure the reliability and security of the Nation's power grid.

To meet these demands, the V&C activity is developing advanced technologies and tools to help create a resilient electric transmission system that can detect disturbances and automatically reconfigure to prevent widespread outage. Key activities include the development of a North American wide-area monitoring system (WAMS) to enhance situational awareness, tools to evaluate and monitor electric market and operational performance, and advanced technologies to enhance the cyber security of control systems including supervisory control and data acquisition (SCADA) systems and distributed control systems.

The WAMS activity includes GPS-synchronized grid monitoring, secure data communications, custom visualization and operator cuing and advanced analysis and control algorithms. These algorithms will perform a real-time assessment of the grid's capability to redispatch generation and balance supply and load to optimize emissions reductions and accommodate wind energy.

A real-time monitoring and visualization system – based on time-synchronized measurement of frequency, voltage and current – will provide operators with visualization screens that display the status of the transmission system over a wide area, and calculate the "health" of the grid in real-time. The approach will be first to develop the capabilities for real-time data collection and begin to build a baseline for modeling system performance. The next step will be to compare actual system operations to this baseline. This will enable the development of new diagnostics and operator cuing tools and lead ultimately to automatic, real-time, switchable grid operation.

This sequential process is depicted in the following diagram.
Predictive Modeling → Real-time Data Collection → Diagnostics/Operator Cuing → Automation

Sensors are an essential "building block" to equip system planners and operators with the real-time information they need for achieving the long-term goal of improved electric transmission and distribution planning and operations. DOE activities in this area involve working with electric utilities, vendors, regulators, and research organizations to expand the breadth of coverage of sensors in the transmission system and the depth of coverage in the distribution system. Advanced GPS time-synchronized sensors known as intelligent electronic devices (IED) are deployed in substations and include phasor measurement units (PMU), digital fault recorders, and circuit breaker monitors. Other sensors that monitor dynamic line conditions (sag monitors) are deployed directly on transmission lines.

The V&C activity involves partnering with universities, national laboratories, vendors, and the electricity industry to develop the underlying theory and software for power system planning and operations applications under competitive markets. Market uncertainties under restructuring have been a threat to grid reliability and the efficient, economic operation of the power system. The V&C subprogram will also model, simulate and experiment with new market designs and operating practices to understand and optimize the new markets for energy, ancillary services, and demand response prior to actual implementation on the power system. Customer demand reduction programs will enable energy- consuming products and processes to respond to market prices of electricity to balance supply and demand, help reduce transmission congestion, and ensure system reliability. Development of advanced analysis and control algorithms requires continued support for a multidisciplinary, geographically-diverse university collaboration seeking innovative solutions to critical challenges to electric power transmission and distribution reliability.

FY 2009 activities include supporting industry in implementing a distributed data management network for real-time data collection, archiving and dissemination for wide-area grid visibility and situational awareness; and developing advanced applications software for automatic grid protection and control.

In FY 2008, a dynamic test set for calibration of phasor measurement units will be completed, in addition to enhancements to the Real Time Dynamic Monitoring System (RTDMS) visualization tool that display incipient grid oscillations.

As recommended in the Final *Report on the August 14, 2003 Blackout in the United States and Canada*, the V&C subprogram is also developing situational awareness capabilities and tools for enhanced modeling and simulation of power grid contingencies, blackouts, and other grid-related events. This capability will be completed in FY 2009 and provide the Department, FERC and DHS with critical, real-time information that is needed to respond appropriately to energy emergencies.

As our dependence on energy increases, so does the risk of a major disruption due to cyber attacks on energy control systems (e.g., supervisory control and data acquisition (SCADA) and distributed control systems (DCS)). Control systems are the digital "brains" that monitor, manage, and control the Nation's vast interconnected network of electric transmission and distribution lines, oil and gas pipelines, and geographically dispersed control centers. The increasingly critical role of control systems in our Nation's infrastructures was emphasized in the *National Strategy for Securing Cyberspace* and the recent report by the President's National Infrastructure Advisory Council on *Convergence of Physical and Cyber Technologies and Related Security Management Challenges.*

Enhanced cyber security for control systems is critical to the development of a reliable and resilient modern grid. Control systems have also become more vulnerable to malicious cyber attacks due to the increased adoption of standardized technologies with known vulnerabilities, lack of cyber security tools suitable for use in a real-time environment, and the increased connectivity to other networks including the internet. Sophisticated cyber attack tools are now widely available on the internet for adversaries with little technical knowledge to launch an attack from almost anywhere using a laptop computer and an internet connection. A major issue area of concern is the currently limited ability to measure and address the vulnerabilities of control systems, detect cyber intrusion, implement protective measures and response strategies, and sustain cyber security improvements over time.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

In FY 2009, the V&C control system security activity will continue to partner with industry to develop a comprehensive and national effort through the implementation of the *Roadmap to Secure Control Systems in the Energy Sector*. Key activities include: development of advanced technologies, cyber security assessment of control systems, development of an integrated risk management capability including a virtual control systems environment, tools and models to evaluate the cyber and physical effects of cyber attacks on the energy infrastructure, and models to evaluate consequences. Activities will include test bed assessments of the cyber vulnerabilities of control system technologies, development of advanced technologies to better secure data communications, development of innovative cryptographic key management schemes to secure legacy systems, and more efficient authentication technologies that do not adversely impact performance and availability. All activities will be coordinated with the Department of Homeland Security in accordance with Homeland Security Presidential Directive 7.

The V&C activity is working closely with control system vendors and end-users (i.e., utilities) to evaluate the cyber security of control systems currently available. In FY 2008, the V&C subprogram will complete cyber security assessments of more than 80 percent of the current market offering for control systems in the energy sector. As part of the assessments, the V&C subprogram provided mitigation recommendations to the vendors who subsequently developed next-generation "hardened" control systems as well as software patches to upgrade legacy systems. One vendor has sold and installed twenty-one new "hardened" systems for various utilities and another vendor issued a software patch that has been downloaded by 81 utilities.

In FY 2008, the V&C activity will also accomplish the following:

- Develop mitigation options for NERC's "top 10" control system vulnerabilities;
- Complete testing and a cyber security analysis of the Inter-Control Center Protocol (ICCP);
- Successfully demonstrate the capability to simulate a cyber attack on a small-scale control system using the virtual control systems environment (VCSE);
- Successfully demonstrate a secure SCADA protocol for authenticating remote serial communication links;
- Complete development of a methodology for the efficient management of encryption keys in a control systems environment;
- Evaluate the functionality and cyber security of an advanced middleware software solution for inter-control center communications;
- Release a report on common control system vulnerabilities; and
- Complete control systems cyber security training for over 1,000 utility representatives

System Control and Data Acquisition (SCADA) (IN, NM)	**8,000**	**0**	**0**
Energy Research and Development Center at the University of Missouri-Rolla (MO)	**300**	**0**	**0**
Energy Grid Modernization Project at Florida State University (FL)	**96**	**0**	**0**

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
SBIR/STTR	**-666**	**0**	**0**

In FY 2007, $595,000 and $71,000 were transferred to the SBIR and STTR programs respectively.

Total, Visualization and Controls	**24,388**	**25,075**	**25,305**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Visualization and Controls There are no substantive changes in this ongoing activity.	+230
Total Funding Change, Visualization and Controls	**+230**

Energy Storage and Power Electronics

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Energy Storage and Power Electronics			
Energy Storage	2,272	2,137	8,803
Power Electronics	474	4,604	4,600
SBIR/STTR	-77	0	0
Total, Energy Storage and Power Electronics	2,823	6,741	13,403

Description

In partnership with industry, the Energy Storage and Power Electronics subprogram develops advanced electricity storage and power electronics technologies for modernizing and expanding the electric grid. This will improve the quality, reliability, flexibility, and cost effectiveness of the existing system.

The long-term goal for energy storage is to increase energy density in a prototype battery or electrochemical capacitor systems by 50 percent.

The long-term goal for power electronics (by 2025) is to demonstrate a prototype solid state breaker (switch) with less than 1 millisecond response. When used in a breaker, these switches will not increase the cost of the system by more than 10 percent.

The subprogram also continues to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the Internet.

The main goals of the Energy Storage and Power Electronics activity (ESPE) is to focus on 1) the advancement of electrical storage devices and materials, and 2) the development of high-voltage power electronics devices that will allow precise and rapid switching of electric power to support long distance transmission and local distribution. This technology is required to meet the needs for higher quality power, the effective application of renewable and distributed energy resources, and significant improvements in the grid's response to varying electrical conditions and sudden disturbances.

Electrical storage devices offer several benefits, including:

- Providing supplemental generation capacity for peak demand management and reduction of transmission congestion, which is valuable as transmission capacity additions are not keeping pace with the growth in peak demand.
- Improving the performance and reliability of the grid by supplying electricity when it is needed, e.g. for back-up power, and to compensate for disturbances, e.g. voltage sag, and to maintain system stability.

- Increasing the value of renewable generation sources, like wind and solar power, to deliver power when required by storing energy at times of low demand and providing it when needed.

High voltage power electronics devices hold substantial promise for transforming the electric power system. High voltage power electronics allow precise and rapid control and switching of electric power to support improved long distance transmission and advanced distribution topologies. This speed and precision will allow the system to respond to system disturbances and operate with lower margins and fewer constraints, thereby reducing the need for additional infrastructure. The Power Electronics activity will focus on material development and incorporation of advanced materials and topologies into utility scale devices including solid state fault current limiters, circuit breakers, transformers, and flexible AC transmission system devices (FACTS) which will enable precise control of power flow on the grid.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Energy Storage	**2,272**	**2,137**	**8,803**

One of the distinctive characteristics of the electricity sector is that supply is relatively fixed, at least in the short-term, while demand will fluctuate. Developing technology to store electrical energy so it can be available whenever needed would represent an important breakthrough. Large scale, megawatt-level electricity storage systems, or multiple smaller distributed storage systems, could significantly reduce transmission system congestion, manage peak loads, make renewable electricity sources more dispatchable, and increase the reliability of the overall electric grid. Reducing the cost and size of energy storage systems is the key to more widespread use. Effort is needed to assess opportunities for new devices and new manufacturing processes to reduce the cost of existing battery storage devices. For all types of systems, effort is needed to explore the possibilities of substituting lower cost materials without sacrificing technical performance. Advances in the design of storage devices are needed for batteries, flywheels, and capacitors, as well as evaluation of trade-offs in features and performance to lower manufacturing costs.

In FY 2007, two flywheel energy storage system frequency regulation tests were completed successfully with the California Energy Commission (CEC) and the New York State Energy Research and Development Authority (NYSERDA). These systems compensate for short-term load/demand inequalities which result in frequency deviations. The CEC system received a signal from the California Independent System Operator (CAISO) while the NYSERDA system read the system frequency directly from the utility line feeding a factory. The systems responded to under frequency conditions by adding power and to over frequency conditions by drawing power from the utility to charge the flywheels. The NYSERDA Gaia project which placed an energy storage system with a fuel cell at an edge-of-grid residence was also completed successfully. A third NYSERDA project was commissioned placing a 1 MW, 7 MWh sodium sulfur battery in a Long Island Municipal Bus refueling station for a peak shaving application. A supercapacitor microgrid stabilization system was commissioned with the CEC to research the feasibility of stabilizing a microgrid fed by a wind turbine, a hydroelectric generator, diesel generators and the grid.

In FY 2008, the Storage activity initiated investigations of novel materials including ionic liquids for possible use as electrolytes in batteries and supercapacitors. The Storage Program also initiated investigations into nano-engineering of electrode materials, extending successful SBIR projects.

Devices combining these technologies will be developed with the long term potential of doubling the energy and increasing the power by at least 50 percent for capacitors, and doubling the lifetime and improving safety of rechargeable non-aqueous batteries. These studies are being performed in coordination with the Department's Office of Science. This activity also continued the development of energy storage devices including advanced batteries, electrochemical capacitors, flywheels, and other energy storage systems to meet the emerging needs of the electric system.

With the significant increase in funding in FY 2009, the activity will expand the material research initiated in FY 2008 and will implement new projects and program areas: System and prototype development and testing; NYSERDA/DOE Joint Storage Initiative; CEC/DOE Energy Storage Collaboration; Fundamental Material Studies for Energy Storage Program Management will coordinate the energy storage and power electronics activities, oversee any SBIR, STTR and State Energy Projects, and manage the Electrical Energy Storage – Applications and Technology (EESAT) Conferences.

The Fundamental Material Studies for Energy Storage Systems (ESS) project will be conducted in coordination with the new Department of Energy Basic Energy Sciences Initiative supporting research projects contributing to technology of electric energy storage in materials chemistry and interfacial chemistry at electrode-relevant surfaces. This new initiative's goals are: discovering new materials, electrolytes, understandings in charge transport, electrolyte physics and chemistry, theory and modeling for electrical energy storage. In FY 2009 the OE ESS activity will take these basic discoveries and significantly increase applied research efforts to form devices and systems substantially improving the operating parameters of energy storage systems. Utility applications of energy storage need increased storage system lifetimes, improved reliability and reduced costs to become widespread. The results of this use-inspired research will be applied to the development of new storage devices which will be evaluated under increasingly realistic test conditions. Batteries with long lifetime capabilities while operating at intermediate states of charge will be developed as well as batteries capable of repeated deep discharge. This will result in increased lifetimes in utility applications and allow the improved integration of solar and other renewables. Electrochemical capacitors and advanced flywheels with greater energy storage capabilities will also be developed.

FY 2009 funding will also allow expanded collaboration in highly leveraged prototype demonstration and deployment projects. The Energy Storage activity has been instrumental in assisting emerging technologies reach this stage. System modeling, prototype development and field testing in realistic grid conditions are critical to that process. State energy agency collaboration has insured that the emerging technologies are deployed in areas of greatest need on the electric grid. This effort will be expanded to include other cost shared utility projects and potential work with other governmental agencies. The energy storage program will seek a third State partner to complement collaborations with California and New York State.

This activity will continue to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the Internet.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Power Electronics	**474**	**4,604**	**4,600**

Power electronics devices hold substantial promise for transforming the electric power system. High voltage power electronics allow precise and rapid switching of electric power to support improved long distance transmission and advanced distribution topologies. Power electronic devices will enable quick response to system disturbances improving grid reliability and allowing increased power flow reducing the need for additional infrastructure. FY 2009 funding will accelerate the material development and incorporation of advanced materials and topologies into utility scale devices including solid state fault current limiters, circuit breakers, transformers and FACTS devices which will enable precise control of power flow on the grid.

One of the most basic power system devices is the switch. A high priority technology need is for power electronic switches with the capability for high voltage, high speed, and reliable operation with a favorable cost/value relationship. New approaches or materials (silicon carbide or diamond) that are not currently used today in power electronics will be needed. Working in high voltage and current domain will require more research into the properties and suitability of advanced materials. There is promise in exploring new materials going beyond silicon. Diamond and silicon-carbide are examples of promising materials for use in power electronics.

There has been, and continues to be, a substantial Federal R&D investment in power electronics that OE leverages. Much of this investment has been targeted at automotive and military applications. Utility applications are very different from these lower power applications. In automotive and military applications, size and weight are the key drivers whereas in utility applications high power and voltage are the critical issues. OE will address these high voltage and high current applications. This will require additional focus on thermal management, topology development and packaging concerns.

In FY 2007, a power electronics project was initiated in collaboration with the Bonneville Power Administration (BPA) and EPRI to prototype an Emitter Turn-Off (ETO) based STATCOM system. The system will be tested in a utility setting at a wind farm in the BPA territory. This project leverages the 10 year development of the Emitter Turn-Off Thyristor and recent efforts to better integrate renewable sources into the grid.

In FY 2008, the power electronics activity was initiated. Main focuses of this activity included:

- Overall system life-cycle costs for power electronics need to be comparable or lower in cost than existing devices to be more marketable;
- Devices need to be able to withstand high voltages, current levels, and power densities;
- Advanced topologies are needed to reach the high power levels of utility applications;
- Performance, reliability, and durability of power electronics must be proven over time;
- Advanced control methodologies and technologies are needed to better coordinate multiple systems; and
- Lower cost and more modular "building block" converter units are needed for series or parallel installations that are programmable for multiple functions and have standardized interfaces.

In FY 2009 the activity will finalize the BPA proof testing and installation at the final wind farm

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

location. Data will be collected and analyzed determining the effectiveness of the ETO switch in this type of application. A prototype 6kV, 50A SiC based three terminal device will be produced and tested. Begin design of a power conditioning system with double the voltage capability. To bring power electronics technology to widespread use in grid applications, the program will begin investigation of a prototype 15 kV class solid state circuit breaker.

This activity will continue to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the web.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**-77**	**0**	**0**

In FY 2007, $69,000 and $8,000 were transferred to the SBIR and STTR programs respectively.

	FY 2007	FY 2008	FY 2009
Total, Energy Storage and Power Electronics	**2,823**	**6,741**	**13,403**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Energy Storage The increased funding supports a significant increase in efforts to develop new and improved energy storage devices and systems at utility scale, incorporating DOE BES basic research results. Substantial improvements will be sought in lifetime, reliability, energy density, and cost. Highly leveraged prototype testing and utility demonstration projects will expand with State energy office participation focusing on areas of greatest utility need.	**+6,666**
Power Electronics There are no substantive changes in this ongoing activity.	**-4**
Total Funding Change, Energy Storage and Power Electronics	**+6,662**

Renewable and Distributed Systems Integration

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Renewable and Distributed Systems Integration			
Renewable and Distributed Systems Integration	24,189	25,466	33,306
SBIR/STTR	-644	0	0
Total, Renewable and Distributed Systems Integration	23,545	25,466	33,306

Description

The main goal of the Renewable and Distributed Systems Integration activity (RDSI) involves developing technologies, tools, and techniques for integrating renewable energy, distributed generation, energy storage, thermally activated technologies, and demand management into electric system planning and operations to manage peak loads, improve customer services, and enhance asset utilization.

The integration uses a systems approach to address technical, economic, regulatory, and institutional barriers for using renewable and distributed systems, and establishes proven value propositions under varying use scenarios for broad implementation.

Improving the ability to integrate renewables and other technologies into the distribution and transmission system will facilitate and support achieving target goals in State portfolio standards for renewables and energy efficiency. In addition, the integrated system will enable "microgrid" operations, new value-added electric services such as premium power for critical loads, and new applications for electricity such as utilizing plug-in hybrid electric vehicles to meet energy diversity and climate change challenges.

The subprogram also continues to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the Internet.

The RDSI activity accomplishes integrated demonstration projects with utilities, State agencies, equipment manufacturers, and technology providers to reach the goal to demonstrate a 20 percent reduction in peak load demand at a distribution feeder by the year 2015. This reduction in peak demand will eliminate or defer the need for new transmission and distribution capacity, reduce congestion and decrease electricity prices and volatility. Successfully meeting this goal will require advancing system management tools that permit both utilities and consumers to benefit form distributed generation capacity and demand reduction practices.

Public policy initiatives, e.g., renewable portfolio standards and mandates to achieve a percentage of peak supply via demand response practices, are intended to increase efficiency, reduce demand on imported energy, and minimize impacts that contribute to climate change. As a result, utilities are being asked to capture the potential value of distributed energy resources when considering investments in "firm" distribution capacity additions. To date, however, there are no standard models, tools, or techniques to evaluate and incorporate distributed generation resources into electric system planning and operations. One of the outcomes of the RDSI demonstrations will be to address the operational issues associated with renewable and distributed generation technologies, as well as the business models needed to incorporate these technologies into capacity planning and demand-side management. The RDSI subprogram serves to enable the utilization of distributed generation technology which offers the potential to increase system reliability, in terms of helping utilities to meet their electricity demand requirements, as well as providing power in response to system disturbances or outages.

Most events that impact reliable operation of the grid occur at the distribution level. These events are characterized as either power outages or power quality disturbances; the latter type of event largely impacts the proper functioning of digital and other sensitive equipment which represent an increasing percentage of total load in the United States. (The Electric Power Research Institute predicts that digital-quality power will reach 30 percent by 2030 under business-as-usual conditions.) RDSI technologies benefits will be methods for achieving the needed reliability at the distribution level by incorporating many technologies into demonstrations, including distributed generation, energy storage, demand response, renewable energy, and power electronics devices.

Another benefit will be to verify the application of distributed energy systems for safe, secure, and cost-effective "islanding" operations, i.e., operating parts of the system while disconnected from the main grid, thereby mitigating the impacts of outages and ensuring a more resilient overall system. This benefit of RDSI is expected to make the overall electric system more flexible and secure.

The RDSI benefits from a reduction in peak power requirements are derived primarily from deferred investments in central generation power plants, as well as in transmission and distribution capacity. This benefit can result in lowering of overall electricity costs to consumers. During critical peak periods, peak load reductions can eliminate or reduce the need for power from the most expensive power plants, as well as provide congestion relief. Finally, reductions in peak load can reduce "wear and tear" on electricity delivery equipment, thus reducing maintenance costs, extending equipment life, and reducing overall capital investment requirements.

In summary, the benefits of the Renewable and Distributed Systems Integration activity (RDSI) include:

1) reduced carbon emissions and emissions of other air pollutants through increased use of renewable energy,
2) increased asset utilization through integration of distributed energy systems and customer loads to reduce peak load and thus price volatility,
3) contribution to achieving goals in Federal and State portfolio standards for renewable energy and energy efficiency,
4) enhanced reliability, security, and resiliency from microgrid applications in critical infrastructure protection, digital equipment applications, and constrained areas of the electric grid,
5) improved system efficiency with on-site, distributed generation and improved economic efficiency through demand-side management, and
6) support of energy diversity by understanding and enabling plug-in hybrid electric vehicle (PHEV) operations with the grid.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Renewable and Distributed Systems Integration	**22,915**	**25,466**	**33,306**

The Renewable and Distributed Systems Integration activity focuses on integrating renewable energy, distributed energy systems, and demand management of customer (industrial/commercial/residential) loads into the planning and operations of the electric transmission and distribution network. This integration supports demonstrating technical and economical feasibility of using renewable and distributed systems in utility-scale applications, and provides sound use cases with robust performance data for broad acceptance and implementation by industries and utilities.

To date, renewable and distributed systems are greatly under-utilized. The Energy Information Administration report, *Electric Power Annual*, cites data for 2005 indicating that renewable energy, other than hydroelectric, accounted for a mere 2.3 percent of net generation, and that demand-side management contributed to a total peak-load reduction of 3.4 percent. To reach the target of 20 percent net generation by renewable energy in 2030, the compound annual growth rate of renewable penetration needs to reach over 10 percent, which is more than twice the overall growth rate for wind, solar, biomass, and geothermal combined in 2005. Similarly challenging is the goal of a 20 percent peak load reduction by 2015 through distributed systems integration into the electric grid.

To reach the target goals for renewable energy and distributed energy systems, significant technical advances both in individual generation technologies and in system design, integration, and operations must be accomplished, requiring focused, accelerated, and well coordinated R&D. The OE program will work closely with the EERE program to ensure that advances in generation technology development (solar, wind, biomass, geothermal, fuel cells) by EERE can be readily integrated into the system through OE's research and developed technologies. The latter will also address economic, institutional, and regulatory barriers.

The future state of a fully integrated electric grid system is referred to as a "smart grid" system. Smart grid utilizes open architecture, standards-compliant technologies, fast two-way communications, and digital controls to integrate all new developments and technologies in renewable and alternative clean energy generation, transmission and distribution, and customer load management. This smart grid system not only directly supports achievement of the target goals for renewable energy and distributed systems, but also enables new operational configurations such as "microgrids," new services such as offering differentiated reliability levels with competitive market pricing, and new applications for electricity use such as fueling plug-in hybrid electric vehicles to meet energy diversity and climate change challenges.

In FY 2009, the Renewable and Distributed Systems Integration activity plans to undertake R&D in the following key technology areas:

▪ **Peak Load Reduction**	**22,915**	**25,466**	**28,306**

This technology area focuses on integration of distributed energy resources (distributed generation, renewables, energy storage, thermally activated technologies, and demand response) to increase utilization of both utility- and customer-owned assets and to reach the goal of 20 percent peak load reduction by 2015.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

Integrated Demonstrations. The demonstration projects selected through an open solicitation in FY 2007 and awarded in FY 2008, will be continued in FY 2009. Each of these awarded projects involves significant use of distributed resources to provide a substantial amount of peak power, i.e., greater than 15 percent of the capacity of distribution feeder(s) and/or substation, and other functions and services. These other functions and services that will be developed and demonstrated through the projects will include low-cost sensors for distribution cables, advanced monitoring for distribution automation, and information gateways to enable demand-side management by both utilities and consumers.

Interconnection Standards Development and Testing. Activities will continue in developing and harmonizing national and international standards for interconnection of distributed resources and electric power systems, and in testing advanced interconnection technologies to support standards development. In FY 2009, IEEE P1547.5, *Draft Technical Guidelines for Interconnection of Electric Power Sources Greater than 10MVA to the Power Transmission Grid*, and IEEE P1547.6, *Draft Recommended Practice for Interconnecting Distributed Resources with Electric Power Systems Distribution Secondary Networks*, will be completed and published. This will follow a series of planned interconnection standards developments in FY 2008, including completion of the 5-year reaffirmation and revision of ANSI IEEE 1547, *Standard for Interconnecting Distributed Resources with Electric Power Systems*.

In the Microgrid area, activity will continue on advanced control strategies development to ensure automatic re-synchronization, fast switching, and coordinated control and protection operations. The integration of agent based control and grid management algorithms will continue; this has been jointly undertaken since FY 2007 with the European Union SmartGrids projects as part of international collaboration on microgrids R&D. This collaborative activity will progress toward system level testing in FY 2009. Additionally, laboratory-scale testing of alternative control technologies under the FY 2005 solicitation awards will be completed in FY 2008; their progression into field demonstrations will depend on successful laboratory testing.

The Renewable Energy Grid Integration activity will be closely coordinated with EERE to fully integrate transmission and distribution system level renewable energy technologies into the electric grid. EERE will be primarily responsible for characterizing renewable generation technology requirements. OE will undertake the integration of renewable generation, as well as, end use technologies, with the electric transmission and distribution grid. Activities may include technology research and tool development for analyzing interactions of renewable energy technology with electric system operations, integration model validation and implementation, and integration demonstrations to support utility acceptance.

▪ **Smart Grid Development and Implementation**	**0**	**0**	**5,000**

The Smart Grid Development and Implementation technology area focuses on defining the characteristics and associated performance of, and developing technologies to meet the performance metrics of, an integrated, intelligent electric transmission and distribution network, also known as a "smart grid." A systems approach is undertaken for all activities, involving design and architecture, integration of electric/market operations and policies, and new capabilities to enable new functions and services in the 21st century.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

Smart Grid Advancement. Smart Grid Advancement projects will involve implementation of smart grid concepts in utilities, with a further objective of implementation in individual States and multi-State regions. The implementation will be guided by a roadmap, with defined performance metrics, that will be developed through a workshop in FY 2008 with open participation by all stakeholders.

Enabling Functions and Services. In the PHEV area, field testing of smart charger controllers will continue, with collection of a full year of performance data in PHEV fleet vehicles to be completed in FY 2009. This will follow the work in FY 2008 to install smart charger controllers in test vehicles and monitor test performance, and the work in FY 2007 to develop smart charger controllers responsive to electricity pricing and load control signals. Additionally, analysis of PHEV impacts on power wholesale pricing under varying PHEV penetration scenarios and charging load profiles, a joint project with the EERE FreedomCAR and Vehicle Technologies, will be completed in FY 2008.

Smart Grid Architecture and Standards. Development and implementation of a smart grid architecture framework to support technical principles of interoperability will continue. A second interoperability forum will be held in FY 2009 to share progress in industry implementation and related standards efforts, following the first forum in FY 2008 to engage industries in interoperability issues and their resolutions. This activity will be transitioned to industry sponsorship in FY 2010.

System simulation and analysis will be conducted to quantify the life-cycle system benefits from attaining smart grid performance metrics will continue, building on the distribution system simulation and analysis tools developed in FY 2007 – FY 2008. The benefits vs. costs will be quantified for performance metrics in reliability indices, system/economic/energy efficiencies, carbon emissions reduction, and electric infrastructure security.

Hawaii/New Mexico Sustainable Energy Project (HI, NM)	**400**	**0**	**0**
Electric Advanced Technology Center (IL)	**250**	**0**	**0**
Modern Grid Initiative (WV)	**624**	**0**	**0**
SBIR/STTR	**-644**	**0**	**0**

In FY 2007, $575,000 and $69,000 were transferred to the SBIR and STTR programs respectively. The amounts shown in FY 2008 and FY 2009 are estimated requirements for the continuation of the SBIR and STTR program.

Total, Renewable and Distributed Systems Integration	**23,545**	**25,466**	**33,306**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Renewable and Distributed Systems Integration The increased funding supports renewable energy grid integration activities facilitating increased deployment of renewables and other clean energy sources to power the Nation through the next century. This work will be coordinated with renewable technology development in the Office of Energy Efficiency and Renewable Energy. It also supports the initiation of implementation of smart grid concepts for an integrated, intelligent electric transmission and distribution network.	+7,840
Total Funding Change, Renewable and Distributed Systems Integration	**+7,840**

Congressional Directed Projects

Funding Profile by Subprogram

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Congressionally Directed Projects	**0**	**24,290**	**0**

Description

The FY 2008 Omnibus Act included 21 congressionally directed projects within the Office of Electricity and Energy Reliability. Funding for these projects was appropriated as a separate funding line although specific projects may relate to ongoing work in a specific programmatic area. Prior year funding for a specific project will be noted in the table below as a non-additive column entry.

Detailed Justification

	(dollars in thousands)		
	FY 2007 *(non-add)*	FY 2008	FY 2009
Congressionally Directed Projects			
▪ Congressionally Directed Project, Chenga Bay Generator Replacement (AK)	**0**	**379**	**0**
▪ Congressionally Directed Project, Alabama Power Project, Integrated Distribution Management System (AL)	**0**	**1,968**	**0**
▪ Congressionally Directed Project, National Center for Reliable Electric Power Transmission (AR)	**0**	**492**	**0**
▪ Congressionally Directed Project, Dine Power Authority (AZ)	**0**	**492**	**0**
▪ Congressionally Directed Project, Navajo Tribal Utility Authority, Fort Defiance (AZ)	**0**	**1,968**	**0**
▪ Congressionally Directed Project, Utility Integration of Distribution Generation (CA)	**0**	**590**	**0**
▪ Congressionally Directed Project, Connecticut Energy Savings Technology Project (CT)	**0**	**738**	**0**
▪ Congressionally Directed Project, Vehicle to Grid Demonstration Project (DE)	**0**	**738**	**0**
▪ Congressionally Directed Project, Florida State University Electric Grid System Study (FL)	**0**	**984**	**0**
▪ Congressionally Directed Project, Wauchula Municipal Electric Substation Rehab (FL)	**0**	**984**	**0**
▪ Congressionally Directed Project, Iowa Stored Energy Plant (IA)	**0**	**1,476**	**0**
▪ Congressionally Directed Project, Pilot Energy Cost Control Evaluation (WV, PA, & IN)	**0**	**1,476**	**0**
▪ Congressionally Directed Project, Willimar Municipal Utilities Power Generation Study (MN)	**0**	**295**	**0**
▪ Congressionally Directed Project, University of Missouri-Rolla Distributed Energy Research Center (MO)	**0**	**492**	**0**
▪ Congressionally Directed Project, New Albany Electrical Substation (MS)	**0**	**886**	**0**

	(dollars in thousands)		
	FY 2007 *(non-add)*	FY 2008	FY 2009
▪ Congressionally Directed Project, Bismarck State College Center of Excellence (ND)	**0**	**5,117**	**0**
▪ Congressionally Directed Project, Energy Surety Research Center at New Mexico Tech University (NM)	**0**	**1,968**	**0**
▪ Congressionally Directed Project, Electric Transmission Line Improvements (NY)	**0**	**1,476**	**0**
▪ Congressionally Directed Project, Rolls-Royce Fuel Cell Systems (US), Inc., Stark State College of Tech., Fuel Cell Prototyping Center, Canton, OH, Solid Oxide Fuel Cell (OH)	**0**	**492**	**0**
▪ Congressionally Directed Project, High Voltage Transmission Lines Phase II (TN)	**0**	**492**	**0**
▪ Congressionally Directed Project, Electric Utility Transmission Program (WA)	**0**	**787**	**0**
Total, Congressionally Directed Projects	**0**	**24,290**	**0**

Explanation of Funding Changes

	FY BY vs. FY CY ($000)
Congressionally Directed Projects	
No funding requested.	-24,290
Total, Congressionally Directed Projects	**-24,290**

Operations and Analysis

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Operations and Analysis					
Permitting, Siting, and Analysis	7,500	5,696	-52[a]	5,644	6,500
Infrastructure Security and Energy Restoration	13,000	5,860	-53[b]	5,807	7,622
Total, Operations and Analysis	20,500	11,556	-105	11,451	14,122

Public Law Authorizations:
P.L. 110-5, Revised Continuing Appropriations Resolution, 2007
P.L. 110-161, Consolidated Appropriations Act, 2008

Mission

The mission of the Operations and Analysis program is: (1) to contribute to the development and implementation of electricity policy at the Federal and State level; (2) to issue authorization for electricity exports and Presidential permits for cross-border transmission lines; (3) to enhance security and reliability of energy infrastructure; and (4) to facilitate recovery from disruptions to the energy supply. The President has designated the Department of Energy as the Lead Sector Specific Agency responsible for protection of the Nation's infrastructure.

The Operations and Analysis program is composed of two independent subprograms: the Permitting, Siting, and Analysis subprogram and the Infrastructure Security and Energy Restoration subprogram.

The Permitting, Siting, and Analysis subprogram implements the electricity grid modernization requirements of the Energy Policy Act of 2005. It assists States, regions, and other Federal agencies to develop and improve policies, market mechanisms, regulations, State laws, and programs. It issues permits for cross-border transmission lines and authorizes electricity exports.

The Infrastructure Security and Energy Restoration subprogram assists other agencies in the restoration of electricity after disasters. The subprogram also provides expert recommendations on the improvement of energy infrastructure security.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for nuclear, energy, science, management, and environmental aspects of the mission) plus 16 Strategic Goals that tie to the Strategic Themes. The Operations and Analysis Subprogram supports the following goals:

Strategic Theme 1, Energy Security: Promoting America's energy security through reliable, clean, and affordable energy.

[a] Includes reductions of $51,834 rescinded in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.
[b] Includes reductions of $53,326 rescinded in accordance with P.L. 110-161, Consolidated Appropriations Act, 2008.

Strategic Goal 1.3, Energy Infrastructure: Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

The Operations and Analysis program has one GPRA Unit Program goal which contributes to Strategic Goal 1.3 in the 'goal cascade."

GPRA Unit Program Goal 1.2.16.00 Electricity Delivery and Energy Reliability: Lead national efforts to modernize the electric grid, enhance security and reliability of the energy infrastructure, and facilitate recovery from disruptions to the energy supply.

Contribution to GPRA Unit Program Goal 1.2.16.00 Electricity Delivery and Energy Reliability
The Operations and Analysis program contributes to this goal through its outreach activities to the energy industry, as well as assisting State and local governments through communications, exercises, vulnerability assessments, and grants designed to bolster energy security. Additionally, under HSPD-7 and HSPD-8 responsibilities, energy sector experts provide assistance, information, and emergency response during energy crises, to assist in restoration and recovery efforts. "Protection" of the infrastructure is the objective of conferences, assessments, and communication efforts. "Response" to crises is the objective of Emergency Support Function #12 preparation, planning and deployments of energy experts.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.3, Energy Infrastructure			
GPRA Unit Program Goal 1.3.16.00 Electricity Delivery and Energy Reliability			
Permitting, Siting, and Analysis	7,500	5,644	6,500
Infrastructure Security and Energy Restoration	13,000	5,807	7,622
Total, GPRA Unit Program Goal 1.3.16.00 Electricity Delivery and Energy Reliability	20,500	11,451	14,122
Total, Strategic Goal 1.3 (Operations and Analysis)	20,500	11,451	14,122

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Strategic Goal 1.3, Energy Infrastructure					
Operations and Analysis/Permitting, Siting, and Analysis					
					Complete DOE's Second Study of National Electric Transmission Congestion.
Operations and Analysis/Infrastructure Security and Energy Restoration					
					Conduct 6 domestic Comprehensive Reviews (vulnerability assessments) and/or energy preparedness exercises. Provide between 2 to 4 technical staff to conduct international energy assessments for a total staff detail of 2-4 months.

Means and Strategies

The Infrastructure Security and Energy Restoration subprogram (ISER) achieves its GPRA goal by conducting outreach activities, collaboration, partnerships, training, exercises, assessments, and emergency preparation and response. By sharing energy information and analysis with industry, States, and other governmental entities, they can better protect energy assets under their cognizance. This sharing is conducted through coordinating councils, conferences, workshops, and training classes, sponsored or co-sponsored by ISER. Through collaborative efforts involving industry, government partners, and national laboratories, strategies for protection are improved. Partnerships with industry leaders, and security experts in DHS, allows for exchanges on policy matters and threat data that ultimately assist industry in protecting their critical assets and key resources.

Grants are provided to State and local governments and industry associations to assist in education, information sharing, and exercising emergency processes and contingency plans. Vulnerability assessments are carried out in partnership with DHS and its agencies on priority critical assets across the country to identify weaknesses and make recommendations for improving the protection and resiliency of the systems.

A cadre of energy sector subject matter experts and trained emergency responders are deployed to work with the Federal Emergency Management Agency (FEMA) in preparation for and in response to emergency situations. When crises occur and energy assets are negatively impacted, the responders deploy to affected areas to work with FEMA, the State governments, and industry to restore the energy supplies.

In regard to international efforts, ISER works with the State Department and the National Security Council when there are requests by foreign countries to assist in the protection of energy assets that are of significant interest to the U.S. In these cases, we provide technical analysis, system assessments, vulnerability assessments, performance testing, training, and possibly verification checks through subject matter experts within ISER, in conjunction with support from experts within the national laboratories.

Validation and Verification

To validate and verify performance, ISER participates in FEMA Regional Interagency Security Committee exercises in all ten FEMA-designated regions. Additionally, ISER participates in national level annual exercises, such as TOPOFF and Ardent Sentry. Direct feedback from industry during symposia and information exchanges provide valuable insight into shortfalls and areas for improvement.

The programmatic activities are subject to continuing review by the Office of Management and Budget (OMB), the Congress, the Government Accountability Office (GAO), and the Department’s Inspector General. Additionally, budget planning, strategic planning, and milestone management are tracked by OMB and the Department’s program management reporting system.

Interagency collaboration with DHS, the National Guard, the Coast Guard, and FEMA provide opportunity for review and discussion of policies and plans, as well as corrective actions resulting from interagency exercises.

Emergency response efforts, such as deployments in response to hurricane damage to the energy infrastructure, are routinely critiqued by FEMA, and generally subject to other reviews by the IG, GAO, or special commissions. ISER efforts are tacked and recorded for later self-evaluation and outside review.

Grants require reporting against identified goals and deliverables. Funded projects are monitored against budget, schedule, and deliverables to ensure that the objectives are met.

Permitting, Siting, and Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY PY	FY CY	FY BY
Permitting, Siting, and Analysis			
Permitting, Siting, and Analysis	7,500	5,644	6,500
Total, Permitting, Siting, and Analysis	7,500	5,644	6,500

Description

The mission of the Permitting, Siting, and Analysis subprogram is to work to "modernize the electric grid" and to "enhance reliability of the energy infrastructure" by contributing to the development and implementation of electricity policy at the Federal and State levels. Implementation of the EPAct sections on grid modernization and demand response relating to transmission assigned to the Department also directly supports the same portions of the program goal. Under the Federal Power Act, Congress has left to the States the primary responsibility of generating and delivering adequate retail electricity. Thus, modernizing the electric grid and enhancing its reliability cannot occur without the active involvement of States and regional bodies. The Permitting, Siting, and Analysis activity also works with States and regions to improve their electricity-related laws, regulations, and policies.

The International Electricity Regulatory function of the Permitting, Siting, and Analysis activity issues permits for cross-border transmission lines and authorizes the export of electricity. A function mandated by executive order, the permitting of cross-border transmission lines helps achieve "modernizing the electric grid" and "enhances the reliability of the energy infrastructure" components of the program goal.

The subprogram also continues to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with the Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the Internet.

The Permitting, Siting, and Analysis activity contributes to the development and implementation of electricity policy at the Federal and State levels. The highest priority for this activity is implementing the electricity grid modernization requirements contained in EPAct that relate to transmission and demand response. In addition, the activity uses education, outreach, and analysis to help States, regional electric grid operators, and Federal agencies to develop and improve policies, market mechanisms, regulations, State laws, and programs that assist the effort to modernize the electric grid. Under the Federal Power Act (FPA), most matters related to generation and retail distribution of electricity is reserved to the States, but the FPA gives jurisdiction to the Federal Energy Regulatory Commission to set the rates, terms, and conditions for the sale of bulk power for resale and the use of transmission facilities. Thus, the mission of this Office to modernize and expand America's electric grid cannot be achieved without the active and supportive involvement of the States. Of particular benefit will be the increased electric infrastructure investment that should result from implementation of the requirements of the Energy Policy Act of 2005 (EPAct) pertaining to transmission, congestion, identification of National Interest Electric Transmission Corridors, designation of and energy corridor designation and the coordination of Federal agency transmission line permitting.

The International Electricity Regulation function of the Permitting, Siting, and Analysis activity issues permits for cross-border transmission lines and authorizes electricity exports. This helps to ensure that electricity is supplied in a competitive and environmentally responsibly manner and helps to ensure a reliable, modern electric grid.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Permitting, Siting, and Analysis	**7,500**	**5,644**	**6,500**

The highest priority for the Permitting, Siting, and Analysis activity of the Operations and Analysis subprogram is implementing the electricity grid modernization requirements contained in EPAct. These include publication of a national transmission congestion study every three years (next is August 2009) that is coupled with periodic designation of national interest electric transmission corridors; coordination of all Federal permits required for siting transmission projects; identification of energy transport corridors on Federal lands in the East, Alaska, Hawaii, and Texas done jointly with Federal resource agencies by August 2009; provision of technical assistance to State public utility commissions and regional electricity-related organizations on various electricity policy topics; and preparation of an annual report to Congress on electric industry economic dispatch practices.

The Department's August 2009 identification of energy corridors on Federal lands in the East, Alaska, Hawaii, and Texas will begin no later than FY 2008, due to the complexity and expense of the extensive public participation and the 40-State environmental impact statement itself that is required.

The Department will conduct analytical and outreach work to support its second national transmission congestion study, as required by EPAct to be completed by August 2009, particularly using lessons learned from the first congestion study released in August 2006.

Requested funds will also be used for work on environmental assessments and other analyses needed for requests by electric transmission developers for the Department, as mandated by EPAct, to coordinate all Federal permits for transmission projects that cross Federal lands.

EPAct authorizes the Department to designate national interest electricity transmission corridors (National Corridors). Under certain circumstances, such designations could result in FERC's having jurisdiction to consider applications for the siting of electricity transmission facilities within the designated National Corridors. FERC has the authority to grant limited eminent domain to those applicants. On October 5, 2007, the Department designated two National Corridors, and is considering requests for rehearing of the designation.

Leading up to the August 2009 national transmission congestion study, the Department will monitor the progress that is being made to relieve known congestion problems using both transmission and non-transmission alternatives, create a transparent process that includes interactions with interested persons and consultation with affected States, and perform technical analyses as required.

As an essential step in the process of gaining public acceptance and State regulatory approvals for the development of modernized grid infrastructure, expert technical assistance is also provided on an as-requested basis to State public utility commissions, State legislatures, regional State associations, regional transmission organizations/independent system operators, Federal officials, and Governors' offices. Topics requiring technical assistance or analysis include: transmission siting; regional resource and transmission planning; and portfolio management.

(dollars in thousands)

"Portfolio management" in this context includes electricity-related policies and market mechanisms for demand response (reducing electricity use at peak times), energy efficiency, renewable energy and other carbon emission reduction strategies. A portion of this effort will be continued support to State utility regulatory commissions on their implementation of their and the utility industry's National Action Plan for Energy Efficiency, which calls for more utility-delivered energy efficiency. Emphasis continues on encouraging the development of regional institutions and regional thinking among States on these and related topics that help modernize the grid and meet the needs of the Nation's 21st Century economy and environmental concerns.

Emphasis will also be given to rapid dissemination of finding of sponsored technical analyses, accomplished in partnership with State, regional, and national organizations that have roles in electric markets and regulation. Permitting, Siting, and Analysis serves as a clearinghouse to assist and inform State and regional policymakers on electricity market policies and programs that can further grid modernization.

The activity also provides any technical analysis behind any Order by the Secretary of Energy issued under the Federal Power Act section 202(c) to address an electricity reliability emergency, such as was done in 2005-2007 to protect grid reliability in certain portions of Washington, DC.

Funds will also support the Department's International Energy Regulation function, which helps achieve the "modernizing the electric grid" and "enhances the reliability of the energy infrastructure" components of the program goal.

In FY 2007, International Electricity Regulation processed 50 electricity export authorizations and processed Presidential permit applications for 10 transmission facilities at the U.S. international borders. Before rendering any regulatory decisions, the environmental impacts of the proposed action must be assessed pursuant to the requirements of the National Environmental Policy Act (NEPA), which in most cases involves preparation of environmental impact statements of environmental assessments. International Electricity Regulation also must analyze the operation of the U.S. electric power supply system to determine that the issuance of a Presidential permit or an electricity export authorization would not adversely affect the reliability of the U.S. electrical grid. These regulatory activities help promote the national energy strategy goal of securing future energy supplies by enhancing international electricity infrastructure, which helps to ensure availability of competitively-priced electricity supplies in an environmentally responsible manner.

	FY 2007	FY 2008	FY 2009
Total, Permitting, Siting, and Analysis	**7,500**	**5,644**	**6,500**

Explanation of Funding Changes

	FY 2008 vs. FY 2009 ($000)
Permitting, Siting, and Analysis The increased funding will satisfy the requirement for public participation and related due process activities in implementing the major electricity infrastructure provisions of EPAct, including Sections 368 and 1221(a). The funding will support additional analysis and documentation for the required second national transmission congestion study, to be issued in August 2009. Increased technical assistance will be provided to State electricity regulatory agencies and to electric utilities as they implement their National Action Plan for Energy Efficiency. The Department expects to review dozens of transmission projects seeking Federal authorizations.	+856
Total Funding Change, Permitting, Siting, and Analysis	**+856**

Infrastructure Security and Energy Restoration

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Infrastructure Security and Energy Restoration			
Infrastructure Security and Energy Restoration	13,000	5,807	7,622
Total, Infrastructure Security and Energy Restoration	13,000	5,807	7,622

Description

The Infrastructure Security and Energy Restoration subprogram (ISER) is involved in safeguarding the Nation's energy infrastructure, responding to and assessing disruptions to energy systems, and ensuring adequate energy supply from foreign sources. The division's efforts with respect to critical infrastructure protection result in mitigating risks to energy facilities by identifying and prioritizing our most critical energy assets, reducing vulnerabilities of those assets, and minimizing the consequences of potential disruptions, attacks, or other incidents. Key activities associated with critical infrastructure protection include efforts underway with energy sectors stakeholders to implement the National Infrastructure Protection Plan, as well as the risk assessments being undertaken at energy facilities in collaboration with our interagency partners, to include the National Guard. These efforts, in part, fulfill our responsibilities as the Energy Sector-Specific Agency and the activities associated with the Energy Sector-Specific Plan. In carrying out these responsibilities, ISER, as the Government Coordinating Council (GCC) Chair, will coordinate closely with the electricity and the oil and gas Sector Coordinating Councils (SCC) and governmental partners through the Critical Infrastructure Protection Advisory Council.

In accordance with the National Response Plan, ISER also conducts emergency response operations in close coordination with energy sector stakeholders involving restoration of the energy infrastructure. Coordinated activities with the Federal Emergency Management Agency (FEMA), as well as with State and local government agencies, are enhancing the level of preparedness for potential emergencies. Situational awareness during emergency response efforts is provided by ISER's staff of energy infrastructure analysts. In addition, ISER works with the National Security Council, Homeland Security Council, U.S. Department of State, Department of Homeland Security and the Defense Department to identify issues that could possibly cause supply interruptions from foreign sources and assess the potential effects on U.S. interests. These activities are instrumental in increasing the efficiency of emergency response operations and mitigating damage associated with disruptions in the energy infrastructure.

The subprogram also continues to develop metrics and benefits, conduct independent peer reviews, and conduct project and strategic analysis in accordance with the Program Assessment Rating Tool (PART). Progress achieved will be reported and available through the Internet.

The Infrastructure Security and Energy Restoration activities ensure the resiliency of the Nation's energy infrastructure, respond to and assess disruptions to energy systems, and ensure adequate energy supply from foreign sources. The ISER activities result in mitigating risks to energy facilities by reducing vulnerabilities and minimizing the consequences of potential disruptions, attacks, or other incidents. Key activities associated with critical infrastructure protection include efforts underway with energy sector stakeholders to implement the National Infrastructure Protection Plan, as well as the risk assessments being undertaken at energy facilities in collaboration with our interagency partners and support from the National Guard. These efforts include our Energy Sector-Specific Agency responsibilities and activities associated with the Energy Sector-Specific Plan. In carrying out these responsibilities, ISER, as the GCC Chair, coordinates closely with the electricity and the oil and gas SCCs and governmental partners through the Critical Infrastructure Protection Advisory Council.

State and local governments derive benefits through ISER's energy assurance program. ISER staff work closely with State and local governments to help them prepare and respond to energy supply disruptions and events. Through the use of the State Energy Assurance Guidelines, developed by ISER, States are better prepared and equipped to prepare plans incorporating both emergency preparedness and critical infrastructure protection programs.

ISER has implemented numerous education and outreach initiatives. Training opportunities, such as table top exercises (simulating energy disruptions), forums, workshops, and web-based training are conducted for Federal, State, and local energy officials to create awareness about the energy infrastructure, the effects of supply disruptions, in addition to critical infrastructure protection and security issues.

In an effort to improve communications during an energy emergency, ISER has developed and maintains the Energy Emergency Assurance Coordinators System (EEAC), a communications protocol offering State and local governments a common platform to share information and technical advice. The EEAC contains over 180 State and local energy officials from across the country who have expertise in electricity, oil, and natural gas, and can be contacted during an emergency.

In accordance with the National Response Plan, ISER also conducts emergency response operations in close coordination with energy sector stakeholders involving restoration of the energy infrastructure. Coordinated activities with the Federal Emergency Management Agency (FEMA), as well as with State and local government agencies, are enhancing the level of preparedness for potential emergencies. Situational awareness during emergency response efforts are provided by ISER's staff of energy infrastructure analysts. In addition, ISER works with the National Security Council, Homeland Security Council, U.S. Department of State, Department of Homeland Security and the Defense Department to identify issues that could possibly cause supply interruptions from foreign sources and assess the potential effects on U.S. interests. These activities are instrumental in increasing the efficiency of emergency response operations domestically and mitigating the damage associated with disruptions in the energy infrastructure both in the U.S. and abroad.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Infrastructure Security and Energy Restoration	**13,000**	**5,807**	**7,622**

The ISER activity for FY 2009 is best understood if segregated by domestic and international activities. For the domestic programs, under Homeland Security Presidential Directive-7 (Critical Infrastructure Identification, Prioritization, and Protection), Homeland Security Presidential Directive-8 (National Preparedness), and the National Response Framework, DOE is the designated Sector Specific Agency responsible for ensuring the security of the Nation's critical energy infrastructure, and assisting State and local governments with energy disruption preparation and response. This role is highlighted by OE's Emergency Support Function #12 responsibilities under the National Response

Framework (NRF), and typically manifested in emergency response actions related to hurricane and tornado impacts.

ISER supports numerous crosscutting activities that enable State and local governments and private sector entities to improve their energy security practices, as well as emergency planning and response capabilities. This activity assists States and local government with energy security activities, the conduct of exercises and simulations, and provides education and outreach. Working with Federal, State, and industry partners, funds will be used to continue important initiatives to reduce the vulnerability of critical energy assets and key resources by developing protection programs, facilitating site assessments visits, and providing energy experts to assist in training teams on the assessment of domestic energy infrastructure.

The Energy Emergency Assurance Coordinators system, a communication protocol for State and local level energy personnel and DOE, will undergo further expansion in FY 2009. Funding will support the continued development and expansion of visualization and modeling to create simulations useful in State and local government exercises, and to track emerging energy sector problems in real-time. Facilitating an increased understanding of energy sector security reliability issues, and critical interdependency issues with other sectors like banking and finance, water and transportation, will support informed decision-making during energy disruptions.

As the Sector Specific Agency responsible for energy, ISER activity will continue the evolving implementation and revisions of the National Infrastructure Protection Plan (NIPP) in cooperation with partner agencies at all governmental levels, private sector owners and operators. As the NIPP evolves and scenario specific annexes are developed and modified, ISER will make the necessary adjustments to its planning and response efforts to ensure the objectives are met within the energy sector.

For our International program, ISER has been tasked, as the technical lead, in support of the interagency Critical Energy Infrastructure Protection (CEIP) initiative. This is coordinated through the Department of State. The initiative's purpose is to work with selected foreign Nations to improve the security and reliability of their critical energy facilities. The CEIP agencies have been asked by the National Security Council to ensure program sustainability for a 5-10 year period. This initiative seeks to enhance the resiliency and reliability of foreign energy assets deemed critical to U.S. interests.

For FY 2009, ISER is continuing to assemble a dedicated capability to carry out initial in-country assessments, prepare interim recommendations, and plan for more robust efforts in the future. The team is comprised of National Laboratory security experts, augmented by energy sector subject matter experts within ISER. The ISER staff members are devoted to domestic infrastructure security and energy restoration tasks, and therefore, there is a need to hire additional Federal staff to be dedicated to the International program. Additionally, enhanced travel and training budgets are required to ensure the staff can perform the work overseas in hazardous conditions.

	FY 2007	FY 2008	FY 2009
Total, Infrastructure Security and Energy Restoration	**13,000**	**5,807**	**7,622**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Infrastructure Security and Energy Restoration The Department is increasing its dedicated capability to conduct vulnerability assessments, analysis, and training for other countries with which we share a mutual interest in the protection of their energy infrastructure. A team of OE staff, augmented by the National Laboratory experts on vulnerability assessment, security modeling and analysis, physical security, protective force tactics, and testing/evaluation for security measures assist the countries in planning for better resilience in their ability to recover from damages to their energy infrastructure. Currently, the OE staff is devoted to domestic infrastructure security and energy restoration tasks. The increased funding is targeted to ensure that OE can assign the proper resources and expertise to meet this country's need for enhanced protection from and response to damages to the energy assets of other countries upon which we rely for supply.	+1,815
Total, Infrastructure Security and Energy Restoration	**+1,815**

Program Direction

Funding Profile by Category

	FY 2007	FY 2008	FY 2009
Chicago Field Office			
Salaries and Benefits	194	498	178
Travel	15	80	25
Support Services	71	42	75
Other Related Expenses	96	84	119
Total, Chicago Field Office	376	704	397
Full Time Equivalents	1	3	1
Golden Field Office			
Travel	5	0	0
Total, Golden Field Office	5	0	0
Full Time Equivalents	0	0	0
Idaho Operations Office			
Travel	10	0	0
Total, Idaho Operations Office	10	0	0
Full Time Equivalents	0	0	0
National Energy Technology Laboratory			
Salaries and Benefits	2,564	4,016	2,743
Travel	35	171	36
Support Services	113	151	116
Other Related Expenses	10	103	10
Total, National Energy Technology Laboratory	2,722	4,441	2,905
Full Time Equivalents	13	7	0
Headquarters			
Salaries and Benefits	8,893	8,088	10,163
Travel	558	840	933
Support Services	2,709	1,833	2,898
Other Related Expenses	2,084	1,697	2,382
Total, Headquarters	14,244	12,458	16,376

	FY 2007	FY 2008	FY 2009
Full Time Equivalents	56	47	66
Total Program Direction			
Salaries and Benefits	11,651	12,602	13,084
Travel	623	1,091	994
Support Services	2,893	2,026	3,089
Other Related Expenses	2,190	1,884	2,511
Total, Program Direction	17,357	17,603	19,678
Total, Full Time Equivalents	70	57	67

Mission

Program Direction covers the cost of sustaining Federal staff required to provide overall direction, management, and support for the Office of Electricity Delivery and Energy Reliability's efforts to achieve its mission. Program Direction includes Federal payroll, travel, support service, and other related services.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Salaries and Benefits	**11,651**	**12,602**	**13,084**

Staff oversee finances and performance of over 100 R&D electric transmission projects; contribute to the development and implementation of electricity policy at the Federal and State levels; issue authorization for electricity exports and Presidential permits for cross-border transmission lines; enhance security and reliability of the grid infrastructure; and facilitate recovery from disruptions to the energy supply.

Funds a total of 80 FTEs that will provide the executive management, program oversight, analysis, and information required for the effective implementation of the Office's program. Of these, 66 FTEs are planned for Headquarters employees in Washington, D.C. and Morgantown, WV, 1 FTE for the Chicago Field Office, and 13 FTEs at NETL. The 13 FTEs at NTEL are counted in the Fossil Energy Budget.

Headquarters personnel work in one of three subprograms (Research and Development; Permitting, Siting, and Analysis; and Infrastructure Security and Energy Restoration) or in the support element called Resource Management.

The personnel in the Research and Development subprogram manage a portfolio of research, development, field testing, and technology demonstration projects, including development and implementation of technology visions and roadmaps, multi-year program plans, budget materials, program evaluations and metrics, public-private partnerships, technology transfer and commercialization plans, and education and outreach strategies. They also monitor and make decisions on funding, evaluate progress toward milestones, and hold research performers and others who receive funds accountable for their performance.

The personnel in the Permitting, Siting, and Analysis subprogram lead the formulation and implementation of the Department's policies and programs with regard to: (1) implementation of electricity policy-related provisions of EPAct assigned to the Department; (2) assistance to States and regional organizations on best practices for various electricity-related policies and programs; and (3) issuance of Presidential permits for new electric transmission lines that cross U.S. international borders and authorizations for electricity exports.

The personnel in the Infrastructure Security and Energy Restoration subprogram represent the Department in its role as the Sector Specific Agency for the Energy Sector in support of the Department of Homeland Security, responsible for implementing the national strategy for the physical and cyber protection of critical infrastructure and key assets, and performing energy restoration support functions under the National Response Plan. They also work through State and local governments, and with private industry, to coordinate the Federal government's efforts to ensure a secure and reliable flow of energy to America's homes, industries, public service facilities, and the transportation system. Working with government and industry leaders, they analyze physical and cyber vulnerabilities of the national energy infrastructure and develop scientific and technological solutions to correct or minimize system vulnerabilities. Finally, they develop, implement, and maintain a cyber security program to assist the Nation's energy sector, including Supervisory Control and Data Acquisition systems.

The personnel in the Resource Management staff provide the administrative, budgetary, financial, logistical, and communications support that allows the Office to achieve its mission and goals in the most strategic and cost effective manner.

Travel	**623**	**1,091**	**994**

The FY 2009 estimate reflects the addition of an international energy infrastructure security program, as well as a decrease in domestic travel. Travel allows the Office to effectively manage R&D electricity technology programs and projects in the field; provide the Department's electricity-related outreach to regional, State, and local organizations with regard to planning needs and issues, policies, siting protocols and new energy facilities; and assist the Department of Homeland Security, State and local governments, and the private sector to help protect against and recover from disruptions in the energy infrastructure.

Support Services	**2,893**	**2,026**	**3,089**

Support Services comprises energy technology specific support on critical science, engineering, environmental, and economic issues that benefit strategic planning program and project effectiveness; technology and market analysis to improve strategic and annual goals; environmental analyses required to process an increased number of Presidential permit applications; development of management tools and analyses to improve overall Office performance, effectiveness, and efficiency; assistance with communications and outreach to enhance the Office's responsiveness to public needs' and development of program-specific information tools that consolidate corporate knowledge, performance tracking and inventory data, improve accessibility to this information, and facilitate its

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

use by the entire staff.

Other Related Expenses	**2,190**	**1,884**	**2,511**

Other Related Expenses includes corporate IT support (DOECOE) and working capital expense, such as rent, supplies, copying, graphics, mail services, printing, and telephones. It also includes equipment upgrades and replacements, commercial credit card purchases using the simplified acquisition procedures to the maximum extent possible, training, and other needs to sustain Federal staff not identified in the above categories.

Total, Program Direction	**17,357**	**17,603**	**19,678**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Salaries and Benefits	+482

Of the additional ten FTEs, six are new hires for the Infrastructure Security and Energy Restoration Division (ISER), and four are new hires for the Permitting, Siting and Analysis Division (PSA).

Among the six new ISER hires are four for the International Energy Security Program. DOE assigned OE as the departmental lead to develop this international program to help ensure adequate U.S. energy supplies from foreign sources. They will support international energy analysis and assessment with other Federal agencies; provide technical onsite guidance; provide policy recommendations to the National Security Council; and coordinate with foreign governments on specific physical, procedural and policy changes to improve the security posture at energy facilities.

In accord with OE's responsibilities under Homeland Security Presidential Directive 8 (HSPD-8) and Emergency Support Function #12 (ESF #12), the other two ISER hires will each serve as a regional coordinator with FEMA on national preparedness and emergency response activities. This enhancement meets the needs of the post-Katrina improvements in OE's emergency response capabilities.

One of the four new PSA hires will ensure OE's compliance with the Energy Policy Act of 2005 (EPAct), Section 368 (b) requirements with regards to designation of corridors for oil, gas, and hydrogen pipelines, and electricity transmission and distribution on Federal land. This hire will serve as the coordinator for the designation of energy corridors on Federal land in the Eastern States, Hawaii, and Alaska.

	FY 2009 vs. FY 2008 ($000)
One of the other four PSA hires will coordinate the completion of the second electric transmission congestion study as required by EPAct Section 216(a).	
The remaining two PSA hires will ensure OE's compliance with the Federal Power Act 216(h) requirements — that DOE act as the lead agency for purposes of coordinating all applicable Federal authorizations and related environmental reviews required to site an electric transmission facility.	
Travel OE will fulfill its new responsibility to develop an international energy infrastructure security program. This will require continued international travel. The decrease in funding reflects less domestic travel.	-97
Support Services Increased funding reflects additional cost associated with 10 new FTEs.	+1,063
Other Related Expenses Increased funding reflects additional cost associated with 10 new FTEs.	+627
Total Funding Change, Program Direction	+2,075

Support Services by Category

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Technical Support			
Feasibility of Design Considerations	128	48	140
Development of Specifications	120	50	116
System Definition	0	20	0
System Review and Reliability Analyses	120	120	125
Trade-off Analyses	120	162	133
Test and Evaluation	0	100	0
Surveys Or Reviews of Technical Operations	302	120	332
Total, Technical Support	790	620	846

Management Support

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Analyses of Workload and Work Flow	120	130	132
Directives Management Studies	250	120	275
Automated Data Processing	90	80	25
Manpower Systems Analyses	0	120	0
Preparation of Program Plans	610	426	671
Training and Education	120	150	132
Analyses of DOE Management Processes	270	160	297
Reports and Analyses Management and General Administrative Services	643	220	711
Total, Management Support	2,103	1,406	2,243
Total, Support Services	2,893	2,026	3,089

Other Related Expenses by Category

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Other Related Expenses			
Other Services	580	375	663
Supplies and Materials	74	75	85
Equipment	45	79	51
Working Capital Fund	1,491	1,355	1,712
Total, Other Related Expenses	2,190	1,884	2,511

Nuclear Energy

Nuclear Energy

Table of Contents

Nuclear Energy
(including transfer of funds)

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for nuclear energy activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, and the purchase of not to exceed **[**20**]***29* passenger motor vehicles**[** for**]**, *including three new buses and 26* replacement **[**only**]***vehicles*, including one ambulance, **[**$970,525,000**]***$853,644,000*, to remain available until expended**[**:**]** **[***Provided*, That**]** **[**$233,849,000 is authorized to be appropriated for Project 99-D-143 Mixed Oxide (MOX) Fuel Fabrication Facility, Savannah River Site, South Carolina: *Provided further*, That the Department of Energy adhere strictly to Department of Energy Order 413.3A for Project 99-D- 143**]**. *(Energy and Water Development and Related Agencies Appropriations Act, 2008.)*

Nuclear Energy
Office of Nuclear Energy

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Energy Supply and Conservation					
University Reactor Infrastructure and Education Assistance	16,547	0	0	0	0
Research and Development					
Nuclear Power 2010	80,291	0	0	0	0
Generation IV Nuclear Energy Systems Initiative	35,214	0	0	0	0
Nuclear Hydrogen Initiative	18,855	0	0	0	0
Advanced Fuel Cycle Initiative	166,092	0	0	0	0
Total, Research and Development	300,452	0	0	0	0
Infrastructure					
Radiological Facilities Management	46,775	0	0	0	0
Idaho Facilities Management	113,723	0	0	0	0
Idaho Sitewide Safeguards and Security	75,919	0	0	0	0
Total, Infrastructure	236,417	0	0	0	0
Program Direction	62,600	0	0	0	0
Transfer from State Department	12,500	0	0	0	0
Subtotal, Energy Supply and Conservation	628,516	0	0	0	0
Funding from Other Defense Activities	-122,634	0	0	0	0
Funding from Naval Reactors	-13,365	0	0	0	0
Total, Energy Supply and Conservation	492,517	0	0	0	0

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Nuclear Energy Appropriation					
Research and Development					
Nuclear Power 2010	0	135,000	-1,229	133,771	241,600
Generation IV Nuclear Energy Systems Initiative	0	116,000	-1,083	114,917	70,000
Nuclear Hydrogen Initiative	0	10,000	-91	9,909	16,600
Advanced Fuel Cycle Initiative	0	0	0	0	301,500
Total, Research and Development	0	261,000	-2,403	258,597	629,700
Fuel Cycle Research and Facilities					
Advanced Fuel Cycle Initiative	0	181,000	-1,647	179,353	0
Mixed Oxide Fuel Fabrication Facilities	0	281,349	-2,560	278,789	0
Total, Fuel Cycle Research and Facilities	0	462,349	-4,207	458,142	0
Infrastructure					
Radiological Facilities Management	0	48,561	-442	48,119	38,700
Idaho Facilities Management	0	117,000	-1,065	115,935	104,700
Idaho Sitewide Safeguards and Security	0	75,949	-688	75,261	0
Total, Infrastructure	0	241,510	-2,195	239,315	143,400
Program Direction	0	81,615	-743	80,872	80,544
Transfer from State Department	0	0	0	0	0
Subtotal, Nuclear Energy Appropriation	0	1,046,474	-9,548	1,036,926	853,644
Funding from Other Defense Activities	0	-75,949	688	-75,261	0
Total, Nuclear Energy Appropriation	492,517	970,525	-8,860	961,665	853,644

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Other Defense Activities (NE) Appropriation[a]					
Infrastructure					
Idaho Facilities Management	15,923	0	0	0	0
Idaho Sitewide Safeguards and Security	75,949	75,949	-688	75,261	78,811
Subtotal Infrastructure	91,872	75,949	-688	75,261	78,811
Mixed Oxide Fuel Fabrication Facility	0	0	0	0	487,008
Program Direction	30,844	0	0	0	0
Subtotal, Other Defense Activities Appropriation	122,716	75,949	-688	75,261	565,819
Less Security Charge for Reimbursable Work	-3,003	-3,003	0	-3,003	0
Total Other Defense Activities Appropriation	119,713	72,946	-688	72,258	565,819
Total, All Appropriations	612,230	1,043,471	-9,548	1,033,923	1,419,463

Preface

The Office of Nuclear Energy (NE) leads the U.S. Government's efforts to develop new nuclear energy generation technologies to meet energy and climate goals, to develop advanced, proliferation-resistant nuclear fuel technologies that maximize energy from nuclear fuel, and to maintain and enhance the national nuclear technology infrastructure. NE helps serve the present and future energy needs of the United States by managing the safe operation and maintenance of the DOE critical nuclear infrastructure that provides nuclear technology goods and services. Beginning in FY 2008, NE funds the Mixed Oxide (MOX) Fuel Fabrication Facility activities, which were previously funded by the National Nuclear Security Administration (NNSA).

NE has nine programs; funds for seven of those programs are requested within the Nuclear Energy appropriation in FY 2009: Nuclear Power 2010 (NP 2010), Generation IV Nuclear Energy Systems Initiative (Gen IV), Nuclear Hydrogen Initiative (NHI), Advanced Fuel Cycle Initiative (AFCI), Radiological Facilities Management (RAD), Idaho Facilities Management (IFM), and Program Direction. Prior to FY 2008, NE had two programs that were partially funded within the Other Defense Activities appropriation—Idaho Facilities Management and Program Direction. Beginning in FY 2008, these programs are funded solely in the Nuclear Energy appropriation. Funds are requested for the remaining two programs, Idaho Sitewide Safeguards and Security and the Mixed Oxide Fuel Fabrication Facility, under the Other Defense Activities appropriation.

[a] Includes only the NE portion of the Other Defense Activities appropriation.

Mission

NE supports the diverse nuclear energy programs of the United States. NE is responsible for leading the Federal government's investment in nuclear science and technology to support the diversity and security of the United States energy supply, and advance United States (U.S.) energy competitiveness.

Nuclear power is a greenhouse gas emissions-free, reliable, and safe source of energy are an essential element in the Nation's energy and environment future. Nuclear power is the second most abundant source of electric energy in the United States, and existing plants are among the most economic sources of electricity on the grid today. NE focuses on the development of advanced nuclear technologies to assure diversity in the U.S. energy supply. This budget request responds to the Energy Security goal to develop new generation capacity to fortify U.S. energy independence and security while making improvements in environmental quality by reducing greenhouse gas emissions. It builds on important work started over the last three years to deploy new nuclear plants in the United States by early in the next decade, and to develop advanced, next generation nuclear technology.

To facilitate the construction of new nuclear power plants in the U.S., the budget provides funds in the NP 2010 program to continue licensing demonstration activities started in previous years, and to develop regulations for nuclear power plant standby support, a program authorized by the Energy Policy Act of 2005. Under this authority, the Department will be able to offer risk insurance that will protect sponsors of new nuclear power plants against the financial impact of certain delays during construction or in gaining approval for operation that are beyond the sponsors' control.

Through NE programs and initiatives, NE seeks to develop advanced, proliferation-resistant nuclear fuel technologies that maximize energy output, minimize wastes, and operate in a safe and environmentally sound manner. The AFCI develops technologies that would enable the reduction of spent nuclear fuel waste requiring geologic disposal. Over the last five years, the U.S. has joined several countries in an international effort to pursue advanced technologies that could treat and transmute spent nuclear fuel from nuclear power plants, while reducing overall proliferation risk. These efforts are continued under the AFCI program through the Global Nuclear Energy Partnership (GNEP). Beginning in FY 2008, NE funds the Mixed Oxide (MOX) Fuel Fabrication Facility activities, which are focused on producing fuel for nuclear reactors from surplus weapon-grade plutonium.

The NE budget request also supports development of new nuclear generation technologies that provide significant improvements in sustainability, economics, safety and reliability, and non-proliferation and resistance to attack. Specifically, the NHI will develop advanced technologies that can be used in tandem with next generation nuclear energy plants to generate economic, commercial quantities of hydrogen to support a sustainable, clean energy future for the U.S. The Gen IV establishes a basis for expansive cooperation with international partners to develop next generation reactor and fuel cycle systems that represent a significant leap in economic performance, safety, and proliferation resistance.

Strategic Themes and Goals and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for energy security, nuclear security, scientific discovery, environmental responsibility, and management excellence) plus 16 Strategic Goals that tie to the Strategic Themes. This Nuclear Energy appropriation supports the following goals:

Strategic Theme 1, Energy Security: Promoting America's energy security through reliable, clean, and affordable energy.

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Theme 2, Nuclear Security: Ensuring America's nuclear security

Strategic Goal 2.2, Weapons of Mass Destruction: Prevent the acquisition of nuclear and radiological materials for use in weapons of mass destruction and other acts of terrorism.

The programs funded within the Nuclear Energy appropriation have three GPRA Unit Program Goals that contributes to the Strategic Goals in the "goal cascade". These goals are:

GPRA Unit Program Goal 1.2.14.00: Develop New Nuclear Generation Technologies - By 2015, enable industry to construct and operate new nuclear power plants, promoting safe, reliable and carbon-free energy production, through the standardization of Generation III+ plant designs, the successful demonstration of nuclear plant permitting and licensing processes, the advancement of Gen IV plant technologies, the construction of pilot-scale hydrogen production experiments, and the commencement of proliferation-resistant spent nuclear fuel recycling technology demonstration activities.

GPRA Unit Program Goal 1.2.15.00: Maintain and Enhance National Nuclear Infrastructure - Maintain, enhance, and safeguard the Nation's nuclear infrastructure capability to meet the Nation's energy, medical research, space exploration, and national security needs.

GPRA Unit Program Goal 2.2.43: Fissile Materials Disposition – Eliminate surplus Russian plutonium and surplus United States plutonium and highly enriched uranium.

Contribution to Strategic Goal

As the U.S. considers the expansion of nuclear energy, it is clear that the Nation must optimize its approach to managing spent nuclear fuel. While the planned geologic repository at Yucca Mountain would be sufficient for all commercial spent fuel generated in the U.S. through 2015, the current "once-through" approach to spent fuel will require the U.S. to consider additional repository space to assure the continued, safe management of spent fuel from currently operating plants and a new generation of nuclear plants. Further, long-term issues associated with the toxicity of nuclear waste and the eventual proliferation risks posed by plutonium in spent fuel remain.

The AFCI is focused on developing technologies which can reduce the volume and long-term toxicity of high level waste from spent nuclear fuel, reduce the long-term proliferation threat posed by civilian inventories of plutonium in spent fuel, and provide for proliferation-resistant technologies to recover the energy content in spent nuclear fuel.

Improving the way spent nuclear fuel is managed will facilitate the expansion of civilian nuclear power in the U.S. and encourage civilian nuclear power in foreign countries to evolve in a more proliferation-resistant manner. Once these recycling technologies are proven, the U.S. and other countries, having the established infrastructure, could arrange to supply nuclear fuel to countries seeking the energy benefits of civilian nuclear power, and the spent nuclear fuel could be returned to partner countries for eventual disposal in international repositories. In this way, foreign countries could obtain the benefits of nuclear energy without needing to design, build, and operate uranium enrichment or recycling technologies. Related contributions are described within the Department's request for the AFCI program in support of GNEP.

The NP 2010 program is focused on resolving the technical, institutional, and regulatory barriers to the deployment of new nuclear power plants, consistent with the recommendations of the Nuclear Energy Advisory Committee (NEAC) report, "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010." In support of the "National Energy Policy" and the President's goal of reducing greenhouse gas intensity by 18 percent by 2012, the NP 2010 program will help enable industry to deploy up to 30 new advanced nuclear power plants in the U.S. over the next decade.

To help facilitate the deployment of new nuclear power plants, the Department is authorized to develop regulations for nuclear power plant standby support through the Energy Policy Act of 2005. Under these regulations, the Department would, with appropriated funds, be able to offer risk insurance that will protect sponsors of new nuclear power plants against the financial impact of certain delays during construction or in gaining approval for operation that are beyond the sponsors' control. This insurance will provide additional certainty to the builders of new nuclear power plants and help lead to the construction of new nuclear power plants by the 2014 timeframe.

For the longer-term future, the Department is pursuing new, next-generation technologies considered to enhance the prospects for a significant expansion in the use of nuclear energy in the U.S. and globally. These technologies are the types of long-term, high-risk, high-pay-off research that only Government-sponsored research can address. As an example, the future energy picture of the U.S. could include a large role for hydrogen as a fuel for automobiles and other elements of the vast U.S. transportation infrastructure. The use of hydrogen would make it possible for the Nation to realize a primary objective of the "National Energy Policy"—to enhance the energy independence and security of the U.S. while making significant improvements in environmental quality. Hydrogen could someday be used to power the nation's transportation system, reducing our reliance on imported oil, and dramatically reducing the harmful emissions associated with the combustion of fossil fuels.

The Department is working with industry and overseas governments to establish the technological infrastructure for nuclear energy-produced hydrogen. Applying advanced thermochemical processes, it may be possible to develop a new generation of nuclear energy plants to produce very large amounts of hydrogen without emitting carbon dioxide or other greenhouse gases—and do so at a cost that is very competitive with imported fossil fuels. NHI will develop new technologies to generate hydrogen on a commercial scale in an economic and environmentally-benign manner. The Department's Offices of Nuclear Energy; Fossil Energy; and Energy Efficiency and Renewable Energy are working in coordination to provide the technological underpinnings of the President's National Hydrogen Fuel Initiative.

Developing the next-generation nuclear systems to make hydrogen possible is one aspect of the Gen IV program. Through this effort, the U.S. will lead multi-national research and development (R&D) projects to develop next-generation nuclear reactors and fuel cycles. This international approach allows for the development of technologies that are widely acceptable; enables the Department to access the best expertise in the world to develop complex new technologies; and allows us to leverage our scarce nuclear R&D resources.

In addition to nuclear R&D programs, the Department has the responsibility to maintain and enhance the Nation's existing nuclear research infrastructure.

The Radiological Facilities Management program maintains DOE nuclear technology facilities in a safe, secure, environmentally compliant, and cost-effective manner to support national priorities. NE maintains the Department's vital nuclear energy research resources and capabilities at Idaho National Laboratory (INL), Oak Ridge National Laboratory (ORNL), and Los Alamos National Laboratory (LANL). The RAD program also supplies new research reactor fuel to universities and disposes of spent fuel from university research reactors.

The Idaho Facilities Management (IFM) program maintains the Department's facilities at Idaho in a safe, secure, and environmentally compliant condition for a range of vital Federal missions. Central to this infrastructure is the Nation's nuclear technology laboratory, INL. The Department is proceeding with plans to establish INL as a world-class nuclear technology laboratory within 10 years.

Beginning in FY 2008, NE funds the Mixed Oxide (MOX) Fuel Fabrication Facility program which converts surplus U.S. weapon-grade plutonium into fuel for commercial light-water reactors. After irradiation, the plutonium would no longer be directly usable. Beginning in FY 2009, the funding for this program is requested in the Other Defense Activities appropriation.

The Program Direction account funds expenses associated with the technical direction and administrative support of NE programs. NE is responsible for leading the Federal government's investment in nuclear science and technology by investing in innovative science and preserving the national research and development infrastructure. This program supports NE's Headquarters, Idaho, and Oak Ridge offices, U.S. mission to International Organization in Vienna, the U.S. mission to the Organization for Economic Cooperation and Development, and the Department of Energy Tokyo Office. NE plans to perform its mission, goals, and activities with excellence in accordance with the President's Management Agenda by: creating an organization that will more effectively implement the Secretary's priorities; updating and expanding the independently created Office of Nuclear Energy Workforce Plan; and continuing to recruit a well-qualified, diverse workforce.

Funding by Strategic and GPRA Unit Program Goal

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Strategic Goal 1.2, Environmental Impacts of Energy			
GPRA Unit Program Goal 1.2.14.00, Develop New Nuclear Generation Technologies	300,452	437,950	629,700
GPRA Unit Program Goal 1.2.15.00, Maintain and Enhance National Nuclear Infrastructure	147,757	164,054	143,400

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Total, Strategic Goal 1.2, Environmental Impacts of Energy	448,209	602,004	773,100
Strategic Goal 2.2, Weapons of Mass Destruction			
GPRA Unit Program Goal 2.2.43.00, Fissile Materials Disposition	0	278,789	0
Subtotal, Strategic Goals 1.2 and 2.2 (Nuclear Energy)	448,209	880,793	773,100
All Other			
Program Direction	31,808	80,872	80,544
Total, Strategic Goal 1.2 and 2.2 (Nuclear Energy)	480,017	961,665	853,644

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by the Office of Management and Budget (OMB) to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The current focus is to establish outcome- and output-oriented goals, the successful completion of which will lead to benefits to the public, such as increased national security and energy security, and improved environmental conditions. DOE has incorporated feedback from OMB into the FY 2008 Budget Request, and the Department will take the necessary steps to continue to improve performance.

The results of the FY 2005 review for the R&D programs, the FY 2006 review for the Infrastructure program, and the FY 2007 review for the University program are reflected in the FY 2009 Budget Request as follows:

NP 2010 received a rating of Adequate; Gen IV and AFCI received a rating of Moderately Effective; and National Nuclear Infrastructure and University Reactor Infrastructure and Education Assistance received a rating of Results Not Demonstrated.

Four of the five programs were assessed top scores for clarity of program purpose and soundness of program design. In the planning area, the PART assessment revealed a need for stronger links between budget and performance data for several of the programs. To address these findings, stronger links between program goals and funding requests are shown in this budget submission.

In the program management area, it was determined that the R&D programs needed to improve their methods for measuring and achieving cost effectiveness in program execution. The FY 2009 budget submission includes an efficiency measure that tracks program overhead against total R&D program costs, following a common methodology adopted by all applied energy R&D programs within the Department.

In addition, the AFCI and Gen IV programs were found to rely upon process oriented, output based metrics that do not indicate whether the programs are successful or demonstrating meaningful progress.

For example, it was determined that AFCI should have metrics in place that demonstrate annual progress on its various components, such as separations, fuels, and transmutation. For the Gen IV program, metrics were needed to compare the key attributes of the various reactor designs (sustainability, proliferation resistance and security, safety and reliability, and economics) more objectively. In response to these findings, NE has developed meaningful, measurable outcome based performance metrics.

The National Nuclear Infrastructure assessment found that the program is effectively targeted through the formal Idaho National Laboratory Ten Year Site Plan, which identifies the mission-essential infrastructure and facilities, planned annual work scope, and performance measures for the laboratory. In FY 2006, as a follow-up action assigned as part of this assessment, NE contracted with the National Academy of Sciences to conduct an extensive, comprehensive, and independent evaluation of R&D and Infrastructure program goals and plans, including the process for establishing program priorities and oversight. The evaluation resulted in a detailed set of policy and research recommendations and associated priorities for an integrated agenda of research activities to support the long-term commercial energy option to provide diversity in energy supply. A pre-publication version of the report was issued in October 2007; the final report is scheduled for publication in January 2008. NE continues to review the report findings, and is working with OMB to develop a viable strategy for implementing the committee's recommendations.

The University Reactor Infrastructure and Education Assistance assessment determined that enrollment target levels of the program have already been met and students no longer need to be encouraged to enter into nuclear related disciplines. In addition, the number of universities offering nuclear-related programs also has increased. These trends reflect renewed interest in nuclear power. Students will continue to be drawn into this course of study and universities, along with nuclear industry societies and utilities, will continue to invest in university research reactors, students, and faculty members. Consequently, Federal assistance was considered no longer necessary, and the FY 2007 Budget Request proposed termination of this program.

Findings from PART assessments are also addressed in the relevant sections of this budget submission.

Basic and Applied R&D Coordination

NE is requesting $55M within the AFCI to support applied research in advanced mathematics for optimization of complex systems, control theory, and risk assessment. This R&D integration focus area was the subject of workshops sponsored by the Office of Science in August 2006 and December 2006. DOE program activities address advanced math for understanding, controlling, and optimizing complex systems such as the electric grid, novel combustion systems and industrial processes and advanced nuclear reactors. Offices within DOE that will benefit from this research integration effort include the Offices of Energy Efficiency and Renewable Energy, Electricity Delivery and Energy Reliability, and Science.

In addition, NE is requesting $59M within AFCI to support applied research in the characterization of radioactive waste. This R&D integration focus area was the subject of workshops sponsored by the Office of Science in September 2005, July 2006 and August 2006. DOE program activities address critical unanswered scientific questions to facilitate the stabilization, long-term storage, treatment, and ultimate disposal of radioactive waste. Offices within DOE that will benefit from this research integration effort include the Offices of Environmental Management, Civilian Radioactive Waste Management, Legacy Management, and Science.

AFCI R&D is focused on transmutation fuels, separations science and engineering and fast reactor design to support the GNEP vision. As part of its coordination with basic R&D activities conducted by the Office of Science, AFCI R&D is executed as an integrated experimental R&D and simulation effort focused on developing the key capabilities and products required for an advanced fuel cycle.

As part of the advanced mathematics focus area, the program will initiate code groups to develop advanced design and simulation codes in support of the goals of AFCI/GNEP. For example, the work of these groups would include three-dimensional integrated modeling to improve safety, performance, design, and construction costs for an advanced burner reactor.

As part of the characterization of radioactive waste focus area, the program is conducting significant R&D activities in spent fuel separations R&D to develop advanced aqueous and electrochemical separations technology alternatives capable of treating spend nuclear fuel in a safe, efficient and proliferation resistant manner. In addition, the program is conducting transmutation R&D to determine methods for lowering the radiotoxicity of spent nuclear fuel.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Advanced mathematics for optimization of complex systems, control theory, and risk assessment[a]			
Office of Nuclear Energy	10,000	19,410	55,000
Characterization of Radioactive Waste[b]			
Office of Nuclear Energy	37,190	53,722	59,000

Indirect Costs and Other Items of Interest

Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by this budget are displayed below.

Indirect-Funded Maintenance and Repair

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Idaho National Laboratory	9,334	9,670	9,892
Oak Ridge National Laboratory	410	421	430
Total, Indirect-Funded Maintenance and Repair	9,744	10,091	10,322

[a] Includes activities within the Systems Analysis and Integration funding activity within Advanced Fuel Cycle Initiative.
[b] Includes activities within the Separations R&D and Transmutation R&D funding activities within Advanced Fuel Cycle Initiative.

Direct-Funded Maintenance and Repair

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Idaho National Laboratory	8,930	9,000	9,000
Oak Ridge National Laboratory	165	169	173
Other	2,133	2,184	2,236
Total, Direct-Funded Maintenance and Repair	11,228	11,353	11,409

Nuclear Energy
Office of Nuclear Energy

Funding by Site by Program

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Argonne National Laboratory			
Advanced Fuel Cycle Initiative	16,400	19,505	47,860
Generation IV Nuclear Energy Systems Initiative	1,297	2,700	1,860
Nuclear Hydrogen Initiative	1,865	650	700
Nuclear Power 2010	23	0	0
Total, Argonne National Laboratory	19,585	22,855	50,420
Brookhaven National Laboratory			
Advanced Fuel Cycle Initiative	1,041	1,425	3,112
Generation IV Nuclear Energy Systems Initiative	286	167	0
Nuclear Hydrogen Initiative	42	44	0
Nuclear Power 2010	0	67	0
Radiological Facilities Management	2,905	3,200	0
Total, Brookhaven National Laboratory	4,274	4,903	3,112
Chicago Operations Office			
Generation IV Nuclear Energy Systems Initiative	40	40	40
Idaho National Laboratory			
Advanced Fuel Cycle Initiative	50,464	44,495	70,050
Generation IV Nuclear Energy Systems Initiative	20,428	67,063	56,950
Idaho Facilities Management	84,435	113,485	102,250
Nuclear Hydrogen Initiative	4,405	3,520	5,200
Radiological Facilities Management	12,200	13,300	14,430
University Reactor Infrastructure and Education Assistance	5,518	0	0
Total, Idaho National Laboratory	177,450	241,863	248,880
Idaho Operations Office			
Advanced Fuel Cycle Initiative	31,416	75	7,762
Generation IV Nuclear Energy Systems Initiative	8,561	8,979	5,010
Nuclear Hydrogen Initiative	1,563	1,152	2,200

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Nuclear Power 2010	79,873	132,771	241,100
Radiological Facilities Management	0	2,920	3,700
Program Direction	0[a]	32,676[b]	32,676
University Reactor Infrastructure and Education Assistance	10,988	0	0
Total, Idaho Operations Office	132,401	178,573	292,448
Lawrence Berkeley National Laboratory			
Advanced Fuel Cycle Initiative	0	540	6,225
Lawrence Livermore National Laboratory			
Advanced Fuel Cycle Initiative	2,295	3,265	388
Generation IV Nuclear Energy Systems Initiative	180	60	0
Total, Lawrence Berkeley National Laboratory	2,475	3,325	388
Los Alamos National Laboratory			
Advanced Fuel Cycle Initiative	15,750	24,350	31,125
Generation IV Nuclear Energy Systems Initiative	85	1,092	0
Radiological Facilities Management	17,014	15,971	15,410
Total, Los Alamos National Laboratory	32,849	41,413	46,535
National Renewable Energy Laboratory			
Nuclear Hydrogen Initiative	550	221	300
NNSA Service Center			
Generation IV Nuclear Energy Systems Initiative	0	700	0
Oak Ridge National Laboratory			
Advanced Fuel Cycle Initiative	15,220	24,550	31,102
Generation IV Nuclear Energy Systems Initiative	1,910	3,108	2,440
Nuclear Hydrogen Initiative	480	129	0
Radiological Facilities Management	11,815	12,178	5,160

[a] Excludes $30,844,000 for Program Direction expenses at the Idaho Operations Office appropriated under Other Defense Activities.

[b] Beginning in FY 2008, funding for Program Direction expenses and Full Time Equivalents for the Idaho Operations Office is requested in the Nuclear Energy appropriation.

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		
Total, Oak Ridge National Laboratory	29,425	39,965	38,702
Oak Ridge Operations Office			
Advanced Fuel Cycle Initiative	25	0	0
Program Direction	2,032	2,189	1,290
Radiological Facilities Management	491	0	0
Total, Oak Ridge Operations Office	2,548	2,189	1,290
Pacific Northwest National Laboratory			
Advanced Fuel Cycle Initiative	1,574	2,865	3,112
Radiological and Environmental Sciences Laboratory			
Idaho Facilities Management	0	2,450	2,450
Program Direction	0	2,774	2,899
Total, Radiological and Environmental Sciences Laboratory	0	5,224	5,349
Sandia National Laboratories			
Advanced Fuel Cycle Initiative	1,760	3,640	6,225
Generation IV Nuclear Energy Systems Initiative	575	1,025	100
Nuclear Hydrogen Initiative	5,147	2,661	3,510
Radiological Facilities Management	1,800	0	0
Total, Sandia National Laboratories	9,282	7,326	9,835
Savannah River National Laboratory			
Advanced Fuel Cycle Initiative	7,613	1,943	18,675
Nuclear Hydrogen Initiative	1,479	1,246	2,200
Nuclear Power 2010	109	0	0
Total, Savannah River National Laboratory	9,201	3,189	20,875
Savannah River Operations Office			
Advanced Fuel Cycle Initiative	0	3,300	0
MOX Fuel Fabrication Facility	0	278,789	0
Total, Savannah River Operations Office	0	282,089	0

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
University of Nevada, Las Vegas			
Advanced Fuel Cycle Initiative	0	4,000	3,105
Generation IV Nuclear Energy Systems Initiative	0	1,400	0
Nuclear Hydrogen Initiative	2,000	0	2,000
Total, University of Nevada, Las Vegas	2,000	5,400	5,105
Washington Headquarters			
Advanced Fuel Cycle Initiative	22,534	45,400	72,759
Generation IV Nuclear Energy Systems Initiative	1,852	28,583	3,600
Nuclear Hydrogen Initiative	1,324	286	490
Nuclear Power 2010	286	933	500
Program Direction	29,776	43,233	43,679
Radiological Facilities Management	550	550	0
Transfer from State Department	12,500	0	0
University Reactor Infrastructure and Education Assistance	41	0	0
Total, Washington Headquarters	68,863	118,985	121,028
Total, Nuclear Energy	492,517	961,665	853,644

Site Description

Argonne National Laboratory

Introduction

Argonne National Laboratory (ANL) is one of the Department of Energy's (DOE) scientific research laboratories and is the Nation's first national laboratory, chartered in 1946. ANL is located approximately 25 miles southwest of the Chicago Loop, occupies 1,500 acres, and is surrounded by a forest preserve.

Advanced Fuel Cycle Initiative

ANL staffs the Advanced Fuel Cycle Initiative (AFCI) Campaign manager positions for separations technology development, waste form development, and fast reactor development, providing leadership over multi-laboratory research activities. Furthermore, ANL is the principal laboratory supporting the development of a fast recycling reactor. ANL also supports the AFCI/GNEP program by performing reactor physics calculations, including spent fuel throughput calculations, for existing commercial light water reactors and Generation IV thermal and fast reactor concepts. ANL has the lead for key systems analysis activities, including certain program reports to Congress and their subsequent updates.

Generation IV Nuclear Energy Systems Initiative
ANL continues to play an important role in conducting key R&D in support of the Generation IV Nuclear Energy Systems Initiative. ANL participates in system design and evaluation activities for the Generation IV systems, makes important contributions to Generation IV fuels and materials efforts, and leads or participates in joint projects with France, Korea, Canada, Euratom, and Japan. ANL leads the United States portion of the Generation IV International Forum (GIF) coordinated research and development activities on the Sodium Fast Reactor (SFR), including the staffing of GIF SFR Steering Committee vice-chair and membership on several GIF SFR Project Management Boards. ANL is responsible for staffing the position of Generation IV National Technical Director for Design and Evaluation Methods, who coordinates the United States (U.S.) efforts on method development and validation. ANL provides one of two U.S. experts for the GIF Experts Group.

Nuclear Hydrogen Initiative
ANL supports the program by conducting laboratory analyses of thermochemical hydrogen production methods, specifically alternative cycles other than sulfur-based cycles.

Brookhaven National Laboratory
Introduction
The Brookhaven National Laboratory (BNL) is a multiprogram laboratory located in Upton, New York. The Department of Energy's BNL conducts research in the physical, biomedical, and environmental sciences, as well as in energy technologies. Brookhaven also builds and operates major facilities available to university, industrial, and government scientists. BNL provides expertise in the design of spallation targets and also related work in the design of the subcritical multiplier. BNL also performs a prospective benefits analysis of the Department of Energy's nuclear energy research and development portfolio in support of the Nuclear Power 2010 (NP 2010), Generation IV Nuclear Energy Systems Initiative (Generation IV), Nuclear Hydrogen Initiative (NHI) and the AFCI.

Advanced Fuel Cycle Initiative
BNL supports the AFCI program by conducting transmutation and fuel systems analyses, and advanced fuels performance modeling.

Nuclear Power 2010
BNL supports NP 2010 through the assessment of the benefits of spending research, development, demonstration, and deployment funds that allow or accelerate the market penetration of the new or improved technologies that will offer greater economic, energy security, and environmental benefits. The outcome of the benefit analysis can be used to determine program funding requirements.

Radiological Facilities Management
The Brookhaven Linear Isotope Producer (BLIP) at BNL uses a linear accelerator that injects 200 million-electron-volt protons into the 33 giga-electron-volt Alternating Gradient Synchrotron. Isotopes such as strontium-82, germanium-68, copper-67, and others that are used in medical diagnostic applications are produced at BLIP.

Chicago Operations Office
Generation IV Nuclear Energy Systems Initiative
The Chicago Operations Office distributes the Generation IV funding contribution to the EPSCoR projects.

Idaho National Laboratory

Introduction

The Idaho National Laboratory (INL) is an extensive research and engineering complex that has been the center of nuclear energy research since 1949. It occupies 890 square miles in southeastern Idaho along the western edge of the Snake River Plain, 42 miles northwest of Idaho Falls, Idaho. The INL consists of three main engineering and research campuses: (1) the Reactor Technology Complex (RTC) at the site, (2) the Materials and Fuels Complex (MFC) at the site, and (3) the Science and Technology Complex (STC) in Idaho Falls. As INL Landlord, NE also operates the Central Facilities Area (CFA) at the site that provides support to all the compounds and campuses at the site. The Office of Nuclear Energy (NE) has Lead Program Secretarial Office (LPSO) responsibility for the Idaho Operations Office (ID). INL is the center for NE's strategic nuclear energy research and development enterprise. INL has a central role in Generation IV nuclear energy systems development, advanced fuel cycle development, and space nuclear power and propulsion applications. The INL has transitioned its research and development focus from environmental programs to nuclear energy programs, while maintaining its multi-program national laboratory status to best serve ongoing and future DOE and national needs. While focused on its role as the center for nuclear research and development, as a multi-program national laboratory, INL continues to pursue national security, and homeland security activities.

Advanced Fuel Cycle Initiative

INL serves as the Technical Integration Office for AFCI. INL also staffs the AFCI Campaign manager positions for Fuels and Systems Analysis, leading the efforts of several national laboratories in the Generation IV and transmutation fuels, systems analysis and computer modeling and simulation arenas. INL has the lead role for the design of the Advanced Fuel Cycle Facility (AFCF). The mission of this facility is to establish the feasibility of advanced separations processes for spent nuclear fuel and the fabrication of advanced fuel types. INL is also responsible for qualification of resulting waste forms. INL capabilities also include nuclear fuel development, irradiation of AFCI transmutation and Generation IV test fuels, post-irradiation examinations, waste and nuclear material characterization, and development of dry, interim storage for spent fuel and other radioactive materials.

Generation IV Nuclear Energy Systems Initiative

INL is the lead laboratory for the Generation IV program and conducts the program's technical integration activities. INL provides the R&D leadership for the Very High Temperature Reactor (VHTR), leads or participates in system design and evaluation activities for this system, and makes important contributions to fuel, materials and energy conversion system efforts. As designated by the Energy Policy Act of 2005, INL is the lead laboratory for the Next Generation Nuclear Plant (NGNP) project activities. This includes the integration of NGNP research and development, design, licensing and industrial participation. INL, together with ORNL, is the principal laboratory responsible for the development of advanced gas reactor fuel for the VHTR. INL leads or participates in a number of joint projects with France, Korea, Canada, Euratom, and Japan. INL is responsible for staffing the position of Technical Director of the GIF, and plays a key role in organizing international GIF Policy Group meetings. INL is also responsible for staffing the position of Chair of the GIF Experts Group and for the organization of the GIF Experts Group meetings.

Idaho Facilities Management

The INL is a multi-program national laboratory that employs research and development assets to pursue a wide range of nuclear power research and development and other national energy security activities such as the AFCI, Generation IV, the Space and Defense Power Systems program, and the Navy's nuclear propulsion research and development program. The purpose of the Idaho Facilities Management (IFM) program is to provide the INL with the infrastructure required to support these efforts and to ensure that the existing infrastructure is maintained and operated in compliance with environment, safety and health rules and regulations.

NE is responsible for 890 square miles of land west of Idaho Falls (the site) and numerous laboratory and administrative facilities located in the town of Idaho Falls. NE operates and maintains buildings, nuclear and radiological facilities and associated support structures; a full complement of site wide utilities, including power, communications and data transmission systems; 800 miles of paved and unpaved roads; 61 miles of high voltage electrical transmission lines; and 14 miles of railroad track.

Nuclear Hydrogen Initiative
INL provides leadership in executing the NHI. INL cooperates with SNL, in its role as Generation IV National Technical Director for Energy Conversion Systems, to ensure efficient integration of Generation IV and NHI activities. INL leads the development of the High Temperature Steam Electrolysis hydrogen production process technology.

Radiological Facilities Management
INL is responsible for the radioisotope power systems heat source and test and assembly operations that were transferred from the Mound Site. Activities also include the transfer of neptunium-237 (Np-237) inventory from the Savannah River Site to the INL during FY 2005. Beginning in FY 2008, INL will provide fuel for university research reactors including fuel for conversions from highly enriched uranium (HEU) to low enriched uranium (LEU), and ship spent fuel from university reactors to DOE's Savannah River site.

University Reactor Infrastructure and Education Assistance
Due to the FY 2007 Continuing Resolution, INL provided fuel for university research reactors including fuel for conversions from HEU to LEU, and to ship spent fuel from university reactors to DOE's Savannah River Site. INL also administered the peer-review of the Nuclear Engineering Education Research (NEER) program to provide competitive investigator-initiated, research grants to nuclear engineering schools; the university reactor upgrade program to provide funding for improvements and maintenance of 20-25 university research reactors; and part of the university programs summer internship program.

Idaho Operations Office

Introduction

The Idaho Operations Office provides procurement, contract, cooperative agreement, and grant support for the Generation IV, Nuclear Hydrogen Initiative, Nuclear Power 2010, and AFCI programs.

University Reactor Infrastructure and Education Assistance
The Idaho Operations Office administered the grants for the NE & HP fellowships and scholarships and the DOE/Industry Matching Grants program, and the NE Education Opportunities program in FY 2007. ID also administers engineering management contracts in support of the AFCI/GNEP initiative.

Lawrence Berkeley National Laboratory
Introduction
Lawrence Berkeley National Laboratory has been a leader in science and engineering research for more then 70 years. Located on a 200 acre site in the hills above the University of California's Berkeley campus, adjacent to the San Francisco Bay, Berkeley Lab holds the distinction of being the oldest of the U.S. Department of Energy's National Laboratories.

Advanced Fuel Cycle Initiative
Lawrence Berkeley National Laboratory provides expertise in waste form research and development, including waste form modeling and simulation.

Lawrence Livermore National Laboratory
Introduction
Lawrence Livermore National Laboratory (LLNL) is a multi-disciplinary research and development laboratory focused on national defense, which has two noncontiguous geographic locations in northern California. LLNL is approximately one square mile and is located 40 miles east of San Francisco. LLNL conducts research in advanced defense technologies, energy, environment, biosciences, and basic science.

Advanced Fuel Cycle Initiative
LLNL provides expertise on the impact of separation technologies on the geologic repository, advanced computer simulations and modeling efforts, and coordination with Office of Science and Civilian Radioactive Waste Management experts from other laboratories.

Generation IV Nuclear Energy Systems Initiative
LLNL is working on the development of the Generation IV lead-cooled fast reactor and associated fuel cycle. LLNL and ANL together serve as the Systems Integration Manager for the lead-cooled fast reactor.

Los Alamos National Laboratory
Introduction
Los Alamos National Laboratory (LANL) is a multi-disciplinary research facility located on approximately 28,000 acres near the town of Los Alamos in northern New Mexico. LANL is engaged in a variety of programs for DOE and other government agencies. LANL's primary mission is to engage in research and technical activities supporting the Nation's defense. LANL also supports DOE missions related to arms control, non-proliferation, nuclear material disposition, energy research, science and technology, and environmental management. Research and development in the basic sciences, mathematics, and computing have a broad range of applications, including: national security, non-nuclear defense, nuclear and non-nuclear energy, atmospheric and space research, geoscience, bioscience, biotechnology, and the environment.

Advanced Fuel Cycle Initiative
LANL supports the AFCI and Generation IV programs through advanced fuels, materials and transmutation engineering research, including accelerator-driven systems. LANL staffs one of the two Deputy Director positions of the AFCI Technical Integration Office. LANL is coordinating several aspects of the GNEP international cooperation initiatives. LANL also supports activities under the

transmutation science education program related to nuclear science and engineering research at U.S. universities.

Radiological Facilities Management
At LANL, a portion of the Plutonium Facility-4 at the Technical Area-55 is dedicated to Pu-238 activities and is used to purify and encapsulate Pu-238 used in radioisotope power sources for the National Aeronautics and Space Administration (NASA) space exploration missions and national security applications. The LANL capabilities were expanded to include establishing a Pu-238 scrap recovery capability to recycle Pu-238 scrap for use in future missions.

At LANL, the 100 MeV Isotope Production Facility (IPF) became fully operable in FY 2005 and produces major isotopes, such as germanium-68, a calibration source for Positron Emission Tomography (PET) scanners; strontium-82, the parent of rubidium-82, used in cardiac PET imaging; and arsenic-73 used as a biomedical tracer.

National Renewable Energy Laboratory
Introduction
The National Renewable Energy Laboratory (NREL) is located in Golden, Colorado.

Nuclear Hydrogen Initiative
NREL coordinates the research in the thermochemical area. Additionally, NREL provides the systems integration function for the DOE Hydrogen program.

Oak Ridge National Laboratory
Introduction
The Oak Ridge National Laboratory (ORNL) is a DOE scientific research laboratory located in Oak Ridge, Tennessee. ORNL also maintains the DOE computer code system, software, and documentation at the Radiation Safety Information Computational Center (RSICC) and serves as a repository for DOE computational research activities, including computer software that is developed by NEER research projects. The RSICC computer software is made available to nuclear engineering departments, NERI and NEER awardees.

Advanced Fuel Cycle Initiative
ORNL conducts research in basic and applied science in support of the AFCI program. ORNL provides materials expertise to develop spallation targets and specific reactor components, conducts research and development on advanced separations technologies, transmutation fuels for advanced recycling reactors and participates in the development and deployment planning of advanced aqueous spent fuel treatment technologies. Specifically, ORNL is performing a Coupled-End-To-End demonstration project of an advance aqueous separations technology supporting the used nuclear fuel recycling objectives of GNEP. AFCI's Campaign manager for Grid-Appropriate Reactors resides at ORNL and integrates and coordinates multi-laboratory research for small reactor design.

Generation IV Nuclear Energy Systems Initiative
ORNL and INL are the principal laboratories responsible for the development of advanced gas reactor fuel for the Very High Temperature Reactor. ORNL will fabricate gas reactor fuel in a laboratory-scale facility to supply demonstration fuel for irradiation testing and fuel performance modeling. ORNL also staffs the Generation IV National Technical Director for Materials, leads the development of the

Generation IV Materials handbook efforts, and conducts much of the materials testing in support of the Generation IV.

Radiological Facilities Management
ORNL provides the unique capabilities for fabricating carbon insulator and iridium heat source components for radioisotope power sources used for NASA space exploration missions. These sophisticated heat source components are necessary for the safe operation of these power systems during normal operation and during launch, reentry or other deployment accidents.

Enriched stable isotopes are processed at two laboratories. The material laboratory performs a wide variety of metallurgical, ceramic, and high vacuum processing techniques; the chemical laboratory performs scraping, leaching, dissolving, oxidizing processes to remove unwanted materials and place the isotope into a "chemically stable" form. Radioactive isotopes are chemically processed and packaged in hot cells in Buildings 4501 and 7920.

Oak Ridge Operations Office

Radiological Facilities Management
Funding provides for oversight and monitoring of the maintenance of DOE leased assets at the Paducah Gaseous Diffusion Plant site. This program assures that USEC Inc. meets its MOA commitments and that the Government's rights and options are preserved. Beginning in FY 2008, the DOE will assume direct responsibility for these oversight and monitoring activities.

Pacific Northwest Laboratory

Introduction
Pacific Northwest Laboratory (PNL) is a multi-program laboratory located on approximately 640 acres of the Department's Hanford site. PNL also monitors a marine science lab in Sequim, Washington.

Advanced Fuel Cycle Initiative
PNL provides technical support to the AFCI in the areas of advanced separations, fuels, materials, nonproliferation analysis, and systems analysis.

Radiological and Environmental Sciences Laboratory (RESL)

Idaho Facilities Management
RESL is a DOE-owned and operated Federal reference laboratory with core mission capabilities in radiation measurement and calibrations, and analytical chemistry. The laboratory conducts measurement quality assurance programs to assure that key DOE missions are completed in a safe and environmentally responsible manner.

Sandia National Laboratories

Introduction
Sandia National Laboratories (SNL) is a research development facility located on approximately 18,000 acres on the Kirtland Air Force Base reservation near Albuquerque, New Mexico and has smaller facilities in Livermore, California and Tonopah, Nevada. The mission of SNL is to meet national needs in the nuclear weapons and related defense systems, energy security, and environmental integrity.

Advanced Fuel Cycle Initiative
SNL staff includes the Manager for the Regulation and Safety crosscut campaign. SNL is also an integral part of the AFCI systems analysis effort. SNL also has the lead for nuclear safeguards, security and regulatory requirements for GNEP proposed facilities.

Generation IV Nuclear Energy Systems Initiative
SNL is responsible for staffing the position of National Technical Director for Energy Conversion, who coordinates the U.S. R&D on advanced systems for converting nuclear-generated heat into marketable energy products. This R&D is focused on advanced gas turbo-machinery with helium or supercritical carbon dioxide as the working fluids.

Nuclear Hydrogen Initiative
SNL serves as the technical integrator for NHI, responsible for coordinating the participation of all laboratories in the development and conduct of the Nuclear Hydrogen Initiative R&D program. SNL is conducting research and development on the sulfur-iodine thermochemical process to operate an integrated demonstration in FY 2008.

Radiological Facilities Management
The Annular Core Research Reactor (ACRR) is a highly flexible facility that has been applied to the mission requirements of the Department in both isotope and national security applications. National security programs use the ACRR's short duration high-power pulse capabilities for component testing. The Isotope Program no longer has a programmatic need for the ACRR. NNSA is currently the only user. The transfer to NNSA of the ACRR and hot cells that have been maintained in a non-nuclear status will be completed by the end of FY 2007.

Savannah River National Laboratory
Introduction
The Savannah River Site (SRS) is an extensive material production and engineering complex that has been a nuclear site since 1951 when construction began supporting the U.S. strategic weapons program. SRS is now a multiprogram operational site covering 310 square mile site near Aiken, South Carolina. Because of its Cold War nuclear legacy, there is a significant level of environmental management cleanup work being performed at the site. In addition to supporting NE programs, the SRS workforce continues to support the National Nuclear Security Administration's weapons disposition program. Savannah River National Laboratory (SRNL) is a multiprogram laboratory located on approximately 34 acres within the Savannah River Site.

Advanced Fuel Cycle Initiative
SRNL conducts research on advanced aqueous separations, systems analysis, advanced safeguards, and waste form development. Building on years of experience operating separations processes and managing waste from nuclear processes, SRS provides engineering analyses in support of AFCI and participates in the development and deployment planning of advanced aqueous spent fuel treatment technologies. Based on it history and current work of stabilizing nuclear material, SRS possesses the most operational experience in spent nuclear fuel separations in the U.S.

Nuclear Hydrogen Initiative
Savannah River assists with hybrid sulfur thermochemical cycle activities.

Nuclear Power 2010
Savannah River provides consultation and expertise on seismic issues.

Savannah River Operations
Introduction
The SRS is an extensive material production and engineering complex that has been a nuclear site since 1951 when construction began supporting the U.S. strategic weapons program. SRS is now a multiprogram operational site covering 310 square mile site near Aiken, South Carolina. Because of its Cold War nuclear legacy, there is a significant level of environmental management cleanup work being performed at the site.

Advanced Fuel Cycle Initiative
SRS performs engineering studies on various process alternatives for the Consolidated Fuel Treatment Center project and prepared several reports for the input into the Programmatic Environmental Impact Statement.

MOX Fuel Cycle Fabrication Facility
NE will oversee the design, construction, and operation of the MFFF to be built at the Department's SRS.

University of Las Vegas, Nevada
Advanced Fuel Cycle Initiative
UNLV is actively engaged in experiments on lead alloy coolants and targets in accelerator-based systems and fast reactor systems. UNLV conducts systems analysis on AFCI/GNEP activities, including the potential for deep burn gas reactor transmutation. UNLV also conducts research using student participation.

Nuclear Hydrogen Initiative
UNLV is working with the Department to perform research and development on candidate heat exchanger designs. UNLV's scope includes complimentary materials testing activities.

Washington Headquarters
FY 2007, FY 2008, and FY 2009 include funding for SBIR and other small business initiatives. For AFCI/GNEP, this account will also fund potential industry contracts for design studies on advanced spent nuclear fuel recycling facilities and advanced recycling reactors.

Nuclear Power 2010
Includes funding for activities conducted in support of the combined Construction and Operating License (COL) demonstration projects. Also, includes funding to develop the regulations, criteria, and process under which the Department would accept, evaluate, and approve applications for standby support contracts from sponsors of new nuclear power plants.

Radiological Facilities Management
Includes funding for certification of isotope shipping casks, independent financial audits of the revolving fund, and other related expenses. Starting in FY 2009, limited investments will be made in

university infrastructure that can achieve production of small quantities of medical research isotopes at lower cost than the national laboratories.

University Reactor Infrastructure and Education Assistance

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
University Reactor Infrastructure & Education Assistance	16,547	0	0	0	0

Public Law Authorizations:
P.L. 110-5, Revised Continuing Appropriations Resolution, 2007
P.L. 110-161, The Consolidated Appropriations Act, 2008

Mission

The mission of the University Reactor Infrastructure and Education Assistance program has been to enhance the national nuclear educational infrastructure to meet the manpower requirements of the Nation’s energy, environmental, health care, and national security sectors. Enrollment levels of the University Reactor Infrastructure and Education Assistance program have increased and the program is no longer considered essential to encourage students to enter into nuclear related disciplines.

The United States (U.S.) has led the world in the development and application of nuclear technology for many decades. This leadership, which spans energy, national security, environmental, medical, and other applications, has been possible because the Government has helped foster advanced nuclear technology education at many universities and colleges across the Nation. The Government has aided these programs to maintain the educational and training infrastructure necessary to develop the next generation of nuclear scientists and engineers. During the 1980s and 1990s, the number of students entering nuclear engineering programs in the U.S. declined causing a corresponding decline in nuclear engineering programs and research reactors. As the decline continued, the existing expertise in the nuclear field was reaching retirement age. Thus, the demand for nuclear scientists and engineers exceeded supply. The University Reactor Infrastructure and Education Assistance program was designed to address these issues by providing support to university nuclear engineering programs and the university research reactor community.

Beginning in FY 2008, funding to continue Federal support for fuel for universities is requested in the Radiological Facilities Management budget under Research Reactor Infrastructure.

In FY 2009, NE will continue to support R&D activities at university and research institutions through competitive awards focused on advancing nuclear energy technologies. Through its Nuclear Energy Research Initiative process, NE will designate at least 20 percent of funds appropriated to its R&D programs for work to be performed at university and research institutions. This commitment to strengthening the nation's nuclear education infrastructure directly supports the goals of the America Competes Act of 2007, which specifically highlighted the need for increased support of the U.S. nuclear science and engineering education enterprise, as well as the President’s American Competitiveness Initiative. These funds will support investigator-initiated basic research and mission-specific applied R&D activities; human capital development activities such as fellowships and young faculty awards;

and, infrastructure and equipment upgrades for university-based research reactors and laboratories. This mutually beneficial arrangement will help university and research institutions bolster their R&D capabilities and help strengthen the U.S. educational infrastructure necessary to support the nuclear renaissance envisioned by this budget request.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for energy security, nuclear security, scientific discovery, environmental responsibility, and management excellence), plus 16 Strategic Goals that tie to the Strategic Themes. The University Reactor Infrastructure and Education Assistance program supported the following goals:

Strategic Theme 1, Energy Security
Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

The University Reactor Infrastructure and Education Assistance program has one GPRA Unit Program goal which contributed to Strategic Goals 1.2 in the "goal cascade":

GPRA Unit Program Goal 1.2.15.00*: Maintain and Enhance National Nuclear Infrastructure - Maintain, enhance, and safeguard the Nation's nuclear infrastructure capability to meet the Nation's energy, medical research, space exploration, and national security needs.*

Contribution to GPRA Unit Program Goal 1.2.15.00 (Maintain and Enhance National Nuclear Infrastructure)

The University Reactor Infrastructure and Education Assistance Program was designed to address declining infrastructure support for U.S. nuclear engineering programs. Since the late 1990s, enrollment levels in nuclear education programs have increased dramatically. In fact, enrollment levels for 2005 reached upwards of 1,500 students. In addition, the number of universities offering nuclear-related programs also has increased. These trends reflect renewed interest in nuclear power. Students will continue to be drawn into this course of study, and universities, along with nuclear industry societies and utilities, will continue to invest in university research reactors, students, and faculty members. Consequently, Federal assistance is no longer necessary, and the FY 2009 Budget proposed termination of the University Reactor Infrastructure and Education Assistance Program. Under the FY 2007 Continuing Resolution, funding was provided to fully fund existing mortgages and close out all activities under the University Reactor Infrastructure and Education Program.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.2, Environmental Impacts of Energy			
GPRA Unit Program Goal 1.2.15.00, Maintain and Enhance National Nuclear			

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Infrastructure			
University Reactor Infrastructure and Education Assistance	16,547	0	0
Total, Strategic Goal 1.2 (University Reactor Infrastructure and Education Assistance)	16,547	0	0

Means and Strategies

The University Reactor Infrastructure and Education Assistance program used various means and strategies to achieve its program goals. The program also performed collaborative activities to help meet its goals.

The Department implemented the following means:

- Used educational incentives, including fellowships, scholarships, research funding, faculty support and private sector funding support from our Matching Grant program, which was aimed at increasing enrollments and graduates in nuclear engineering.
- Pursued programs that were geared towards increasing minority participation and support by pairing nuclear engineering schools with minority institutions enabling students from minority universities to achieve degrees in both nuclear engineering and their chosen technical field.

The Department implemented the following strategies:

- Worked to develop a pipeline of qualified and interested students in the area of nuclear science by training and educating middle and high school science teachers through the funding of the American Nuclear Society (ANS) Workshops.
- Improved the tools available to present and future students by upgrading university reactors and enabling others to share reactor time creating a stronger infrastructure by improving reactor operations and broadening the reach of the reactor facilities to those who would not otherwise have access to such sophisticated facilities.
- Met periodically throughout the year with stakeholder organizations such as the Nuclear Engineering Department Heads Organization (NEDHO); the University Working Group; the Test, Research, and Training Reactor Management Group (TRTR); and other committees of professional organizations such as the ANS to review program activities; discuss program issues; and solicit input, advice, and guidance.

Validation and Verification

All peer-reviewed university activities grantees are required to submit annual reports to DOE outlining the progress achieved. Once annual reports are submitted, they are logged in the NE database and reviewed by the NE Program Manager for compliance with the Program's stated goals and objectives. Nuclear Engineering Education Research (NEER) annual and final reports are posted to the NEER web page at http://neer.inel.gov/. These annual reports provide an opportunity to verify and validate performance. Also, quarterly, semi-annual, and annual reviews of financial reports consistent with program plans are held to ensure technical progress, cost and schedule adherence, and responsiveness to program requirements.

Program evaluations of Innovations in Nuclear Infrastructure and Education (INIE) grant activities are typically conducted twice a year. In addition, comprehensive reviews are held with each INIE consortium to go over performance and cost. Each consortium member has an opportunity to provide progress information and input into upcoming performance. Further, INIE awardees are required to submit annual progress reports to NE on activities conducted during the year. The report was revised in FY 2005 to make the report more standardized. They are logged in the NE database and reviewed by the NE Program Manager for compliance with program goals.

NE conducts annual reviews of existing fellowship and scholarship recipients prior to renewing any awards.

All three-year radiochemistry grants are reviewed annually through site visits by the program manager.

Program Assessment Rating Tool (PART)

The Department has implemented a tool to evaluate selected programs. PART was developed by the Office of Management and Budget to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

A PART was completed for the University Reactor Infrastructure and Education Assistance program during the FY 2007 budget formulation cycle. The assessment determined that enrollment levels of the program have increased and that students no longer need to be encouraged to enter into nuclear related disciplines. In addition, the number of universities offering nuclear-related programs also has increased. These trends reflect renewed interest in nuclear power. Students will continue to be drawn into this course of study and universities, along with nuclear industry societies and utilities, will continue to invest in university research reactors, students, and faculty members. Consequently, Federal assistance is no longer necessary, and the 2007 Budget proposed termination of this program.

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
University Reactor Infrastructure and Education Assistance			
University Nuclear Infrastructure	5,559	0[a]	0
Fellowships/Scholarships to Nuclear Science and Engineering Programs at Universities	4,413	0	0
Health Physics Fellowships & Scholarships	300	0	0

[a] $2,947,000 for fuel is requested in the Radiological Facilities Management Budget under Research Reactor Infrastructure.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Nuclear Engineering Education Research (NEER) Grants	5,000	0	0
Radiochemistry Awards	1,275	0	0
Total, University Reactor Infrastructure and Education Assistance	16,547	0	0

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
University Nuclear Infrastructure	**5,559**	**0**[a]	**0**

The UNI program provided fuel for the universities; instrumentation, electronics, hardware, and software upgrades for the research reactors; and reactor sharing and research support for educational institutions to facilitate the development of the Nation's next generation of nuclear scientists and engineers.

Under the FY 2007 Continuing Resolution, funding was provided to purchase of a new shipping cask to enable continuation of spent fuel shipments from reactors at the Massachusetts Institute of Technology, the University of Missouri and various other university reactors, and for the fabrication and shipment of fresh fuel to and spent fuel from university research reactors.

No funding is requested for these activities in FY 2008 or FY 2009. Funding to provide fresh reactor fuel for universities is requested in the Radiological Facilities Management budget under Research Reactor Infrastructure.

Fellowships/Scholarships to Nuclear Science and Engineering Programs at Universities	**4,413**	**0**	**0**

The University Partnership program encouraged students enrolled at minority-serving institutions to pursue a nuclear engineering degree in cooperation with universities that grant those degrees.

Under the FY 2007 Continuing Resolution, funding was provided to fully fund and close out all existing fellowships, scholarships, and partnerships. No new awards were funded.
No funding is requested for this activity in FY 2008 or FY 2009.

Health Physics Fellowships & Scholarships	**300**	**0**	**0**

Under the FY 2007 Continuing Resolution, funding was provided to fully fund and close out all existing Health Physics fellowships and scholarships.

No funding is requested for this activity in FY 2008 or FY 2009.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Nuclear Engineering Education Research (NEER) Grants	**5,000**	**0**	**0**

The NEER program provided grants allowing nuclear engineering faculty and students to conduct innovative research in nuclear engineering and related areas.

Under the FY 2007 Continuing Resolution, funding was provided to fully fund and close out all NEER grants.

No funding is requested for this activity in FY 2008 or FY 2009.

Radiochemistry Awards	**1,275**	**0**	**0**

The Department provided grants every three years to support faculty and graduate/post doctorate students in radiochemistry.

Under the FY 2007 Continuing Resolution, funding was provided to fully fund and close out all existing radiochemistry awards.

No funding is requested for this activity in FY 2008 or FY 2009.

Total, University Reactor Infrastructure and Education Assistance	**16,547**	**0**	**0**

Research and Development

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Research and Development					
Nuclear Power 2010	80,291	135,000	-1,229	133,771	241,600
Generation IV Nuclear Energy Systems Initiative	35,214	116,000	-1,083	114,917	70,000
Nuclear Hydrogen Initiative	18,855	10,000	-91	9,909	16,600
Advanced Fuel Cycle Initiative	166,092	0	0	0	301,500
Total, Research and Development	300,452	261,000	-2,403	258,597	629,700

Public Law Authorizations:
P.L. 110-5, Revised Continuing Appropriations Resolution, 2007
P.L. 110-161, The Consolidated Appropriations Act, 2008

Mission

The mission of the Office of Nuclear Energy's (NE) Research and Development (R&D) program is to secure nuclear energy as a viable, long-term commercial energy option, providing diversity in the energy supply. In the short term, government and institutional barriers will be addressed to enable new plant deployment decisions by nuclear power plant owners and operators who wish to be among the first to license and build new nuclear facilities in the United States (U.S.). In the longer term, new nuclear technologies that can compete with advanced fossil and renewable technologies will be developed, enabling power providers to select from a diverse group of generation options that are economical, reliable, safe, secure, and environmentally acceptable. In FY 2008, the Advanced Fuel Cycle Initiative (AFCI) is included in the Fuel Cycle Research and Facilities program.

Nuclear energy has the potential to safely and reliably generate electricity for our 21st century economy, to produce economical hydrogen for transportation use without emitting greenhouse gases, and to produce heat and clean water to support growing industry and populations worldwide. NE is a key participant in on-going integrated benefits assessment activities conducted for applied R&D programs in the Department. Analyses to measure the benefits of the NE R&D portfolio compared its programs' contributions to nuclear technologies against other electricity-generating and hydrogen-producing fossil and energy efficiency and renewable energy technologies. These analyses showed that the economic benefit of the NE R&D portfolio, in terms of energy system cost saving, potentially could total $45 billion per year by 2050, many times the cost of the government's cumulative investment. Moreover, the additional reduction in carbon dioxide emissions from nuclear technologies influenced by NE R&D could be 246 million tons of carbon equivalents per year by 2050. These projected savings show that NE R&D plays a significant role in the Energy, Science, and Environment portfolio, which, taken together, is estimated to save $256 billion and 730 million tons of carbon equivalent per year. These results indicate substantial benefit can be derived from the Department's applied R&D portfolio investments.

At the same time the expanded use of nuclear energy domestically and globally presents challenges that must be met. Some of these challenges will be met through excellence in the use of nuclear power (e.g., nuclear safety). Others, such as nuclear waste and economic issues, can be addressed in part through advances in technology. Investment in long-term R&D could help expand the use of nuclear energy worldwide. NE focuses on much of its research on long-term, highrisk R&D that industry does not have the incentive to undertake on their own.

For the Nuclear Power 2010 (NP 2010) program, the FY 2009 budget request continues new nuclear plant licensing and reactor engineering and design activities started in previous years. In FY 2009, the NP 2010 program will cost share the work being performed by industry partners to respond to information requests from the Nuclear Regulatory Commission (NRC) as they advance their review of the two combined Construction and Operating License (COL) applications. Additionally, NP 2010 will continue to cost share the engineering and design activities of the reactor vendors for two Generation III+ advanced, light water reactors including issues related to design certification requests being reviewed by NRC. The scope of work being executed in FY 2009 will achieve progress necessary to maintain the goal of licensing and design certification decisions by NRC in FY 2010 and FY 2011, an industry decision to build in FY 2010, and completion of standardized reactor designs in FY 2011. Successful completion of these activities will lead to deployment of new nuclear plants in the next decade.

For the Generation IV Nuclear Energy Systems Initiative (Gen IV) program, the FY 2009 budget request continues critical gas reactor R&D that will help achieve desired goals of sustainability, economics, and proliferation resistance to ready the technology for commercial deployment in the 2030 timeframe. In FY 2009, Gen IV R&D focuses specifically on component and material aging and degradation where results will directly benefit existing nuclear plants by extending their current operating licensing period and designing advanced reactor concept plants with a longer operating life. Continued investigation of technical and economical challenges and risks are needed to support NGNP design and licensing basis development. In FY 2009, NGNP R&D includes broader activities conducted in support of the VHTR concept and benchmarking methodologies in conjunction with the Generation IV International Forum (GIF). Successful completion of these activities is necessary to support the 2011 decision to proceed with the demonstration of an NGNP by 2021, as directed by EPAct. Key to the strategy for conducting R&D under the Gen IV Nuclear Energy Systems Initiative is the multiplication effect on investment derived from international collaboration. By coordinating U.S. efforts with those of the GIF partner nations, our funding is leveraged by a factor of two to ten, depending on the reactor concept involved.

For the Nuclear Hydrogen Initiative (NHI) program, the FY 2009 budget request continues integrated laboratory-scale (ILS) experiments begun in FY 2008 on two baseline nuclear hydrogen production technologies. It also completes the design of an ILS experiment for the Hybrid Sulfur thermochemical cycle. These experiments are being conducted in order to provide the necessary information needed to make a recommendation of the hydrogen production technology to be coupled with the NGNP as required by the Energy Policy Act of 2005 (EPAct 2005). Additional NHI activities planned in FY 2009 are targeted at improving the efficiency and economics of advanced, high temperature hydrogen production technologies. Successful completion of these activities will represent tangible progress toward demonstrating nuclear hydrogen production at a cost competitive with other hydrogen production technologies.

For the Advanced Fuel Cycle Initiative (AFCI) program, which is focused on implementing the Global Nuclear Energy Partnership (GNEP), the FY 2009 budget request continues to develop methods to reduce the volume and long-term toxicity of high-level waste from spent nuclear fuel, reduce the long-term proliferation threat posed by civilian inventories of plutonium in spent fuel, and provide for proliferation-resistant technologies to recover the energy content in spent nuclear fuel. These activities continue R&D to develop advanced recycling technologies capable of extracting highly radioactive elements from commercial spent nuclear fuel and using that material as fuel in nuclear reactors to generate additional electricity. The FY 2009 request also supports continuation of conceptual design activities for the AFCF, ABR and CFTC, necessary to support the GNEP vision of a closed fuel cycle. Successful achievement of these activities will improve the way spent nuclear fuel is managed, and will facilitate the expansion of civilian nuclear power in the United States and encourage civilian nuclear power internationally to evolve in a more proliferation-resistant manner.

In FY 2009, NE will continue to support R&D activities at university and research institutions through competitive awards focused on advancing nuclear energy technologies. Through its Nuclear Energy Research Initiative process, NE will designate at least 20 percent of funds appropriated to its R&D programs for work to be performed at university and research institutions. This commitment to strengthening the nation's nuclear education infrastructure directly supports the goals of the America Competes Act of 2007, which specifically highlighted the need for increased support of the U.S. nuclear science and engineering education enterprise, as well as the President's American Competitiveness Initiative. These funds will support investigator-initiated basic research and mission-specific applied R&D activities; human capital development activities such as fellowships and young faculty awards; and, infrastructure and equipment upgrades for university-based research reactors and laboratories. This mutually beneficial arrangement will help university and research institutions bolster their R&D capabilities and help strengthen the U.S. educational infrastructure necessary to support the nuclear renaissance envisioned by this budget request.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for energy security, nuclear security, scientific discovery, environmental responsibility and management excellence), plus 16 Strategic Goals that tie to the Strategic Themes. The NE R&D program supports the following goals:

Strategic Theme 1, Energy Security: Promoting America's energy security through reliable, clean, and affordable energy

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

The NE R&D program has one GPRA Unit Program goal which contributes to Strategic Goal 1.2 in the "goal cascade":

GPRA Unit Program Goal 1.2.14.00: Develop New Nuclear Generation Technologies - By 2015, enable industry to construct and operate new nuclear power plants, promoting safe, reliable and carbon-free energy production, through the standardization of Generation III+ plant designs, the successful demonstration of nuclear plant permitting and licensing processes, the advancement of Gen IV plant technologies, the construction of pilot-scale hydrogen production experiments, and the commencement of proliferation-resistant spent nuclear fuel recycling technology demonstration activities.

Contribution to GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)

The NE R&D program supports near-term technology development and demonstration activities that advance the goals of the National Energy Policy and Energy Policy Act of 2005 to enhance long-term U.S. energy independence and reliability and expand the contribution of nuclear power to the Nation's energy portfolio. The NP 2010 program supports this program goal by identifying sites for new nuclear power plants, developing and bringing to market advanced standardized nuclear plant designs, evaluating the business case for building new nuclear power plants, demonstrating untested regulatory processes through submission of combined Construction and Operating License applications to seek Nuclear Regulatory Commission (NRC) approval for building and operating new advanced light water reactor (LWR) nuclear plants in the U.S. leading to an industry decision to build in the next few years.

Gen IV supports this program goal through the development of innovative, next-generation reactor and fuel cycle technologies. The Gen IV program supports R&D that could help achieve the desired goals of sustainability, economics, and proliferation resistance. Further examination of materials, and fuels and the development of advanced computer modeling tools will support the design processes needed to proceed with a demonstration of the Very-High-Temperature Reactor as the reactor technology for the NGNP. The NGNP is being developed for economical production of electricity, hydrogen gas and other desirable products derived from high quality heat. The Gen IV program will implement research and development activities on component and material aging and degradation that will directly benefit existing nuclear plants by extending their current operating licensing period and designing future plants with a longer operating life.

NHI contributes to this program goal by researching, developing, and demonstrating economical hydrogen production technologies using high temperature heat from advanced nuclear energy systems. The initiative will develop hydrogen production technologies that are compatible with nuclear energy systems through scaled experiments.

The AFCI supports near-term technology development and demonstration activities that advance the goals of the National Energy Policy and Energy Policy Act of 2005 by developing the enabling technologies needed to reduce high level waste volume and separate and transmute long-lived, highly radiotoxic elements. These activities directly support the vision and goals of GNEP. In addition to advanced fuel cycle R&D activities, the program will develop an Advanced Burner Reactor, which will be a prototype for future commercial plants and incorporate advanced design features to improve performance, reduce cost and improve safeguards. A nuclear fuel recycling center will employ state-of-the-art technologies to provide proliferation-resistant LWR separations capability. Finally, AFCF will provide technology development capability to support fast reactor design and development of transmutation fuel and/or transmutation targets.

Funding by Strategic and GPRA Unit Program Goal

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Strategic Goal 1.2, Environmental Impacts of Energy			
GPRA Unit Program Goal 1.2.14.00, Develop New Nuclear Generation Technologies			
Nuclear Power 2010	80,291	133,771	241,600
Generation IV Nuclear Energy Systems Initiative	35,214	114,917	70,000
Nuclear Hydrogen Initiative	18,855	9,909	16,600
Advanced Fuel Cycle Initiative	166,092	0	301,500
Total, Strategic Goal 1.2 (Research and Development)	300,452	258,597	629,700

Annual Performance Results and Target

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)					
Research and Development					
	Achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Advanced Fuel Cycle, Generation IV Nuclear Energy Systems and Nuclear Hydrogen Initiatives. (MET TARGET)	*Maintain total administrative overhead costs in relation to total program costs of less than 8 percent. (Baseline for administrative overhead rate is currently being validated) (MET TARGET)*	*Maintain total administrative overhead costs in relation to total program costs of less than 8 percent. (MET TARGET)*	*Maintain total administrative overhead costs in relation to total R&D program costs of less than 8 percent.*	*Maintain total administrative overhead costs in relation to total R&D program costs of less than 8 percent.*
Nuclear Power 2010					
Select for award at least one cost-shared project with a power generating company-led team for activities required to demonstrate for the first time the combined Construction and Operating License (COL) process. (MET TARGET)	Issue project implementation plans for two COL Demonstration Projects. (MET TARGET)	Complete engineering and licensing demonstration activities necessary to implement the NP 2010 program in accordance with the principles of project management, to help ensure that program performance goals are achieved on schedule and within budget. (MET TARGET)	Complete NP 2010 engineering and licensing activities, focusing on the resolution of reactor certification and design issues and the preparation and review of COL applications, to enable an industry decision in 2010 to build a new nuclear power plant. (MET TARGET)	Enable industry to make a decision to build a new nuclear power plant by 2010 by supporting New Nuclear Plant Licensing Demonstration Projects and by administering the Department's standby support program.	Enable industry to make a decision to build a new nuclear power plant by 2010 by supporting New Nuclear Plant Licensing Demonstration Projects and by administering the Department's standby support program.
Generation IV Nuclear Energy Systems Initiative					
Award one or more contracts for the Next Generation Nuclear Plant pre-conceptual design. (NOT MET)	Issue the final design documents for the fuel capsule, test train, fission product monitoring system, and control system for the fuel irradiation shakedown test (AGR-1). (MET TARGET)	Complete Generation IV research and development activities to inform a design selection for the next generation nuclear power plant by FY 2011. (MET TARGET)	Complete Generation IV research and development activities, focusing on fuels and materials testing and plant system optimization, to inform the functional and operational design requirements of a next generation of nuclear power plant by FY 2011. (MET TARGET)	Determine a path forward for the design and construction of a next Generation nuclear power plant by 2011 by submitting an NGNP licensing strategy to Congress and completing NGNP conceptual design technology selection studies.	Determine a path forward for the design and construction of a next generation nuclear power plant by 2011 by partnering with private industry on the development of NGNP, performing environmental assessment activities, and continuing with the research, analysis and conceptual design activities needed to identify the preferred and alternative technologies for the reactor system, including examination of fuel and graphite materials.

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
Nuclear Hydrogen Initiative					
Complete final designs for the baseline thermochemical and high-temperature electrolysis laboratory-scale experiments. (MET TARGET)	Issue conceptual design documents for the thermochemical and high-temperature electrolysis pilot scale experiments. (MET TARGET)	Complete development of key technologies and infrastructure requirements in preparation for the thermochemical and high-temperature electrolysis integrated laboratory-scale experiments. (MET TARGET)	Complete NHI research and development activities focused on thermochemical and high temperature electrolysis (HTE) processes to support the Department's selection of a hydrogen production technology in 2011. (MET TARGET)	Select a hydrogen production technology by 2011 that will be demonstrated in a pilot scale experiment by conducting integrated laboratory-scale experiments on sulfur-iodine, thermochemical and HTE processes, and by developing advanced interface components to connect a nuclear heat source to a hydrogen production plant.	Select a hydrogen production technology by 2011 that will be demonstrated in a pilot scale experiment by conducting integrated laboratory-scale experiments on sulfur-iodine, thermochemical and HTE processes, and by developing advanced interface components to connect a nuclear heat source to a hydrogen production plant.
Advanced Fuel Cycle Initiative					
Complete fabrication and irradiation of advanced LWR proliferation-resistant transmutation fuel samples, and initiate post-irradiation examination of the samples. (MET TARGET)	Issue preliminary report on the post-irradiation examination (PIE) of actinide-bearing metal and nitride transmutation fuels in the Advanced Test Reactor (ATR). (MET TARGET)	Complete research and development activities that allow the AFCI program to support the Secretary of Energy's determination of the need for a second geologic repository for spent nuclear fuel by FY 2008. (MET TARGET)	Complete research and development activities, focused on advanced fuel separations technology development and demonstration, to support the Secretary of Energy's determination of the need for a second geologic repository for spent nuclear fuel by FY 2008. (MET TARGET)		Support the Secretary of Energy's path forward for achieving the GNEP vision by completing advanced separations and fuels research and development and associated technology development activities, and economic evaluations to support the deployment of GNEP facilities.
Achieve variance of less than 10 percent from cost and schedule baselines for AFCI activities. (MET TARGET)	Conduct laboratory-scale test of group actinide separation process (plutonium, neptunium, americium and curium extracted together) with actual LWR spent fuel and report preliminary results. (MET TARGET)				Support the Secretary of Energy's path forward for achieving the GNEP vision by continuing conceptual design activities, including economic evaluations, for the Advanced Fuel Cycle Facility.
Issue the report on the demonstration of a laboratory-scale separation of americium/curium from spent nuclear fuel to support the development of advanced fuel cycles for enhanced repository performance. (MET TARGET)					Support the Secretary of Energy's path forward for achieving the GNEP vision by initiating conceptual design activities, including preliminary economic evaluations of various alternatives for an Advanced Burner Reactor prototype.

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
					Support the Secretary of Energy's path forward for achieving the GNEP vision by completing technical, economic and policy analyses, including cooperative agreements with industry, which inform conceptual design alternatives for a nuclear fuel recycling center.

Means and Strategies

The R&D program will use various means and strategies to achieve its GPRA Unit Program goals. However, various external factors may impact the ability to achieve these goals. The program also performs collaborative activities to help meet its goals.

The Department will implement the following means:

- A joint government/industry cost-shared effort to identify sites for new nuclear power plants, develop advanced standardized Generation III+ nuclear plant designs, evaluate the business case for building new nuclear power plants, and demonstrate untested regulatory processes through submission of combined Construction and Operating License applications to seek the NRC's approval to build and operate new advanced nuclear power plants in the U.S. leading to an industry decision to build in the next few years.

- Hydrogen production technologies compatible with nuclear energy systems are being developed by NHI. This program includes participation of the national laboratories, industry, and university research communities as well as international research partners. While these technologies are not sufficiently mature to require industry cost sharing at this time, cost sharing will be required for the final engineering-scale demonstration. The initiative will employ competitive selection processes for design, construction, and operation activities.

- Advanced, next-generation reactor systems that offer the most sustainable, cost-competitive, reliable, and secure means of generating electricity and hydrogen are being developed by the Gen IV. The program includes participation by the national laboratories, industry, and university research communities as well as the international research community represented by the Generation IV International Forum (GIF). Industrial and international cost sharing will be pursued where practical during the R&D on these intermediate- and long-term reactor technologies and the construction of the NGNP at the Idaho National Laboratory.

- Joint government/industry cost-shared R&D activities to establish the technical and licensing basis to extend the safe and economical operation of the existing nuclear plants to at least 80 years. Laboratory R&D will be conducted to research, develop, test, and license high-performance LWR reactor fuel and clad materials to extend the operating cycles and enhance safety and productivity of existing nuclear plants. The reactor fuel R&D initiative will include participation of colleges and universities, industry, and national laboratories.

- Collaborate with industry to: 1) define the most commercially viable designs and business models under which advanced fuel cycle technologies could be deployed, 2) provide industry representation on appropriate expert review panels and 3) ultimately construct AFCI/GNEP facilities.

The Department will implement the following strategies:

- Partnering with the private sector, national laboratories, universities, and international partners to develop and deploy advanced nuclear technologies to increase the use of nuclear energy in the U.S.

- Leading the international community in pursuit of advanced nuclear technology that will benefit the U.S. with enhanced safety, improved economics, and reduced production of wastes.

- Conducting international cost-shared R&D in the Gen IV, NHI and AFCI/GNEP programs.

These strategies will result in the efficient and effective management of NE programs - thus putting the taxpayer's dollars to more productive use.

The following external factors could affect NE's ability to achieve its strategic goal:

- Whether new nuclear plant technology is deployed depends to a large extent on power demand and economic and environmental factors beyond the scope of DOE R&D programs. In the near term, it depends on complex economic decisions made by industrial partners.

- Deployment of advanced fuel cycle technologies will depend upon policy decisions that will determine the implementation of advanced spent fuel reprocessing technologi8es (e.g. the Secretary of Energy's mid-2008 decision on GNEP) as well as reducing risks and establishing an appropriate business case for private sector investment and commercial deployment.

- All nuclear energy research programs rely heavily on data produced through collaborations with foreign nations. Should vital data from foreign partners prove unavailable, an increased U.S. effort in technology development would be required.

In carrying out the program's mission, NE performs the following collaborative activities:

- The Department and the NRC coordinate program planning to assure that their R&D activities are complimentary, cost effective, and not duplicative.

- The Department is working with industry on a cost-shared basis to conduct demonstrations of untested Federal regulatory and licensing processes governing the siting, construction, and operation of nuclear power plants.

- The Gen IV is receiving broad international cooperation and support, consistent with the objectives of the program. The GIF, composed of representatives from twelve governments and the European Union, provides guidance for executing the R&D of these next-generation nuclear energy systems.

- Participation in international experiments related to the development of advanced fuel cycle technologies is being performed in support of AFCI/GNEP objectives.

- NE collaborates with other programs within the Department, such as the Office of Science, the Office of Fossil Energy, and the Office of Energy Efficiency and Renewable Energy, on the President's Hydrogen Fuel Initiative.

- NE will collaborate with other programs within the Department, such as the Office of Science, the Office of Civilian Radioactive Waste management, and the National Nuclear Security Administration, all of whom have roles supporting AFCI/GNEP.

Validation and Verification

To validate and verify program performance, NE conducts various internal and external reviews and audits. NE's programmatic activities are subject to periodic review by Congress, the Government Accountability Office, the Department's Inspector General, the NRC, the U.S. Environmental Protection Agency, state environmental and health agencies, the Defense Nuclear Facilities Safety Board, and the Department's Office of Engineering and Construction Management. In addition, NE provides continual management and oversight of its R&D programs—NP 2010, Gen IV, NHI and AFCI. Periodic internal and external program reviews evaluate progress against established plans. These reviews provide an opportunity to verify and validate performance. Monthly, quarterly, semi-annual and annual reviews, consistent with program management plans and project baselines, are held to ensure technical progress, cost and schedule adherence, and responsiveness to program requirements.

The Department obtains advice on the direction of nuclear energy R&D programs from the independent Nuclear Energy Advisory Committee (NEAC). NEAC, a formal Federal advisory committee, provides expert advice on long-range plans, priorities, and strategies for the nuclear technology R&D and research infrastructure activities of NE. NEAC has several active subcommittees examining various aspects of nuclear technology R&D. Reports issued by these subcommittees that address the future of nuclear energy include: the "Long-Term Nuclear Technology Research and Development Plan", the "Nuclear Science and Technology Infrastructure Roadmap", "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010", "A Technology Roadmap for Generation IV Nuclear Energy Systems", "Report of the Subcommittee on Nuclear Laboratory Requirements", and "An Evaluation of the Proliferation Resistant Characteristics of Light Water Reactor Fuel with the Potential for Recycle in the United States".

At the end of FY 2006, the General Accountability Office issued a report, *Status of DOE's Effort to Develop the Next Generation Nuclear Plant*, which highlighted that the initial NGNP R&D activities are favorable and that the project has a well laid out schedule for completing construction of a demonstration plant by 2021 as authorized under the Energy Policy Act of 2005. The report notes that a significant amount of R&D remains to be conducted and that DOE is making progress on its efforts to involve industry stakeholders.

In FY 2007, the General Accountability Office began a comprehensive audit of GNEP. Once released, the findings will help inform the AFCI/GNEP implementation strategy.

Program Assessment Rating Tool (PART)

The Department has implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. NE's R&D programs have incorporated feedback from OMB into the FY 2009 Budget Request, and have taken the necessary steps to continue to improve performance.

The results of the FY 2005 review are reflected as follows: for NP 2010 program, an overall PART score of 69 was achieved with a perfect 100 score for Section I, Program Purpose & Design. A score of 89 was achieved for Section II, Strategic Planning reflecting the need to improve the linkage between budget and performance data at the Departmental level. A score of 88 was achieved for Section III, Program Management reflecting the need to measure and achieve cost effectiveness in program execution. A score of 45 was achieved for Section IV, Program Results/Accountability, indicating that the program needed to establish on an annual basis an independent assessment of the overall program, evaluating the program's progress against established annual and long-term goals. In addition, OMB did recognize that the NP 2010 was a relatively new program with limited progress in achieving its long-term goals. This area was strengthened in early FY 2004 by the establishment of the new NEAC Subcommittee on Evaluations. After the issuance of the PART recommendation, independent assessments of the program were carried out by NEAC. However, in the more recent fiscal years, independent baseline reviews are being conducted and will provide the necessary analysis to demonstrate program progress. In addition, the NP 2010 program has established monthly earned value management reporting by the participants which tracks current progress and aids in implementing corrective actions to maintain progress.

For Gen IV, an overall PART score of 79 was achieved with perfect scores of 100 for Section I, Program Purpose & Design, and Section III, Program Management. These scores reflect the continued effective management of the program. A score of 90 was achieved for Section II, Strategic Planning reflecting the need to improve the linkage between budget and performance data at the Departmental level. A score of 60 was achieved for Section IV, Program Results/Accountability, which reflects the strengthening of long-term performance goals for the program compared with the previous year's performance goals. The need for improvements in the conduct of independent evaluations was identified. This area was strengthened in early FY 2004 by the establishment of the new NEAC Subcommittee on Evaluations.

For AFCI, an overall PART score of 76 was achieved with top scores of 100 in Section I, Program Purpose & Design, and Section III, Program Management. These scores are attributable to the continued use of effective program management practices. A score of 90 was achieved for Section II, Strategic Planning reflecting the need to improve the linkage between budget and performance data at the Departmental level. A score of 53 was achieved for Section IV, Program Results/Accountability, indicating the need to better demonstrate the cost effectiveness of the program. To address these findings, the program revised its near and long-term goals, and is working to increase cost effectiveness by continuing to increase international cost-shared R&D costs through expanded collaborations.

In addition, the AFCI program was found to rely upon process oriented, output based metrics that did not indicate whether the program is successful or demonstrating meaningful progress. These programs revised their performance measures in FY 2006 to capture progress made on the programs' core elements. By focusing on a future outcome, the measure allows for trending of annual progress toward a consistent objective.

In FY 2006, as a follow-up action assigned as part of this assessment, NE contracted with the National Academy of Sciences to conduct an extensive, comprehensive, and independent evaluation of R&D and Infrastructure program goals and plans, including the process for establishing program priorities and oversight. The evaluation resulted in a detailed set of policy and research recommendations and associated priorities for an integrated agenda of research activities to support the long-term commercial energy option to provide diversity in energy supply. A pre-publication version of the report was issued in October 2007; the final report is scheduled for publication in January 2008. NE continues to review the report findings, and is working with OMB to develop a viable strategy for implementing the committee's recommendations.

Basic and Applied R&D Coordination

NE is requesting $55M within R&D for the AFCI to support applied research in advanced mathematics for optimization of complex systems, control theory, and risk assessment. This R&D integration focus area was the subject of workshops sponsored by the Office of Science in August 2006 and December 2006. DOE program activities address advanced math for understanding, controlling, and optimizing complex systems such as the electric grid, novel combustion systems and industrial processes and advanced nuclear reactors. Offices within DOE that will benefit from this research integration effort include the Offices of Energy Efficiency and Renewable Energy, Electricity Delivery and Energy Reliability, and Science.

In addition, NE is requesting $59M within AFCI to support applied research in the characterization of radioactive waste. This R&D integration focus area was the subject of workshops sponsored by the Office of Science in September 2005, July 2006 and August 2006. DOE program activities address critical unanswered scientific questions to facilitate the stabilization, long-term storage, treatment, and ultimate disposal of radioactive waste. Offices within DOE that will benefit from this research integration effort include the Offices of Environmental Management, Civilian Radioactive Waste Management, Legacy Management, and Science.

AFCI R&D is focused on transmutation fuels, separations science and engineering and fast reactor design to support the GNEP vision. As part of its coordination with basic R&D activities conducted by the Office of Science, AFCI R&D is executed as an integrated experimental R&D and simulation effort focused on developing the key capabilities and products required for an advanced fuel cycle.

As part of the advanced mathematics focus area, the program will initiate code groups to develop advanced design and simulation codes in support of the goals of AFCI/GNEP. For example, the work of these groups would include three-dimensional integrated modeling to improve safety, performance, design and construction costs for an advanced burner reactor.

As part of the characterization of radioactive waste focus area, the program is conducting significant R&D activities in spent fuel separations research and development to develop advanced aqueous and electrochemical separations technology alternatives capable of treating spend nuclear fuel in a safe, efficient and proliferation resistant manner. In addition, the program is conducting transmutation R&D to determine methods for lowering the radiotoxicity of SNF.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Advanced mathematics for optimization of complex systems, control theory, and risk assessment[a]			
Office of Nuclear Energy	10,000	19,410	55,000
Characterization of Radioactive Waste[b]			
Office of Nuclear Energy	37,190	53,722	59,000

[a] Includes activities within the Systems Analysis/Advanced Computing and Simulation funding activity within Advanced Fuel Cycle Initiative.
[b] Includes Separations R&D and Transmutation R&D funding activities within Advanced Fuel Cycle Initiative.

Nuclear Power 2010

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Nuclear Power 2010			
Cost-shared Program with Industry	80,166	132,771	241,100
Standby Support Program	125	1,000	500
Total, Nuclear Power 2010	80,291	133,771	241,600

Description

The Nuclear Power 2010 Program (NP 2010) supports near term technology development and regulatory demonstration activities that advance the National Energy Policy (NEP) goals of enhanced long-term U.S. energy independence and reliability through the expanded contribution of nuclear power to the U.S. energy portfolio. Nuclear energy is a large-scale, non-greenhouse gas-emitting energy source that can be expanded to meet growing demand over the next twenty years. Efforts taken with industry to increase the production of nuclear-generated electricity will play an important role in meeting the country's energy and environmental goals.

NP 2010 is a joint government/industry cost-shared effort to identify sites for new nuclear power plants, develop and bring to market advanced standardized nuclear plant designs, demonstrate untested regulatory processes, and evaluate the business case for building new nuclear power plants. These efforts are designed to pave the way for industry decisions to build and operate new, advanced nuclear power plants in the United States.

The deployment of new nuclear plants supports the NEP and the Energy Policy Act of 2005 (EPAct) objectives for energy supply diversity and energy security. With about 20 percent of our Nation's current electricity production generated by nuclear power plants, deploying new baseload, nuclear generating capacity will help maintain nuclear power's contribution to the national electricity production portfolio as the U.S. demand for electricity increases. Projections in the Energy Information Administration's "Annual Energy Outlook 2007" indicate that the United States will need to construct more than 292 gigawatts of new generating capacity by 2030 requiring 3-4 gigawatts per year of new nuclear power be brought on-line beginning in 2015 to maintain 20 percent of the electricity share.

NP2010 seeks to support utility decisions by 2010 to build new nuclear plants. To achieve the objective of new nuclear plant deployment, NP2010 closely cooperates with industry and other government agencies to address the technical, regulatory, and institutional barriers that currently exist. More specifically, these obstacles include the uncertainties associated with new nuclear plant designs and the Federal regulatory and licensing processes and the business risks resulting from these uncertainties. NP 2010 was designed to address these obstacles through partnership with industry.

The FY 2009 budget request continues new nuclear plant licensing and reactor engineering and design activities started in previous years. In FY 2009, the NP 2010 program will cost share the work being performed by industry partners to respond to information requests from the Nuclear Regulatory Commission (NRC) as they advance their review of the two combined Construction and Operating License (COL) applications. Additionally, NP 2010 will continue to cost share the engineering and design activities of the reactor vendors for two Generation III+ advanced, light water reactors including issues related to design certification requests being reviewed by NRC. The scope of work being executed in FY 2009 will achieve progress necessary to maintain the goal of licensing and design certification decisions by NRC in FY 2010 and FY 2011, an industry decision to build in FY 2010, and completion of standardized reactor designs in FY 2011. Successful completion of these activities will lead to deployment of new nuclear plants in the next decade.

NP2010 supports technology development leading to the deployment of Generation III+ advanced, light water reactors, which offer advancements in safety and economics over the Generation III designs certified in the 1990s by the Nuclear Regulatory Commission (NRC). To reduce the regulatory uncertainties and enable the deployment of new Generation III+ nuclear power plants in the United States, it is essential to demonstrate the untested Federal regulatory processes for the siting, construction, and operation of new nuclear plants. In addition, design finalization of two standard plant technologies along with NRC certification is needed to reduce the high initial capital costs of the first new plants so that these advanced technologies can be competitive and deployable within the next decade.

NP2010 partners with industry teams, led by Dominion Energy (Dominion) and NuStart Energy Development, LLC (NuStart), representing power generation companies that operate more than two-thirds of all the U.S. nuclear power plants in operation today. The FY 2009 budget request continues the licensing demonstration activities started in previous years. Activities include continuation of the New Nuclear Plant Licensing Demonstration projects that will exercise the untested licensing process to build and operate a new nuclear plant and will achieve the certification of two advanced Generation III+ advanced reactor designs. Engineering activities in support of the submission of two combined Construction and Operating License (COL) applications to NRC will continue.

In FY2009, first-of-a-kind design activities under NP 2010 project teams led by GE-Hitachi Nuclear Energy Americas (GE-Hitachi) and Westinghouse Electric Company (WEC) will be accelerated for two standard nuclear plants, the Westinghouse AP1000 and the General Electric (GE) Economic Simplified Boiling Water Reactor (ESBWR). The focus in FY 2009 will be on the engineering and design necessary to complete vendor component/equipment procurement specifications and allow the utilities to issue contracts to initiate fabrication of modular plant components and to finalize firm project construction cost and schedule estimates required by the utilities to receive approval for cost recovery through their Public Utility Commissions; commit to build a new nuclear plant; execute Engineering, Procurement, and Construction contracts; and begin loan discussions with financial institutions. These activities ensure that the projects will stay on track to meet deployment schedules in 2010.

As a result of the NP 2010 Program and EPAct 2005 financial incentives, in 2007 four power companies applied to the Nuclear Regulatory Commission for combined COLs, and another 14 companies announced their intentions to apply for COLs over the next two years. These companies will benefit from the work being accomplished under the NP 2010 Program. In FY 2008 and FY 2009, companies that have already announced plans to submit COL applications to NRC will have submitted these applications, most referencing the AP1000 or ESBWR designs supported by the NP 2010 program.

In addition to NP 2010's cost shared efforts, the program includes additional incentives to further mitigate regulatory and financial hurdles faced by utilities outlined in Title VI, Section 638, "Standby Support for Certain Nuclear Plant Delays," of the EPAct 2005, which authorizes the Secretary of Energy to pay covered costs to project sponsors if full power operation of an advanced nuclear facility is delayed by regulatory or litigation occurrences as defined in the final rule for Standby Support. Standby Support is a form of insurance protection from delay in nuclear plant operation beyond the control of the power company owner. The Secretary is authorized to enter into contracts covering a total of six reactors. The Department anticipates that sponsors will submit requests for standby support coverage as soon as FY 2008. When received, the Department will review these requests and enter into conditional agreements with sponsors in advance of executing standby support contracts. In FY 2009, the Department will continue to process Conditional Agreements. Additionally, the Department will be prepared to accept project sponsors' required documentation for Standby Support contracts as such information is finalized by the sponsor. Further, the Department will pursue implementation of other EPAct 2005 related incentives supporting nuclear power.

Detailed Justification

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Cost-shared Program with Industry	**80,166**	**132,771**	**241,100**

To demonstrate the untested regulatory process for obtaining NRC approval for constructing and operating new nuclear power plants, the Department established competitively selected, cost-shared cooperative agreements in FY 2005 with industry to obtain combined COLs. Additionally, the agreements included scope for completion of design certification and standard plant designs for Westinghouse's AP1000 and GE's ESBWR. The submission of the COL applications and the timely responses to inquiries from the NRC review of requests for design certification and the COL applications will demonstrate the progress needed to support an industry decision to deploy in 2010.

In FY 2007, the licensing and engineering activities necessary to complete the preparation of two COL applications were completed and followed by an independent quality review prior to application submission to the NRC early in FY 2008. The Department:

- Continued support of industry to complete the Atomic Safety Licensing Board hearings and issuance of two Early Site Permits by the NRC; the first NRC-approved sites available for building new nuclear power plants in over 25 years.
- Continued preparation of the Dominion and the NuStart COL applications including pre-application licensing interactions with NRC. Initial draft applications underwent an industry peer review process prior to submittal to the NRC.
- Resolved all open items in the ESBWR design certification draft safety evaluation report.
- Completed initial first-of-a-kind engineering (FOAKE) required to prepare COL applications for the ESBWR and AP1000 reactor designs and closed all design certification COL action items.

- Continued design finalization activities for the ESBWR and AP1000 standardized designs, including the engineering analyses and calculations, design criteria documents, and design technical information necessary for an industry decision to purchase new nuclear plants. Design activities achieved in FY 2007 allowed the program to remain on track to support industry completion of standardized reactor designs in 2011.

Successful implementation of these activities in FY 2007 maintained the schedule for an industry decision in 2010 to build a new nuclear power plant.

In FY 2008, the COL project teams (NuStart, Dominion, GE-Hitachi, and WEC) begin working with the NRC staff to resolve COL application questions arising from the NRC staff review. The Department support will:

- Continue industry efforts to obtain the Dominion Early Site Permit.
- Enable submission of the Dominion and NuStart COL applications to NRC in the first quarter of FY 2008.
- Begin interactions with NRC to address questions on the COL applications including development of responses to NRC Requests for Additional Information (RAIs).
- Continue first-of-a-kind design finalization activities for the standardized AP1000 and ESBWR designs and prepare the engineering analyses and calculations, design criteria documents, design technical information, and total cost and schedule necessary for an industry purchase of a new nuclear plant.
- Resolve open items related to the ESBWR design certification to allow NRC to issue completed chapters of the safety evaluation report.

Successful implementation of these activities is necessary to maintain the schedule for an industry decision in 2010 to build a new nuclear power plant.

In FY 2009, the COL project teams (NuStart, Dominion, GE-Hitachi, and WEC) will continue working with the NRC to resolve COL application questions resulting in issuance of Safety Evaluation Reports and Environmental Impact Statements. Reactor vendor activities will focus on accelerated completion of FOAKE for the AP1000 and ESBWR standard plant designs. In addition, GE will be interfacing with NRC to obtain issuance of Safety Evaluation Report (SER) for the design certification document and the Final Design Approval for the ESBWR. Westinghouse will interface with NRC to obtain approval of the revised AP1000 design certification.

The Department support will:

- Continue industry interactions with NRC on the COL applications including responses to NRC RAIs, meetings with the Advisory Committee on Reactor Safety, and issuance of Safety Evaluation Reports and Final Environmental Impact Statements.
- Continue first-of-a-kind design finalization activities for the standardized AP1000 and ESBWR

(dollars in thousands)

designs and preparation of the engineering analyses and calculations, design criteria documents, and design technical information.

- Accelerate design finalization activities necessary to complete vendor component/equipment procurement specifications and allow the utilities to issue contracts to initiate fabrication of modular plant components and other long lead equipment. Initiate additional FOAKE and design details to increase standardization of component design, selection, and qualification and formulate training and procedure programs.
- Lower the risk of new plant construction by ensuring better price stability and cost control resulting in power company decisions to execute Engineering, Procurement, and Construction contracts.
- Resolve open ESBWR certification items to allow the NRC to issue the Final Design Approval and initiate the design certification rulemaking. Support NRC issuance of final SER for design certification.

Successful implementation of these activities is necessary to maintain the schedule for an industry decision in 2010 to build a new nuclear power plant.

	FY 2007	FY 2008	FY 2009
Standby Support Program	**125**	**1,000**	**500**

The Energy Policy Act of 2005 authorizes the Secretary to provide standby support contracts for up to six new advanced nuclear reactors.

In FY 2007, the Department:

- Developed the process and criteria under which the Department would accept and approve requests for conditional agreements between the Department and project sponsors that will convert to standby support contracts once plant construction has commenced. The Department contracted with subject matter experts to assist in the development of financial guidance and estimates of standby support contracts.

In FY 2008, the Department will:

- Receive and review requests for conditional agreements from sponsors of new nuclear power plants as well as develop estimated costs of each request using financial and technical subject matter experts.
- Support initiatives addressing other EPAct 2005 incentives for advanced nuclear energy facilities.

In FY 2009, the Department will:

- Complete review of application requests and issue conditional agreements for standby support.
- Begin to receive and review required documentation for standby support contracts.
- Continue to support initiatives addressing other EPAct 2005 incentives for advanced nuclear energy facilities.

	FY 2007	FY 2008	FY 2009
Total, Nuclear Power 2010	**80,291**	**133,771**	**241,600**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Cost-shared Program with Industry The increase from $132,771,000 to $241,100,000 is needed to maintain the overall NP 2010 schedule to complete the reactor design certifications and continue licensing interactions with NRC to support utility decisions by 2010 to build new nuclear plants. Funds support the licensing activities focused on design and engineering activities, including increased interactions between NRC and the power companies and reactor vendors to resolve outstanding issues. The increase further supports the acceleration of FOAKE to support long-lead procurement, decisions by state regulators, and construction decisions in support of 2015 operation, as well as, additional FOAKE and design details needed to develop and design construction-level modularization plans; increase standardization of component design, selection, and qualification; and formulate training and procedure programs. In addition, this funding will drive risks of new plant construction lower ensuring better price stability and cost control thus providing a more sound basis upon which an industry decision to build can be made and potentially accelerating that decision up to a year.	+108,329
Standby Support Program The decrease from $1,000,000 to $500,000 is due to the reduction of program activities resulting from the transition from the evaluation of requests for conditional agreements with support of subject matter experts to review of supporting documentation.	-500
Total Funding Change, Nuclear Power 2010	**+107,829**

Generation IV Nuclear Energy Systems Initiative

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Generation IV Nuclear Energy Systems Initiative			
Generation IV R&D	7,799	0	9,750
Next Generation Nuclear Plant R&D	26,415	114,092	59,500
International Nuclear Energy Research Initiative (I-NERI)	1,000	0	0
SBIR/STTR	0	825	750
Total, Generation IV Nuclear Energy Systems Initiative	35,214	114,917	70,000

Description

The President's National Energy Policy and the Energy Policy Act of 2005 (EPAct) acknowledge the potential for nuclear energy to help meet our nation's growing need for safe, reliable, and environmentally responsible energy supply. The goal of the Generation IV (Gen IV) Nuclear Energy Systems Initiative is to address the fundamental research and development (R&D) issues necessary to establish the viability of next-generation nuclear energy system concepts and investigate the application of the R&D results to extend the operating life of existing light water reactors (LWR). Successfully addressing the fundamental R&D issues of Gen IV concepts that excel in safety, sustainability, cost-effectiveness, and proliferation-resistance, will allow these advanced reactor concepts to be considered for future commercial development and deployment by the private sector. Specific international benchmarking methodologies are being developed to enable the critical evaluation of each Gen IV concepts' relative merits. This includes the development of an economics evaluation and modeling of proliferation resistance and physical protection.

The Generation IV Nuclear Energy Systems Initiative has two R&D elements: Gen IV R&D and Next Generation Nuclear Plant (NGNP) R&D. Gen IV R&D is aimed at readying technologies that will further improve the economic and safety performance of existing LWR and advanced Gen IV reactor concepts. The Gen IV R&D is specifically focused on component and material aging and degradation resulting from long-term operation in the harsh nuclear environment (temperature, chemistry, and radiation). Results of this research will directly benefit existing nuclear plants by enabling the extension of their current operating licensing period. It will also enable the design of advanced reactor concept plants with a longer operating life. NGNP R&D is a very-high temperature reactor (VHTR) research, design, and demonstration program that will establish the commercial potential of gas reactors as a provider of process heat for industrial applications. The Nuclear Hydrogen Initiative (treated under a separate line in the budget) is working closely with NGNP R&D to develop technologies that will apply high temperature process heat and/or electricity from next generation nuclear energy systems to produce hydrogen at a cost competitive with other alternative transportation fuels.

The Department's strategic plan lays the groundwork of an ambitious, long-term vision for a zero-emission future that is free from the reliance on imported energy. To realize this vision, the Department administers a portfolio of nuclear research programs to support near term deployable reactor technologies and, for the longer-term, advanced reactor and fuel cycle management technologies.

Gen IV Nuclear Energy Systems Initiative activities have potential benefits that cut across the full range of the NE R&D portfolio. These include pioneering the use of risk-informed reactor licensing and developing advanced systems to measure accurately system-operating parameters for use in multiple reactor types. The principle focus of Gen IV Nuclear Energy Systems Initiative is to develop next-generation gas reactor technologies that can contribute to meeting the President's Advanced Energy Initiative and compete economically with advanced fossil and renewable technologies, enabling power providers to select from a diverse group of options that are economical, reliable, safe, secure, and environmentally acceptable.

Overall, Gen IV concepts are being developed to use high-burnup fuel, transmutation fuel, and recycled fuel. Such fuel cycle strategies allow for efficient utilization of domestic uranium resources and minimization of waste generation. Proliferation resistance and physical protection improvements are being designed into Gen IV concepts to help thwart those who would target nuclear power plants for terrorist acts or use them improperly to develop materials for nuclear weapons. Gen IV concepts will feature advances in safety to improve public confidence in the safety of nuclear energy while providing enhanced investment protection for plant owners. Competitive life-cycle costs and acceptable financial risk are being factored into Gen IV concepts with high-efficiency electricity generation systems, modular construction, and shortened development schedules before plant startup.

The FY 2009 budget request continues critical gas reactor R&D that will help achieve desired goals of sustainability, economics, and proliferation resistance to ready the technology for commercial deployment in the 2030 timeframe. In FY 2009, Gen IV R&D focuses specifically on component and material aging and degradation where results will directly benefit existing nuclear plants by extending their current operating licensing period and designing advanced reactor concept plants with a longer operating life.

Continued investigation of technical and economical challenges and risks are needed to support NGNP design and licensing basis development. In FY 2009, NGNP R&D includes broader activities conducted in support of the VHTR concept and benchmarking methodologies in conjunction with the Generation IV International Forum (GIF). Successful completion of these activities is necessary to support the 2011 decision to proceed with the demonstration of an NGNP by 2021, as directed by EPAct. Key to the strategy for conducting R&D under the Gen IV Nuclear Energy Systems Initiative is the multiplication effect on investment derived from international collaboration. By coordinating U.S. efforts with those of the GIF partner nations, our funding is leveraged by a factor of two to ten, depending on the reactor concept involved.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Generation IV R&D	**7,799**	**0**	**9,750**

Gen IV R&D activities are aimed at long-term technology advances to further improve the safety performance and lower production costs of advanced reactor concepts for potential commercial deployment in the 2030 timeframe. In addition, the program is undertaking component and material aging and degradation activities that will help provide the basis for supporting the extension of the current operating licensing period for existing nuclear reactors, and will enable the design of advanced reactor concept plants with longer operating life spans.

In FY 2007, the Gen IV program focused on developing the SFR and VHTR reactor technologies that support GNEP and NGNP, respectively. Beginning in FY 2008, long-term VHTR technologies are funded as a part of Next Generation Nuclear Plant (NGNP) R&D and long-term SFR activities are funded as a part of the AFCI.

The VHTR concept features a helium-cooled reactor with excellent passive safety features. The VHTR uses a coated-particle fuel form that can withstand extreme temperatures (up to about 1600ºC) while maintaining its fission product inventory. This makes the VHTR uniquely capable of delivering high-temperature heat (up to 1000ºC) to industrial processes, including innovative efficient hydrogen production processes. A number of GIF partner countries are cooperating with the U.S. to accelerate the design of a prototype reactor. The GIF System Arrangement for the VHTR was signed in November 2006 by Canada, Euratom, France, Japan, Korea, Switzerland, and the U.S. The Republic of South Africa is conducting its internal ratification process. Second-tier implementing arrangements on Hydrogen Production and Fuels under the GIF VHTR System Arrangement were signed in 2007 and the VHTR Materials Project Arrangement is scheduled for signature in 2008. The use of liquid salt as a cooling mechanism is also being examined in conjunction with the VHTR under a novel concept known as the Advanced High-Temperature Reactor (AHTR) due to its potential advantages in economics over the helium-cooled VHTR. In FY 2007, the Department:

- Conducted cost-share research in GIF VHTR Projects for Design, Safety, and Integration; Computational Methods and Benchmarks; Materials; and Fuel and Fuel Cycle.
- Initiated collaborative project with France on composite materials for VHTR control rod structures.
- Initiated collaborative project with France and the Republic of Korea on mechanical and corrosion testing of nickel-based alloys for VHTR applications.
- Conducted, in cooperation with France and the Republic of Korea, thermal-hydraulic analyses and experiments for VHTR safety.
- Continued collaboration with Japan on zirconium-carbide fuel particle coatings.
- Continued pre-conceptual design studies on prismatic-core and pebble-bed versions of the AHTR to establish the concept's viability and advantages.
- Co-chaired the GIF VHTR Steering Committee and contributed to the joint GIF VHTR R&D Plans.

Successful completion of activities in FY 2007 furthered knowledge of the VHTR reactor technology, substantively contributing to an enhanced understanding of the safety, economics and proliferation challenges and risks associated with this reactor technology. In FY 2008 and FY 2009, the VHTR activities are funded under NGNP R&D. See NGNP R&D section for information on VHTR FY 2008 and FY 2009 activities.

The SFR concept features a fast-spectrum reactor capable of spent fuel recycling. The primary mission for the SFR is the management of high-level wastes and, in particular, management of plutonium and other actinides. The U.S. participates in long-term SFR R&D activities with the objective of developing a medium-sized (~600 MWe) SFR with the flexibility to consume transuranic actinides (TRUs). The primary system operates at essentially atmospheric pressure. A secondary sodium system acts as a buffer between the radioactive sodium in the primary system and the energy conversion system in the power plant. The GIF System Arrangement for the SFR was signed in February 2006 by France, Japan, the Republic of Korea, and the U.S.; Euratom acceded in November 2006. The first second-tier implementing arrangement, the SFR Project Arrangement for Advanced Fuels, was signed in early FY 2007, followed by the Project for Component Design and Balance of Plant (BOP) and the Project for Global Actinide Cycle International Demonstration in late 2007.

In FY 2007, the Department:

- Continued test irradiations of coupons of various metallic and composite materials in collaboration with France under the FUTURIX SMI program.
- Initiated development of ODS steels for high-temperature and long-life service as SFR structural materials, in collaboration with France, under the materials crosscut activities.
- Conducted a series of tests on a bench-scale Brayton cycle turbine-generator with helium at nominal pressures as the working fluid, to obtain experience with Brayton-cycle machinery behavior and validate computational methods.
- Issued a contract with a commercial vendor for design of a bench-scale (~1 megawatt) closed-loop Brayton-cycle turbine-compressor system using supercritical carbon dioxide as the working fluid.
- Developed computational methods to analyze the system behavior near the carbon dioxide critical point and to develop appropriate control methods.
- Co-chaired the GIF SFR Steering Committee and authored a rewrite of the joint GIF R&D Plan for the SFR.

Successful completion of activities in FY 2007 furthered knowledge of the SFR reactor technology, substantively contributing to an enhanced understanding of the safety, economics and proliferation challenges and risks associated with this reactor technology. In FY 2008 and FY 2009, the SFR activities are funded under the AFCI. See AFCI request for information on SFR FY 2008 and FY 2009 activities.

In FY 2007, Gen IV R&D also continued to monitor international R&D activities on the Lead-Cooled Fast Reactor, Gas-Cooled Fast Reactor, and Supercritical-Water-Cooled Reactor, and collaborate with GIF partner nations in areas that may be advantageous to the United States. These reactor technologies are discussed below:

Lead-Cooled Fast Reactor: The Lead-Cooled Fast Reactor (LFR) concept is a lead (Pb) or lead-bismuth-eutectic (LBE) cooled small modular reactor with a closed fuel cycle. The design features a long-lived core (15-30 years) replaceable as an integral unit with vessel and coolant for high proliferation resistance. The LFR will utilize the advantages of lead or LBE coolant to achieve high core outlet temperatures, which will allow realization of high system efficiency. The reactor will accommodate a closed fuel cycle while ensuring substantial proliferation resistance by limiting access to fuel and associated fuel handling infrastructure. GIF partner countries including EURATOM, Japan, Switzerland, and Korea have expressed interest in exploring this concept in cooperation with the United States.

In FY 2007, LFR activities were focused on:

- Monitoring international R&D, participation in GIF LFR forums, and completion of bilateral collaboration projects with Euratom and Korea.
- Completed the preliminary concept design of the LFR reactor and associated systems. This includes analyses to ensure that the systems meet design objectives of 15-30 year core refueling intervals for enhanced proliferation resistance, natural circulation, and other passive safety features and autonomous load-following.

Gas-Cooled Fast Reactor: The Gas-Cooled Fast Reactor (GFR) system features a fast-spectrum, helium-cooled reactor and closed fuel cycle as the reference concept. The GFR uses a direct-cycle helium turbine for highly efficient electricity production. An alternate GFR concept, which uses supercritical carbon dioxide as the coolant, may offer similar high efficiency while maintaining lower coolant temperatures. The GFR's fast neutron spectrum makes it possible to utilize available fissile and fertile materials (including depleted uranium from enrichment plants) several orders of magnitude more efficiently than thermal-spectrum gas reactors with once-through fuel cycles. Furthermore, through the combination of a fast neutron spectrum and full recycle of actinides, GFRs minimize the production of long-lived radioactive waste isotopes and can be designed for management of minor-actinides in spent fuel. Interest for the GFR is high in GIF member countries EURATOM, France, Japan, Korea, South Africa, and the U.K.

In FY 2007, GFR activities were focused on:

- Monitoring international R&D and participation in GIF GFR forums.
- Continued preliminary concept design of GFR forced natural circulation decay heat cooling system.

Supercritical-Water-Cooled Reactor: The Supercritical-Water-Cooled Reactor (SCWR) concept is a high-temperature, high-pressure water-cooled reactor that operates above the thermodynamic critical point of water. The system may have a thermal or fast neutron spectrum depending upon the core design. The SCWR holds the potential for significant advantages compared to existing water-cooled reactors. The advantages are due to greater thermal efficiency, lower coolant mass flow rate per unit of core thermal power, elimination of discontinuous heat transfer regimes within the core, and the elimination of steam dryers, steam separators, re-circulation pumps, as well as steam generators.

Therefore, the SCWR will be a simpler plant with fewer major components and better economics. There is strong international interest in the SCWR within the GIF from Canada, EURATOM, Japan, and Korea.

In FY 2007, SCWR activities were focused on:

- Monitoring international R&D and participating in GIF SCWR forums.

Successful completion of activities in FY 2007 furthered knowledge of the LFR, GFR, and SCWR reactor technologies, contributing to an enhanced understanding of the safety, economics and proliferation challenges and risks associated with these reactor technologies. No funds were provided for LFR, GFR and SCWR activities in FY 2008. No funds for these activities are requested in FY 2009, as the focus of the GenIV R&D program is shifting to component and material aging and degradation (discussed below).

In the past, crosscutting research activities, were conducted where results will have applicability to two or more of the Gen IV concepts. In FY 2007, Gen IV crosscutting technology activities focused on:

- Completing the organization, data base structure, software, and web-enabled user interface of the *Generation IV Materials Handbook*, started the initial materials data population with historical data and new data developed in the Gen IV Program, and persuaded the international GIF community to adopt the *Generation IV Materials Handbook* as the preferred materials database vehicle for all GIF-generated data.
- Completing, in collaboration with GIF partners, *GIF Cost Estimating Guidelines version 3* with associated software (G4ECONS) to provide a standardized methodology for estimating capital cost and life-cycle cost of nuclear energy systems.
- Completing, in collaboration with GIF partners, *Evaluation Methodology for Proliferation Resistance and Physical Protection of Generation IV Nuclear Energy Systems version 5.*
- Providing critical Secretariat and meeting facilitation support for three GIF Policy Group and three GIF Expert Group meetings.
- Represented the U.S. at Steering Committee meetings of the IAEA International Project for Innovative Reactors and Fuel Cycles (INPRO), provided extra-budgetary funding for INPRO's Common User Criteria initiative, and provided a U.S. cost-free expert to the IAEA in support of INPRO.

Successful completion of crosscutting R&D activities in FY 2007 contributed to an enhanced understanding of the safety, economics and proliferation challenges and risks associated with GenIV reactor technologies, and increased the usability of information derived from R&D activities. In FY 2008 and FY 2009, crosscutting areas supportive of gas reactor technology and secretariat support for GIF Policy and Expert Groups are funded under NGNP R&D. See NGNP R&D section for information on GIF Policy and Expert Groups FY 2008 and FY 2009 activities.

Beginning in FY 2009, Gen IV R&D will focus specifically on component and material aging and degradation where results will directly benefit existing nuclear plants by extending their current operating licensing period and designing advanced reactor concept plants with a longer operating life. Previously, Gen IV R&D included monitoring and participation in international R&D activities on fast-spectrum reactors that are cooled by lead or helium, and thermal-spectrum reactors cooled by liquids slats. The development of benchmarking methodologies (economics, proliferation resistance and physical protection, and reactor safety) and GIF technical and policy development support will continue under NGNP R&D.

In all nuclear plant systems, component, structures and reactor vessel materials undergo aging and other degradation as a result of thermal, mechanical, chemical, and environmental stress factors in conjunction with radiation-induced damage. This research will develop the scientific basis for understanding and managing materials aging by addressing the fundamental issues through tests, experiments, and analyses. Accordingly, the materials activities fall into the following categories:

- ***Materials for Radiation Service:*** The performance of component, structural, and reactor vessel materials is limited by the degradation of physical and mechanical properties as a result of exposure to energetic neutrons, high temperatures conditions, or by the exposure to the chemical environment provided by the primary coolant medium. These material performance issues continue to emerge as nuclear plants age and challenge the extension of plant life beyond 60 years. This research would address aging and degradation failure mechanisms in irreplaceable civil structures, such as containment tendons and concrete at elevated service temperatures, as well as cabling and underground piping in plants past 60 years. It would also investigate and understand the many potential environmental precursors of degradation. Combining the evaluation of materials as a function of neutron exposure offers an opportunity for addressing the development and qualification of materials for multiple systems within a coordinated set of irradiation experiments. The long-term, low-dose irradiation of reactor vessel steels is a key program element for extending the vessel life beyond 60 years. This program will seek to obtain data and material samples of decommissioned irradiated reactor vessel for advanced aging and neutron embrittlement experiments. This understanding would support mechanism-based component life predictions for critical structures, systems, and components and reduce the uncertainty in component life predictions. It would also provide drivers and insights for developing components with longer life, or for possibly pursuing life extension methods such as pressure vessel annealing.
- ***Development of Microstructure-Properties Models:*** The development and evolution of the fundamental microstructural features that establish materials performance need to be understood to further improve material performance and/or ensure the very long operational life envisioned for current and new reactor systems. This will require a combination of theory and modeling activities tied to detailed microstructural characterization and mechanical property measurements. The models must be developed using the best current materials science practices in order to provide a sound basis for interpolating and extrapolating materials performance beyond experimental databases, as well as providing the fundamental understanding needed to make designed changes in material compositions and processing to achieve improved properties.
- ***Materials for High-Temperature Service:*** Although the operating conditions vary significantly from one reactor system to the next, analysis indicates that significant commonality exists with regard to the selection of materials for their high-temperature structural components. Even though many of the materials required for construction of high-temperature, out-of-core components are the same as those used for some in-core applications, the focus of this crosscutting technology

(dollars in thousands)

development task will be on their unirradiated, high-temperature qualification. Short-term tensile and fatigue properties will be evaluated for these materials. Time-dependent creep and creep-fatigue will also be addressed since they are the primary limitations for materials use.

In FY 2009, the Department will:

- Initiate laboratory and industry cost-shared research projects on material and component aging and degradation focused on fuel clad failures, structural and reactor vessel materials that challenge nuclear plant operations beyond 60 years. These efforts would also re-establish a long-term, low-irradiation reactor vessel program.

Successful completion of activities in FY 2009 will establish a foundation for work in subsequent years that will ultimately help provide the basis for supporting the extension of the current operating licensing period for existing nuclear reactors, and will enable the design of advanced reactor concept plants with longer operating life spans.

	FY 2007	FY 2008	FY 2009
Next Generation Nuclear Plant R&D	**26,415**	**114,092**	**59,500**

The Department's NGNP R&D program is focused on critical path needs that will inform a Secretarial decision on the future of the project no later than 2011 as called for in the Energy Policy Act of 2005 (EPAct). Key considerations include the availability of a licensable fuel for the reactor, design of high project-risk components, such as the heat exchanger between the reactor and the hydrogen production plant, and qualification of nuclear grades of graphite for use in the reactor. In order to prepare for the 2011 Secretarial decision on whether to proceed on to final design and construction activities, the program is conducting activities related to licensing, design, fuel development, and materials qualification. The scope of work for the design activities include descriptions of the reactor, hydrogen production and electricity generation systems, the integrated plant layout, details on design selection rationale, cost and schedule forecasts, and R&D needs for producing a demonstration reactor.

The Department is working closely with both the international community and the U.S. private sector to continue R&D on the NGNP. The Department is engaging the international community via GIF and bilateral agreements pioneered under I-NERI. The Department is optimistic about potential collaborations with countries, such as Canada, France, Japan, the Republic of South Africa, Switzerland, the Republic of Korea, and the European Union. The Department is working with the U.S. private sector to establish industrial requirements, produce design information for the NGNP, and explore potential public-private partnerships to advance the project.

In FY 2007, the Department:

- Completed a draft of the NGNP licensing strategy in collaboration with the U.S. Nuclear Regulatory Commission (NRC) as directed in the EPAct 2005.
- Competitively selected three industry teams comprised of 26 domestic and foreign engineering companies to develop pre-conceptual designs of the NGNP. A conceptual design specification was developed by Idaho National Laboratory (INL) based on the results of the three pre-conceptual designs.
- Worked with industry to build a substantial community to help guide our R&D investments. Companies involved with NGNP include representatives from the petrochemical and utility businesses, as well as, traditional nuclear reactor vendors, component suppliers, and design/construction firms.
- Commenced irradiation testing, in the Advanced Test Reactor (ATR), of the first fuel specimens in a state-of-the-art, multi-cell capsule, and test train to provide shakedown test information for NGNP fuel.
- Continued the support of industry code committees in qualifying high-temperature materials and analytical methods.
- Completed the design and constructed mock-ups for testing graphite material properties (creep) inside the ATR.
- Completed pre-conceptual design studies for the NGNP that define NGNP plant layout, key design parameters, and additional R&D needs.
- Conducted a study to identify the fueling options for the NGNP, including foreign and domestic manufacturer readiness and their ability to obtain a NRC manufacturing license.

Successful completion of activities in FY 2007 supports the program's scheduled 2011 selection of functional and operational design requirements of the NGNP in accordance with the Energy Policy Act of 2005.

In FY 2008 and FY 2009, the Department will be conducting conceptual design activities that focus on high project-risk systems and components. Beginning in FY 2008, longer term R&D associated with the very-high temperature reactor (VHTR) will be funded under NGNP R&D, as well as, those activities associated with the development of benchmarking methodologies (economics, proliferation resistance and physical protection, and reactor safety) and GIF technical and policy development support.

In FY 2008, the Department is:

- Completing the joint development of the NGNP Licensing Strategy with the NRC and submitting the strategy to Congress as required by EPAct 2005.
- Continuing the irradiation of the first NGNP fuel tests in the ATR.
- Completing the fabrication and characterization of low enriched uranium UO2 coated particles for the second in-reactor fuel test for NGNP.
- Incorporating the findings from the fuel trade study conducted in FY 2007 into the NGNP fuels research plan.

- Continuing the support of industry code committees in qualifying high-temperature materials and analytical methods.
- Pursing benchmarked analyses of pebble-bed and prismatic cores for both physics and heat transport.
- Initiating conceptual design activities aimed at high project-risk systems and components.
- Completing the assembly of the graphite creep test apparatus.
- Conducting cost-shared research in GIF VHTR Projects for Design, Safety, and Integration; Computational Methods and Benchmarks; Materials; and Fuel and Fuel Cycle.
- Continuing international collaborative projects on composites, and high-temperature metallic materials testing, thermal-hydraulic analyses and experiments, and zirconium-carbide fuel particle coatings.
- Continue development benchmarking methodologies (economics, proliferation resistance and physical protection, and reactor safety).
- Co-chairing the GIF VHTR Steering Committee and providing critical GIF Secretariat and meeting facilitation support for two GIF Policy Group and two GIF Expert Group meetings.
- Support for two Congressionally Directed Projects – $1,000 for CVD single –crystal diamond optical switch (MD); and $3,000 for Technology Transfer Activities (NM).

Successful completion of these activities in FY 2008 will support the program's scheduled 2011 selection of functional and operational design requirements of the NGNP in accordance with the Energy Policy Act of 2005.

In FY 2009, the Department will:

- Complete the irradiation of the first NGNP fuel tests in the ATR.
- Continue conceptual design activities for high project-risk systems and components.
- Negotiate with industry an agreement on cooperative development of NGNP.
- Continue analytical method and code development for benchmarking pebble-bed and prismatic cores in both physics and heat transport.
- Continue the support of industry code committees in qualifying high-temperature materials and analytical methods.
- Complete the design of the test train for simulating severe fuel damage.
- Work with the NRC to resolve regulatory uncertainties for gas reactors.
- Conduct cost-shared research in GIF VHTR Projects for Design, Safety, and Integration; Computational Methods and Benchmarks; Materials; and Fuel and Fuel Cycle.

(dollars in thousands)

- Continue international collaborative projects on composites, and high-temperature metallic materials testing, thermal-hydraulic analyses and experiments, and zirconium-carbide fuel particle coatings.
- Continue development benchmarking methodologies (economics, proliferation resistance and physical protection, and reactor safety).
- Co-chair the GIF VHTR Steering Committee and providing critical Secretariat and meeting facilitation support for two GIF Policy Group and two GIF Expert Group meetings.
- Maintain the *Generation IV Materials Handbook* and arrange for other GIF organizations to share existing data and new materials data developed in the Gen IV Program.

Successful completion of these activities in FY 2009 will support the program's scheduled 2011 selection of functional and operational design requirements of the NGNP in accordance with the Energy Policy Act of 2005.

A significant amount of NGNP R&D activities are conducted in partnership with United States' university research community in part through the use of NERI grants. Competitive solicitations for NERI research include key research components for the NGNP. NERI will continue to be executed using independent peer reviews critical to ensuring the pursuit of leading edge technologies.

	FY 2007	FY 2008	FY 2009
International Nuclear Energy Research Initiative (I-NERI)	**1,000**	**0**	**0**

The Generation IV Technology Roadmap identifies near-term reactor concepts being investigated by the international research community that have relevancy to U.S. technology needs. These International Near-Term Deployment (INTD) concepts identified by Nuclear Energy Research Advisory Council and GIF allow the U.S. to engage the international community in bi-lateral fashion beyond the six Gen IV concepts. International, cost-shared R&D enhances the Department's ability to leverage its limited research funding with nuclear technology research funding from other countries, while also providing the U.S. greater credibility and influence in international activities associated with the application of nuclear technologies. The Department currently has in place bilateral I-NERI agreements with France, the Republic of Korea, Organization for Economic Co-operation and Development Nuclear Energy Agency, the European Union, Canada, Brazil, and Japan. Negotiations to establish new bilateral agreements are underway with the Republic of South Africa and the United Kingdom.

In FY 2007, the Department used the requested funding to complete INTD R&D projects initiated in FY 2005.

No funds are requested in FY 2008 and FY 2009.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**825**	**750**

The FY 2007 and FY 2008 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

	FY 2007	FY 2008	FY 2009
Total, Generation IV Nuclear Energy Systems Initiative	**35,214**	**114,917**	**70,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Generation IV R&D The increase from $0 to $9,750,000 is focused on component and material aging and degradation, where results will have applicability to existing light water reactors and advanced reactor concepts.	+9,750
Next Generation Nuclear Plant R&D The decrease from $114,092,000 to $59,500,000 reflects elimination of $9,000,000 for Russian gas reactor work, elimination of $7,000,000 on deep burn characteristics of gas-cooled reactors, and a refined focus on critical R&D as informed by design activities conducted in FY 2007 and FY 2008.	-54,592
SBIR/STTR The decrease from $825,000 to $750,000 reflects a more accurate accounting of R&D expenditures subject to SBIR and STTR.	-75
Total Funding Change, Generation IV Nuclear Energy Systems Initiative	**-44,917**

Nuclear Hydrogen Initiative

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Nuclear Hydrogen Initiative			
Nuclear Hydrogen Initiative	18,855	9,632	16,135
SBIR/STTR	0	277	465
Total, Nuclear Hydrogen Initiative	18,855	9,909	16,600

Description

The Nuclear Hydrogen Initiative (NHI) will support the future production of hydrogen for commercial applications by conducting research and development (R&D) of enabling technologies, demonstrating nuclear-based hydrogen production technologies, and studying potential hydrogen production strategies. The objective of the NHI is to develop technologies that will apply heat and/or electricity from next generation nuclear energy systems to produce hydrogen at a cost competitive with other alternative transportation fuels. The Next Generation Nuclear Plant (NGNP), a High-Temperature Gas Reactor concept being developed as part of the Generation IV Nuclear Energy Systems Initiative (Gen IV), is being coordinated and optimized to work with the hydrogen generation technologies developed under NHI. Hydrogen is an essential ingredient in many energy production and chemical industries. It is currently produced using natural gas, which is a costly and often imported fuel source. Hydrogen is used in oil refining, coal liquifaction, bio-fuel production, and many other applications. Hydrogen may also be used in the future directly as a transportation fuel, however, its importance to existing industry is sufficient justification for developing and assisting industry in demonstrating the technology required to efficiently produce hydrogen using a nuclear heat source.

United States (U.S.) climate change policy is focused on reducing the greenhouse gas (GHG) intensity of the U.S. economy. The transportation sector is one of the largest contributors to GHG emissions. Hydrogen is the most promising greenhouse gas-free fuel for use in transportation. Hydrogen may also be used to boost the energy value of existing fossil fuels, making them burn much cleaner, and in the recovery of liquid fuels from our vast domestic resources of coal, tar oil sands, and oil shale. Currently, the only economical, large-scale method of hydrogen production involves the conversion of methane into hydrogen through a steam reforming process. This process produces ten kilograms of GHG for every kilogram of hydrogen, defeating a primary advantage of using hydrogen—its environmental benefits. Another existing method, conventional electrolysis, converts water into hydrogen using electricity. Conventional electrolysis is typically used for small production quantities and is inherently less efficient because electricity must first be produced to run the equipment used to convert the water into hydrogen. The NHI is developing processes that couple with advanced nuclear reactors for highly-efficient, large-scale production of hydrogen without emission of GHG.

The FY 2009 budget request continues integrated laboratory-scale (ILS) experiments begun in FY 2008 on two baseline nuclear hydrogen production technologies. It also completes the design of an ILS experiment for the Hybrid Sulfur thermochemical cycle. These experiments are being conducted in order to provide the necessary information needed to make a recommendation of the hydrogen production technology to be coupled with the NGNP as required by the Energy Policy Act of 2005 (EPAct 2005). Additional NHI activities planned in FY 2009 are targeted at improving the efficiency and economics of advanced, high temperature hydrogen production technologies. Successful completion of these activities will represent tangible progress toward demonstrating nuclear hydrogen production at a cost competitive with other hydrogen production technologies.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Nuclear Hydrogen Initiative	**18,855**	**9,632**	**16,135**

The program focuses on R&D activities associated with thermochemical and high-temperature electrolysis processes designed to demonstrate the viability of using heat and/or electricity from various advanced reactors being researched by the Gen IV, with the goal of producing hydrogen at a price that is cost competitive with other alternative fuels. Much of the program's focus is vested in the most promising technologies—the Sulfur-Iodine (S-I) and Hybrid Sulfur thermochemical cycles and high-temperature electrolysis. The objective of this program is to demonstrate the technologies at increasingly larger scales, culminating in a demonstration of an industrial-scale hydrogen production process that would be technically and economically suited for commercial deployment. FY 2007 activities focused on the final design and construction of integrated laboratory-scale experiments. In FY 2008 and FY 2009, these experiments will be operated to validate closed-cycle operations and evaluate long-term performance of components and materials. Based on the outcomes of the integrated laboratory-scale experiments, a technology down select to the most promising technology for a pilot-scale experiment will be made by 2011, with construction of a pilot-scale experiment by 2013, and a commercial-scale demonstration by 2019.

Based on their level of technical maturity, the sulfur family of thermochemical cycles (S-I and Hybrid Sulfur) and high-temperature electrolysis are considered "baseline" processes and have the highest R&D priority. Operation of integrated laboratory-scale experiments on an S-I thermochemical system in FY 2008 will be used to confirm the technical and economic viability of the chosen materials. To better leverage this research and increase the probability of achieving the program schedule and objective, the Hybrid Sulfur cycle will also be investigated. An integrated laboratory-scale High-temperature electroloysis (HTE) experiment with one 240-cell module was first operated at the end of FY 2007. The experiment will be operated in FY 2008 and FY 2009 with the addition of two more electrolyzer modules for a total of 720 cells.

NHI R&D activities will be conducted through several vehicles including international collaborations via the Gen IV International Forum and bilateral agreements pioneered under the International Nuclear Energy Research Initiative and domestically via the national laboratories. Program reviews are conducted as a part of the planning and evaluation process and as a part of DOE's Hydrogen Program Annual Merit Review. Additional reviews will be performed in conjunction with the Hydrogen Technical and Fuel Cell Advisory Committee established under Section 807 of the EPAct 2005.

As described above, near-term activities are focused on constructing and operating integrated laboratory-scale thermochemical and high-temperature electrolysis hydrogen production systems.

In FY 2007, the Department prepared for integrated laboratory-scale system experiments for the two technologies and performed the following activities:

- Completed assembly of integrated laboratory-scale S-I thermochemical system and pre-operational testing consisting of system operation using water as a surrogate fluid.
- Completed initial longevity testing for materials for pilot-scale, sulfur-based thermochemical process equipment.
- Developed and tested electrolyzer membranes for Hybrid Sulfur thermochemical process.
- Conducted component reaction tests and completed a down select process to the two most promising alternative cycles.
- Completed assembly and pre-operational testing of integrated laboratory-scale HTE system consisting of verification of individual component performance.
- Started feasibility studies, which had been awarded at the end of FY 2006, to determine whether the use of existing nuclear power plants is a cost-effective means of producing hydrogen.
- Incorporated materials and heat exchanger test data into the system interface model for integrating nuclear and hydrogen plants.
- Performed laboratory-scale tests on heat exchangers and materials.

Successful achievement of these activities significantly contributes to the program's 2011 selection of a technology that will be demonstrated in a pilot scale hydrogen production project, scheduled for 2013. This technology may also be employed in the demonstration of the next generation nuclear power plant.

In FY 2008, the Department will begin testing of integrated laboratory-scale experiments and perform the following:

- Conduct integrated laboratory-scale experiments on S-I thermochemical system to confirm the technical viability of the integrated system.
- Conduct tests of multi-cell electrolyzers for the Hybrid Sulfur thermochemical cycle.
- Operate solid oxide electrolysis cell stacks at prototypic temperatures (750 – 900 C) to confirm efficiency and demonstrate cell sealing and interconnect technologies.
- Conduct HTE integrated laboratory-scale experiment operation consisting of three 240-cell modules at 5 kWe power level each and 15 kWe total.

Successful achievement of these integrated tests and research on membranes, catalyst and materials performed in FY 2008 will be used to inform the 2011 selection of a hydrogen technology that will be demonstrated in a pilot scale project, scheduled for 2013.

In FY 2009, the Department will:

- Continue operation and testing on the SI integrated laboratory-scale thermochemical experiment to assess long-term process stability and component durability.
- Evaluate the effect of process improvements, such as membranes and improved catalysts, on thermochemical cycle efficiency.
- Design an integrated laboratory-scale experiment for the Hybrid Sulfur cycle at the Savannah River National Laboratory in preparation for construction in FY 2010.
- Continue HTE experiments begun in FY 2008 to investigate long-term cell operability and

thermal cycling issues.

- Incorporate the results from the integrated laboratory scale experiments into the hydrogen production economic analysis model to identify cost drivers and support the hydrogen technology selection required by the EPAct 2005 in 2011.

Successful achievement of continued testing of integrated laboratory-scale systems and operation of additional experiments will enable the 2011 selection of the technology that will be demonstrated in a pilot-scale hydrogen production experiment, scheduled for 2013.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**277**	**465**
The FY 2008 and FY 2009 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.			
Total, Nuclear Hydrogen Initiative	**18,855**	**9,909**	**16,600**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Nuclear Hydrogen Initiative The increase from $9,632,000 to $16,135,000 reflects the need to obtain additional operational performance data from the Integrated Laboratory Scale experiments that were deferred in FY 2008.	+6,503
SBIR/STTR The increase from $277,000 to $465,000 is due to changed R&D levels within the NHI program.	+188
Total Funding Change, Nuclear Hydrogen Initiative	**+6,691**

Advanced Fuel Cycle Initiative

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Advanced Fuel Cycle Initiative			
Separations Research and Development	34,595	0	59,217
Advanced Fuels Research, Development and Testing	38,160	0	53,000
Transmutation Research and Development	2,595	0	53,400
Systems Analysis/Advanced Computing and Simulation	18,877	0	73,000
Transmutation Education	24,185	0	1,000
Advanced Fuel Cycle Facility	9,000	0	10,383
Consolidated Fuel Treatment Center	8,000	0	18,000
Advanced Burner Reactor	8,750	0	18,000
GNEP Technology Development	17,930	0	0
GNEP Global Partnership Development	0	0	4,500
Fast Neutron Test Capability	4,000	0	10,000
SBIR/STTR	0	0	1,000
Total, Advanced Fuel Cycle Initiative	166,092	0[a]	301,500

Description

The mission of the Advanced Fuel Cycle Initiative (AFCI) is to develop fuel cycle technologies that will support the economic and sustained production of nuclear energy while minimizing waste and satisfying requirements for a controlled, proliferation-resistant nuclear materials management system. In FY 2008, AFCI is included in the Fuel Cycle Research and Facilities program.

AFCI is focused on implementing the Global Nuclear Energy Partnership (GNEP), which is our nation's comprehensive initiative that supports the safe, secure expansion of nuclear power both internationally and domestically. Internationally, GNEP is working to establish a framework to ensure that nuclear power expansion can be achieved appropriately with reduced risk of nuclear weapons proliferation. Domestically, GNEP is developing the advanced technologies and facilities needed to change the nuclear fuel cycle to one in which spent nuclear fuel (SNF) is recycled. Once deployed, this new approach will allow the United States (U.S.) to separate SNF into waste and usable components, allowing reactors to extract additional energy, and providing options for more effective management of the residual waste. AFCI is developing these new technologies so that they may be deployed as part of the nuclear fuel cycle to support operation of current nuclear power plants, Generation III+ advanced light water reactors (LWR), and Generation IV advanced reactors.

[a] In FY 2008, the Advanced Fuel Cycle Initiative is included in the Fuel Cycle Research and Facilities program.

World energy demand is projected to significantly increase over the coming decades. The Energy Information Agency projects that electricity demand will double by 2030 with much of the increase coming in developing countries as they experience double-digit rates of economic growth and seek to improve standards of living. Energy is a necessary driver for human development and this demand for energy will be met using available production technologies.

The U.S. currently has 104 operating commercial nuclear reactors providing approximately 20 percent of our domestically produced electricity, and producing over 2000 metric tons of SNF per year. Expansion of nuclear power is a key component of the National Energy Policy (NEP) and Climate Change Technology Strategy. However, expansion cannot occur without a sustainable path forward for managing SNF.

Historically, the U.S. has used a once through or open fuel cycle in which nuclear fuel is used a single time in the reactor prior to disposal. AFCI/GNEP will develop new technologies that will enable beneficial recycling of SNF. This would enable the U.S. to ultimately move to a closed fuel cycle, where SNF is recycled and reused as fuel to produce additional energy, rather than disposing of it after one use.

To meet growing energy demands and to ensure a viable strategy for SNF management, the National Security Strategy of the United States proposed:

> "*…the Global Nuclear Energy Partnership to work with other nations to develop and deploy advanced nuclear recycling and reactor technologies. This initiative will help provide reliable, emission-free energy with less of the waste burden of older technologies and without making available separated plutonium that could be used by rogue states or terrorists for nuclear weapons. These new technologies will make possible a dramatic expansion of safe, clean nuclear energy to help meet the growing global energy demand.*"[a]

The global expansion of nuclear power promoted by the National Security Strategy of the United States is designed to enhance the national, environmental, and economic security of the U.S. The contribution of AFCI/GNEP in each of these areas is discussed below.

National Security

Principally, AFCI/GNEP benefits U.S. national security by developing advanced spent fuel recycle technologies which extract actinides (Np, Pu, Am, Cm) from SNF without separating out pure plutonium; these highly radioactive elements are then destroyed through their use as fuel or as targets in fast reactors. These technologies address proliferation risk through the reduction of inventories of commercially-generated plutonium (which is contained in all commercial spent fuel) throughout the world.

AFCI/GNEP will further advance the nonproliferation and national security interests of the U.S. by reinforcing its nonproliferation policies through establishment of an international framework to provide a reliable fuel service for those counties with nuclear power by making it unnecessary for them to develop indigenous enrichment or reprocessing capabilities.

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[a] *The National Security Strategy of the United States of America* (March, 16, 2006): 29.

In addition to the inherent benefits derived from a spent fuel recycling process that consumes plutonium but does not result in the extraction of pure plutonium, AFCI/GNEP will, in collaboration with the National Nuclear Security Administration (NNSA), help enhance the international non-proliferation regime by development of advanced materials accountability and control, monitoring and safeguards systems that will contribute to enhancing proliferation resistance of integrated spent fuel recycling systems, here and potentially throughout the world.

Environmental Security

Of the challenges that must be addressed to enable future expansion of nuclear energy in the U.S. and worldwide, none is more important than dealing effectively with SNF and high-level waste. Compared to other industrial waste, SNF generated per unit of electricity is relatively small in mass. However, it contains components that are radioactive for many thousands of years, and its disposal requires resolution of many political, social, technical, and regulatory issues. For many years, several countries, including the United States, have pursued advanced technologies that could treat and transmute SNF from nuclear power plants. These technologies have the potential to significantly reduce the quantity, heat loading, and radiotoxicity of waste requiring geologic disposal.

Technologies developed by AFCI/GNEP would enable nuclear power reactors to recover additional energy value from SNF by recycling reusable materials to fuel nuclear power reactors. Recycling SNF reduces the volume and toxicity of waste requiring disposal in a geologic repository, and supports the development of proliferation-resistant technologies related to the global expansion of nuclear power. Continuing the current path of a once-through fuel cycle will require additional U.S. spent fuel repositories. Establishing a closed fuel cycle, as outlined under the GNEP Strategic Plan, will minimize the number of U.S. repositories required in this century.

Nuclear power is a key component of the U.S. Climate Change Technology Strategy. The global expansion of nuclear power supported by AFCI/GNEP will significantly reduce greenhouse gas emissions associated with energy production. Domestic nuclear power plants are saving as much as 600 million metric tons of carbon dioxide emissions every year. The development of a closed fuel cycle can significantly help in the deployment of new nuclear capacity through the development of a sustainable SNF management process.

Economic Security

AFCI/GNEP is expected to be a major stimulant to the revitalization of the domestic nuclear industry through development of the nuclear infrastructure required to support a closed fuel cycle. The GNEP vision includes the deployment of several major facilities, each of which plays a significant role in a domestic nuclear revitalization.

The Consolidated Fuel Treatment Center (CFTC) is a nuclear fuel recycling center that will separate spent nuclear fuel into reusable and waste components. The Advanced Burner Reactor (ABR) is an advanced recycling reactor that will produce electricity while destroying transuranic elements from SNF. The Advanced Fuel Cycle Facility (AFCF) is a world class research and development (R&D) facility that will support all aspects of the closed fuel cycle envisioned by AFCI/GNEP.

The CFTC will validate key elements of a SNF recycling program, including the separation of LWR and fast reactor SNF into usable components, the fabrication of transmutation fuel from those components and the preparation of advanced waste forms for geologic disposal. The facility will meet AFCI/GNEP objectives including substantial advancements in safeguards, material control and accountability, separations, fuel fabrication, and waste forms.

The ABR is a fast reactor capable of consuming transuranics and other actinides in support of a closed nuclear fuel cycle. Eliminating these materials from LWR SNF reduces both heat and waste loads on a geologic repository, potentially expanding the capacity of a geologic repository by at least an order of magnitude. As a fast reactor, it is capable of providing the fast neutron flux needed for future Generation IV reactor development and advanced fuels qualification. Without a domestic fast reactor, technology development activities that cannot be adequately pursued via computer and simulation modeling and using other domestic facilities, will require the U.S. to purchase in-reactor test time from foreign states. Prior to construction of the ABR, the Department will develop a domestic fast neutron source to provide limited technology development capabilities.

The AFCF will be the premier U.S. R&D facility for the engineering-scale demonstration of advanced fuel cycle technologies. The facility will consist of four modules fundamental to the development and ultimate deployment of these advanced proliferation-resistant technologies: Aqueous Separations, Electrochemical Processing, Fuel Fabrication, and Waste Forms. It will advance development of the entire integrated fuel recycling system from receiving SNF, to separating it into recyclable and waste materials, fabricating new advanced fuel forms including Lead Test Assemblies, and developing advanced waste forms destined for final disposition.

The AFCF is not intended to replace the research being performed at the national laboratories. Advanced fuel cycle R&D will continue at those locations. As this laboratory research matures and it becomes desirable test technologies that may prove successful at a larger scale, then the AFCF shall perform these tasks and fulfill its mission.

The engagement of industry to provide input on the technology and policy issues that need resolution in order to successfully implement the AFCI/GNEP facilities is considered to be a key element of the overall strategy. Industry involvement will help the program analyze the feasibility of commercial deployment and identify approaches that accomplish AFCI/GNEP goals at a lower cost, lower risk, or accelerated schedule. While the CFTC and ABR facilities are envisioned as industry-led projects, the AFCF is envisioned as a Department owned and operated facility located at a DOE site.

AFCI/GNEP is pursuing a research agenda that supports the National Energy Policy and Energy Policy Act of 2005 to explore advanced spent fuel treatment technologies in cooperation with our international partners. The Department will continue to emphasize joint collaborative activities in spent fuel treatment research, design, and development.

Considerable expertise in these technologies has been developed internationally, and the potential for significant cooperation, cost-sharing and collaboration is very high. The Department is currently collaborating with many countries including France, Japan, Russia, and China in areas such as separations, fuels, transmutation engineering and test facilities. Additional collaborations with other fuel cycle states, such as the United Kingdom, are being considered as well.

AFCI/GNEP international collaborations could provide a near-term means for an off-set in the cost of development of various reactor and fuel cycle technologies. Fuel cycle technology collaboration has the potential for accelerating development time by sharing knowledge and experimental data.

In FY 2009, AFCI/GNEP continues to develop methods to reduce the volume and long-term toxicity of high-level waste from spent nuclear fuel, reduce the long-term proliferation threat posed by civilian inventories of plutonium in spent fuel, and provide for proliferation-resistant technologies to recover the energy content in spent nuclear fuel. These activities continue R&D to develop advanced recycling technologies capable of extracting highly radioactive elements from commercial spent nuclear fuel and using that material as fuel in nuclear reactors to generate additional electricity. The FY 2009 request also supports continuation of conceptual design activities for the AFCF, ABR and CFTC, necessary to support the GNEP vision of a closed fuel cycle. Successful achievement of these activities will improve the way spent nuclear fuel is managed, and will facilitate the expansion of civilian nuclear power in the United States and encourage civilian nuclear power internationally to evolve in a more proliferation-resistant manner.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Separations Research and Development	**34,595**	**0**	**59,217**

The goal of the Separations Research and Development (R&D) activity is to develop advanced aqueous and electrochemical separations technology alternatives capable of treating the existing and projected inventory of SNF and fast reactor recycle fuel in a safe, efficient and proliferation-resistant manner. The U.S., which developed essentially all separations technologies currently deployed in the world, has not been directly involved in civilian spent fuel processing since 1974. The central purpose of Separations Research and Development is to support that effort though R&D on processes that do not separate plutonium and providing technologies for industrial applications. Vigorous efforts will be required to achieve those aims. Information developed under this activity will be used to help inform a recommendation to the Secretary of Energy in 2008 on the future course of GNEP. The current suite of advanced aqueous processes has potential for meeting proliferation-resistant separations objectives, while improving the waste management associated with current aqueous separations technologies. However, electrochemical processing (referred to previously as pyroprocessing) may be better suited to address the requirements of sodium-bonded metallic fast reactor fuels. This R&D provides alternatives for important parts of the separations processes where a high or moderate risk is present. This task also supports long-term R&D for next-generation facilities. Data for modeling and simulation validation is developed under this activity.

This program will:

- Significantly reduce the volume and hazard of spent nuclear fuel that must be stored in a repository.
- Allow actinides in spent nuclear fuel to be used as a future fuel for either or both LWR and ABR in a safe and proliferation resistant manner.
- Provide a way that long lived actinides can be consumed so the ultimate waste products are less radiotoxic.
- Support GNEP in producing an energy source that has a very low emission of greenhouse

(dollars in thousands)

gases.
- Develop and test advanced monitoring and accountability technologies that will strengthen nuclear nonproliferation.
- Improve simulation technologies that will reduce separations costs and improve reliability.
- Develop advanced waste forms.

Before separations can be adopted by industry on a commercial scale the technology must be proven to provide the needed separations in a cost-effective manner, while reducing proliferation problems associated with the PUREX process. Issues such as extracting strontium/cesium for separate decay storage; finding better processes for extracting americium and curium; developing equipment for materials accountability; and finding better waste forms for gaseous effluents including tritium, carbon-14 and iodine-129 are examples of where improvements are desirable. A long term R&D program will take on each of the issues to make the process increasingly efficient for the future. In the very short term the program has emphasized activities which will give the Secretary better information for the 2008 decision on GNEP direction for the future. Currently the program is focused on Advanced Proliferation-Resistant Aqueous Fuel Treatment and Other Separation Processes including Electrochemical Processing.

	FY 2007	FY 2008	FY 2009
▪ **Advanced Proliferation-Resistant Aqueous Fuel Treatment**	**24,445**	**0**	**25,000**

Laboratory-scale experiments have proven the advanced, aqueous-based UREX+ technologies to be capable of removing uranium from spent fuel at purity levels of up to 99.999 percent and essentially free of high-level radioactive contaminants. The resulting material (uranium, which comprises approximately 95% of SNF) could theoretically be disposed of as low-level waste or retained for use as reactor fuel. If spent fuel were processed in this manner, the volume of high-level waste requiring disposal in a geologic repository could be significantly reduced, potentially lowering the cost of storage and disposal of the remaining high-level waste and significantly increasing the technical capacity of a geologic repository.

Additional research is continuing to evaluate aqueous chemical treatment methods to separate selected actinide and fission product isotopes from the process stream after the uranium has been removed. Certain long-lived fission products (i.e., iodine-129 and technetium-99) are significant contributors to the potential dose from a repository and the long-term radiotoxicity of spent fuel, and could also be separated for transmutation or incorporation into new waste forms for safe disposal. Other gaseous radionuclides will be collected and safely sequestered. Materials now considered high-level wastes in LWR spent fuel processing facilities, such as fuel element hulls and end boxes from chop-leach dissolution, may be decontaminated sufficiently to qualify as low-level waste or even recycled for reuse in new fuel elements.

In FY 2007, the Department:

- Continued the AFCI separations technology development activity to advance the knowledge of advanced aqueous separations process development though refined and focused laboratory based demonstrations, data collection, and evaluations. Specifically, there were laboratory-scale end-to-end demonstrations of recycling technologies using actual spent LWR fuel at multiple national laboratories to develop a statistical performance database, the use of an oxidation process to recover tritium, a test involving separation of americium and curium from other transuranics, qualification of a new strontium/cesium extraction process to increase system operability and reduce system complexity, and demonstration of the recovery of tritium and then mixing it with zirconium.
- Demonstrated uranium and transuranic product conversion and treatment of undissolved solids and cladding hulls were performed.
- Continued work on product and waste storage forms, particularly for transuranics, strontium/cesium, iodine and technetium. The complete collection of gaseous fission products and activation products was evaluated and experiments begun to demonstrate their collection and waste forms.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Continue development of advanced aqueous separations processes with an increasing emphasis on simplification of the process steps. Coupled end-to-end demonstrations of various UREX+ flowsheets will be conducted, with the separated products made available for advanced fuels and waste form development activities.
- Replace the current design base flowsheet for strontium/cesium recovery and alternate extraction processes will be investigated to minimize the number of different solvents needed to obtain the required transuranic separations. Tests will continue on the applicability and efficiency of aqueous processing and recycle of high burn-up fast reactor spent fuel.
- Investigate the direct transition from transuranic products in solution in nitric acid to solid oxides containing uranium and capable of effective pellet formation in detail, along with the fabrication processes which allow remote fuel fabrication such as microsphere formation and vibration consolidation.
- Continue R&D to optimize the stability of waste forms and efficiency of waste form production including the bench scale demonstration of solidification processes for both cesium/strontium waste and technetium alloys. Improved waste forms for gaseous effluents from aqueous processing, including tritium, carbon-14, iodine-129 and the rare earth gases, will also be developed. In the case of the latter, effort will be devoted to the selection of an efficient process for separation of radioactive krypton from non-radioactive xenon.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

- Advanced safeguards instrumentation and detection equipment development and testing will continue.
- Conduct international collaborations into advanced reprocessing, including possible integrated demonstrations of advanced aqueous separations flowsheets in Russia, Japan, and France.

▪ **Other Separations Processes (Including Electrochemical processing)**	**10,150**	**0**	**34,217**

Electrochemical processing (previously referred to as pyroprocessing) is a proliferation-resistant non-aqueous approach used to separate the actinides in spent fuel from fission products. AFCI electrochemical processing activities support reduction of nuclear waste radiotoxicity by separating minor actinides from spent fuel coming from metal-fueled fast reactors for recycle. While using electrochemical processing to treat spent fuel from the Experimental Breeder Reactor-II (EBR-II), electrochemical process improvements have been made, which increase its applicability to other advanced reactor fuels.

In FY 2007, the Department:

- Continued electrochemical treatment of EBR-II spent driver fuel and testing of high-throughput electrorefiners and testing of processes involving the combined use of both aqueous and electrochemical separations technologies. The aqueous portion of the process development included an extension of process instrumentation development for on-line, real-time accountability measurements applied to separations facilities for increased proliferation resistance.
- Continued studies on the applicability of pyrochemistry to the separation of cesium and strontium from spent fuels. The most promising approaches to the application of electrochemistry to the separation of americium and curium were evaluated, and the process with the highest promise was studied in greater detail for its application to the recycle of fast reactor fuel and the preparation of long-term storage forms. Improved sampling and other monitoring activities were conducted in order to increase proliferation resistance.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Test the applicability of electrochemical processing to the treatment and recycle of high burnup fast reactor spent oxide and metal fuels using FFTF fuel irradiated to more than 200,000 megawatt days per ton.
- Process of EBR-II spent fuel, with final decisions on the optimum way to treat EBR-II blanket fuel expected.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

- Conduct collaborative electrochemical processing R&D with South Korea, Japan, and possibly Canada and Russia will continue, with focus on off-gas treatment methods.
- Establish the feasibility of the separation of americium from curium and the optimum method of isolating strontium and cesium from the other fission products remaining in the waste salt.
- Investigate safeguards issues related to special material accountability. The development of electrochemical processing equipment capable of processing rates equivalent to a scale of 100 tons/year capacity will be emphasized. The development of waste forms for gaseous effluents from preprocesses, including carbon-14, iodine-129, tritium, krypton-95 and various xenon isotopes will be pursued.
- Continue research activities supporting the nuclear fuel recycling center including aqueous processes at one DOE national laboratory, and electrochemical processes at one DOE national laboratory facility. Research activities are fully integrated with the design and construction schedules. The Department will continue to work collaboratively with the international community to efficiently leverage existing infrastructure resources. A strategy for joint collaboration with Japan and France on the utilization of existing infrastructure and new capabilities will continue to be pursued.

	FY 2007	FY 2008	FY 2009
Advanced Fuels Research, Development, and Testing	**38,160**	**0**	**53,000**

The goal of the Advanced Fuels Research, Development, and Testing activity is to develop, fabricate, and test transmutation fuels and transmutation targets using recycled SNF. While a portion of this fuel development effort is aimed at producing transmutation fuels for use in LWRs, most of this effort is being directed at producing fuels suited for use in fast reactors which offer the best opportunity to transmute (consume) most of the transuranics in the recycled fuel efficiently and safely. Advanced transmutation fuels fabricated from LWR spent fuel are the critical, linchpin components of the AFCI/GNEP concept. These advanced fuel designs will permit extracting vast amounts of currently unavailable energy from spent fuel materials while doing so in a proliferation-resistant manner and increasing the load capacity of the Yucca Mountain repository by as much as fifty-fold. This activity also supports long-term R&D for next-generation nuclear reactors (i.e., Generation IV), including generating data which can be used to validate modeling and simulation activities.

Currently, advanced transmutation fuels are fabricated in small batches (e.g. one to four fuel pins) using bench-scale facilities primarily at Idaho National Laboratory, and include nitride fuels, dispersion fuels, sphere-pac fuels, inert matrix fuels and transmutation targets. Advanced fuel development work is focused on near term R&D in support of qualifying transmutation fuel and targets for an advanced burner reactor. In addition, this Advanced Fuel Research, Development and Testing work is closely integrated with the technology development activities that support the engineering and design of the planned AFCF. The AFCF will be capable of fabricating sufficient transmutation fuel for lead test assemblies. These lead test assemblies will be irradiated in an advanced burner reactor and will provide the performance data needed by the Nuclear Regulatory Commission (NRC) for transmutation fuel qualification.

Much of the advanced fuels irradiation testing and examination work is being done in the Advanced Test Reactor (ATR) thermal neutron source at the Idaho National Laboratory (INL). Irradiation testing at the ATR is shifting from less precise, un-instrumented tests which estimate conditions at the fuel sample to more precise instrumented tests. These instrumented tests will provide valuable data on irradiation conditions at the fuel sample and will reduce development time and costs while improving the efficiency of the advanced transmutation fuels. Irradiations will also take place domestically when a fast neutron source is available. In addition, the cost, scope and schedule to provide a transient test capability are being developed.

Research efforts in advanced fuels are being leveraged through several ongoing and planned international research collaborations. Two U.S. origin fast reactor transmutation fuel irradiation tests (FUTURIX-FTA and MI) have been initiated in the French Phenix reactor. In addition, discussions for an international arrangement for transmutation fuel irradiation tests in the Japanese JOYO fast reactor and in fast test reactors in Russia have been initiated. This international cooperation is necessary since the U.S. does not have a fast reactor in which to perform these irradiations.

In FY 2007, the Department:

- Completed irradiation tests of the initial set of high burn-up transmutation fuels in the ATR, commenced post irradiation examinations, and completed fabrication of metal transmutation fuels for future irradiation tests in the ATR.
- Initiated two U.S. origin fast reactor transmutation fuel irradiation tests (FUTURIX-FTA and MI) in the French Phenix reactor.
- Initiated discussions for transmutation fuel irradiation tests in the Japanese JOYO fast reactor and explored expansion of international fast spectrum irradiation test possibilities with Russia.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Continue irradiation and testing of metal and oxide transmutation fuels in the ATR and fabricate and begin irradiation of a new series of instrumented transmutation tests.
- Complete irradiation of U.S. origin transmutation fuels in the French Phenix fast reactor.
- Continue to develop plans and agreements for irradiation of U.S. origin fuels and materials in Japanese and Russian fast reactors.
- Expand the fundamental research to support the development of computational simulation and modeling of fuel behavior.

(dollars in thousands)

- Continue to develop cost, scope, and schedule information for a transient test capability which will enable the testing of advanced fuels in atypical reactor conditions.
- Initiate post irradiation examination activities for high burn-up fuel that was irradiated in the FFTF in Hanford, Washington.
- Initiate research on alternative transmutation fuels and targets with high potential and low technical maturity (e.g. sphere-pac and dispersion fuels) including preparations for irradiation testing.
- Initiate research activities to develop an alternate fuel cycle in which LWR spent fuel would be separated and the resulting uranium and plutonium oxide (MOX) would be recycled into fuel for LWRs. Research would be conducted to determine the MOX fuel performance of varying fuel compositions of plutonium and uranium.
- Continue activities that support the design of advanced fuel cycle systems, addressing only the highest-priority activities associated with remote fuel and target fabrication technology. This includes limited evaluations of improvements needed for existing DOE laboratory facilities that can be used for remotely fabricated test pins and limited size fuel elements. The Department will continue to work collaboratively with the international community to efficiently leverage existing infrastructure resources. A strategy for joint collaboration with Japan and France on the utilization of existing infrastructure and new capabilities will continue to be pursued.

	FY 2007	FY 2008	FY 2009
Transmutation Research and Development	**2,595**	**0**	**53,400**

Transmutation Research and Development includes Transmutation Research and Development and Grid Appropriate Reactors.

	FY 2007	FY 2008	FY 2009
▪ **Transmutation Research and Development**	**2,595**	**0**	**33,400**

Transmutation, as it applies to AFCI/GNEP, converts long-lived radioactive isotopes into shorter-lived, and therefore, produces less radiotoxic long-lived isotopes. As a result, transmutation can lower the radiotoxicity of spent nuclear fuel to below that of natural uranium ore by reducing the time for decay from hundreds of millennia to as little as centuries. The Transmutation R&D effort is focused on long-term R&D to reduce operational uncertainties, improve transmutation system performance, and reduce costs through development of advanced technologies. The effort is focused on fast reactors because the transmutation of transuranics is best performed in fast reactors.

Because capital investment in reactors is the dominant cost of any nuclear fuel cycle, the work described here is a critical component to assure an economically viable closed fuel cycle. To reduce the cost of future fast reactors, a variety of innovative solutions are being researched. Reduced uncertainty on the physics behavior of the reactor can eliminate unwarranted design margins that are costly and add little or no value. Improved materials that perform better and longer are needed. The Transmutation R&D Program is a long-term program that will address these issues. Its success will largely determine if industry will deploy fast reactors beyond the initial ABR and ultimately determine the success of the GNEP fuel cycle vision.

It is envisioned that this program will expand from its current bench scale R&D effort to a full scale research and development effort that can develop and demonstrate the needed components, physics, and safety technologies that will provide the desired breakthroughs. This will be accomplished by expanding existing facilities, developing key domestic facilities, leveraging program knowledge by exchanging information with the international fast reactor programs, and performing joint research in foreign facilities with unique capabilities.

In FY 2007, the Department:

- Completed design concept studies to evaluate the feasibility of innovative technologies.
- Evaluated and refined cross sections for plutonium isotopes to reduce the uncertainties in reactor physics calculations.
- Conducted mechanical testing and analysis of structural materials irradiated in the FFTF, which provided valuable and rare data on the effects of long term irradiation on structural steels.
- Conducted assessment of existing fast reactor design tools; the selection of candidate structural materials for use in fast spectrum transmutation systems.
- Completed a sodium technology gap analysis.
- Coordinated international activities dealing with transmutation systems.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Continuing work on advanced concept studies designed to reduce the cost and improve the performance of the future commercial fast reactor fleet.
- Continuing R&D activities on evaluation and refinement of physics cross sections for plutonium and other priority isotopes.
- Initiating development and/or restart of key fast reactor technology facilities.
- Retrieving irradiated advanced material samples which were placed in the Phenix fast reactor in France in 2007, and preparing for their post irradiation examination.
- Continuing R&D on improvements in areas such as advanced materials and safety technologies.
- Continuing integration of advanced modeling and simulation activities with those of Transmutation R&D.
- Continuing high-priority development of candidate materials, components, and equipment that provide a significant opportunity to reduce the costs to design, construct and operate the initial ABR prototype, as well as improve plant performance in the near-term will be pursued. The Department will continue to work collaboratively with the international community to efficiently leverage existing infrastructure. A strategy for joint collaboration with Japan and France on the utilization of existing infrastructure and new capabilities will continue to be pursued. The Department will continue

investigation of increased scale fuel recycling concepts, including initial site evaluation and infrastructure design to support the hosting of a (100-200 metric ton per year) nuclear fuel recycling center and an advanced recycling reactor. DOE will obtain a nuclear utility perspective for evaluating and deploying GNEP facilities.

- **Grid Appropriate Reactors** **0** **0** **20,000**

A core component of the AFCI/GNEP vision is the creation of international partnerships that facilitate the expanded, world-wide use of nuclear energy while reducing proliferation risk associated with global deployment. In support of this goal, AFCI/GNEP supports the development of grid-appropriate reactors (previously referred to Small Reactors), which are well suited to the capabilities and needs of developing countries where electricity demand is expected to more than double by 2030. These reactors would be designed to achieve high standards of safety, security and proliferation resistance and would be sized to suit those countries smaller and less developed power grids. The successful deployment of these reactors, coupled with the GNEP vision of reliable fuel services, will provide an attractive energy solution to many countries and will serve to eliminate the need for them to develop the more proliferation-vulnerable parts of the nuclear fuel cycle (e.g., uranium enrichment facilities).

Smaller power plants (<500 MWe) are particularly suitable for expansion into the less developed countries because they would: match grid capacities better; offer simplified operations with greater margins of safety; require less capital outlay; allow countries to add capacity in smaller increments to better match demand growth; and be better suited to provide important non-electrical products such as process heat and fresh water through desalination.

Besides the United States, several countries, including France, Russia, Japan, Korea, South Africa, India, and Argentina, have already recognized the global market need for smaller sized nuclear power plants and are moving forward aggressively with the development of small and medium-sized reactors (SMR). Because it is ultimately the responsibility of private industry to develop and market commercial nuclear power plants, the role of AFCI/GNEP will be to pave the way for U.S. industry to effectively compete in the international market by helping to remove various barriers for deployment and to accelerate development and demonstration of new designs. To accomplish this, a dual-path approach has been formulated for development and demonstration of an AFCI/GNEP-sponsored grid-appropriate reactor.

Near-term Path

The first path provides a fast-track implementation that strives to have a plant design ready for deployment by 2015. In addition to addressing the existing international demand for increased power, this fast-track deployment will better allow the U.S. to: influence other supplier countries working to deploy similar reactors to meet GNEP strategic objectives; facilitate U.S. industry participation and competitiveness in the rapidly emerging nuclear market; and provide near-term credibility in meeting key GNEP objectives.

The near-term development track will target countries with current but limited nuclear experience, such as countries operating one or more research reactors. Pursuing this fast track will serve to identify and help resolve related infrastructure and regulatory needs for deployment of grid-appropriate systems in developing countries, such as plant licensing, workforce education and training, international agreements, etc.

AFCI/GNEP has determined that light water technology is the most suitable for near-term deployment for several reasons, including operational experience, time to achieve safety certification, availability of vendors and feedback from potential user states. To this end, a public-private partnership established via a competitive solicitation is being pursued with an award forecast in FY 2009. The solicitation would create a cooperative agreement to support design certification by the NRC of an advanced light-water design of less than 500 MWe. This would result in the world's first small reactor certified by the NRC, a recognized leader in nuclear regulation, and would provide a near-term ability to deploy nuclear energy in developing countries that have some nuclear experience, thereby enabling a key GNEP objective to be met. Finally, a U.S. reactor design with NRC design certification would have a significant competitive advantage in this emerging world market. It is envisioned that DOE's role will be cost-sharing and facilitation of a NRC design safety analysis leading to a design certification by 2016. Total DOE funding to accomplish this will be about $100 million spread approximately equally over five years (FY 2009 – 2013) representing about 20% of the estimated costs to develop the final design for the reactor and conduct the NRC design evaluation.

Long-term Path

The second path in the dual-path strategy focuses on accelerating reactor technology developments that are needed to deploy next-generation designs suitable for a broader global market. These designs will offer further enhancements in plant performance, such as improved safety, proliferation resistance, security, and economics. It is too early to know precisely the technologies but possibilities include next-generation LWRs, gas-cooled reactors, liquid-metal cooled reactors and other advanced systems. The next-generation designs will build on the successful resolution of critical infrastructure issues for the near-term system and will involve the development of more robust reactor technologies in order to extend the availability of nuclear power plants to countries with no current nuclear experience. Because of the R&D needed to achieve these performance objectives, the next-generation reactors are targeted for a deployment date of 2030.

It is planned that DOE will fund preliminary designs for 3-5 systems before selecting a preferred technology. Private industry involvement will be sought with a goal to build and operate a prototype reactor as the means to obtain NRC design approval to allow commercial sales. This next-generation reactor would be suitable for deployment in developing countries with little or no infrastructure, a significant marker potential and key to reaping GNEP's strategic benefits of national, economic and environmental security.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

In FY 2009, the Department will:

- Award a competitively bid public-private partnership to cooperatively fund a safety evaluation by the NRC of a small nuclear reactor (< 500 MWe). This funding will continue through FY 2013 with the goal of achieving a NRC Final Design Approval by 2016.
- Begin nuclear infrastructure assessment and assistance to developing countries to help them prepare to introduce nuclear energy and ensure it is accomplished to the highest levels of safety and safeguards. Two assessments and at least one assist visit are planned in developing countries using a team of national laboratory employees with experience in the International Nuclear Safety Program.
- Develop innovative next-generation systems suitable for deployment in developing countries with no nuclear experience will be done through competitive process beginning in FY 2009. Crosscutting technology development activities specific to small reactors (e.g. instrumentation and control, advanced manufacturing, physical protection and safeguards) will also be funded in support of the near-term and next-generation concepts.

	FY 2007	FY 2008	FY 2009
Systems Analysis/Advanced Computing and Simulation	**18,877**	**0**	**73,000**

Systems Analysis/Advanced Computing and Simulation includes Systems Analysis and Integration and Advanced Computing and Simulation.

	FY 2007	FY 2008	FY 2009
▪ **Systems Analysis and Integration**	**14,977**	**0**	**18,000**

The Systems Analysis and Integration activity examines the possible combinations of nuclear technologies to optimize the technical, economic, and environmental aspects of the fuel cycle as a whole, from mining to waste disposal. This includes an administrative function centered at INL to manage the integration process so that all technical activities of AFCI are coordinated and Integrated. Systems Analysis develops and applies evaluation tools to formulate, assess, and guide program activities to evaluate various combinations of reactor types, reprocessing techniques, and waste disposal systems to meet program goals and objectives.

In addition to optimization, Systems Analysis and Integration is also focused on the evaluation and down-selection of the most promising spent fuel treatment technologies, fuels technologies, reactors, and advanced fuel cycle deployment strategies acquired from AFCI and Generation IV R&D activities. Proliferation resistance analyses conducted by the NNSA and efforts conducted under the Safeguards Technology campaign are factored in as a high-priority, ongoing activity, especially in the area of advanced separations technologies.

Additionally, Systems Analysis and Integration investigates optimal systems architecture to reduce the burden on potential future geologic repositories by removing the uranium and major heat-generating components of SNF, and optimizing the destruction of actinides to reduce the time it takes for the radiotoxicity of the waste to decay to levels comparable to the radiotoxicity of uranium ore. A systematic analysis of fuel cycle performance is performed for promising options, the results of which assist the Department in effectively prioritizing program R&D and establishing requirements for proposed projects. In a related activity, Systems Analysis and Integration produces the annual "AFCI Comparison Report" for Congress, which compares various separations, fuels and reactor technologies being researched by the AFCI and Generation IV programs against the goals and objectives of those programs.

Systems Analysis and Integration also includes cost analysis activities and establishing consistent cost bases for use in evaluating the advanced fuel cycle technologies. To this end, the "Advanced Fuel Cycle Cost Basis Report" provides a comprehensive set of cost data for use in evaluating various AFCI and Generation IV technology deployment options. The report and its associated modeling efforts are intended to aid the evaluation of those elements that dominate nuclear fuel cycle costs, and help develop more efficient and less costly fuel cycle systems.

In FY 2007, the Department:

- Focused on the development of information to support a Secretarial recommendation to Congress by January 2010 on the need for second repository, and the development of key technical and economic information to support the Secretary's decision in 2008 on the GNEP path forward. Analyses comparing direct disposal of spent fuel with disposal after the fuel has been recycled and actinides have been consumed in advanced recycling reactors were conducted and continue in FY 2008.
- Developed an integrated, systems-level model analyzed all elements of the fuel cycle including economics, safety and environmental issues, proliferation issues, and sustainability. The functionality of this systems-level model will be enhanced each year. Applications of this model included an initial deployment analysis for a potential recycling system.
- Updated the "Advanced Fuel Cycle Cost Basis Report" and the business studies of the accelerated recycling program to obtain inputs from industry, investment communities, and academic communities on implementation of a large scale advanced fuel cycle complex in the U.S. and across the globe. These activities will support the development of a technology roadmap, a business plan containing cost projections and comparisons to other fuel cycle alternatives, and a plan outlining a schedule, waste streams, milestones, and performance metrics.
- Established a GNEP Technical Integration Office (TIO) at the INL staffed with participants from both INL and other laboratories. The TIO assists the program by providing a technical integration and systems engineering support function between proposed facility projects and between the projects and research and technology development areas. It assists the Department with execution by ensuring consistency in approach to project controls, and also is responsible for conducting technical activities in support of top-level, cross-cutting work activities. The TIO is fully staffed and operational. An integrated waste management strategy is under development. Updates to the Comparison Report to Congress and A Systems Analysis Report to Congress were

submitted. In addition, deployment systems analyses were conducted for a variety of deployment system alternatives and supporting technology development. These analyses provide planning support for GNEP implementation.

- Expanded effort Systems Analysis/Advanced Computing and Simulation to focus on the high priority of developing advanced simulation codes for fast reactor design and fuel performance.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Focus primarily on activities to support an effective and rapid implementation of the Secretary's 2008 decision concerning GNEP. This is anticipated to include necessary technical and systems integration of the advanced fuel cycle R&D with the advanced burner reactor, the recycling program, and the advanced fuel cycle facility.
- Focus on assessing the details of GNEP implementation, technical options and issue analysis, and overall optimization.
- Implement a technical risk mitigation plan for the program to promote success, and work to address key remaining technical decisions and interface requirements.

	FY 2007	FY 2008	FY 2009
▪ **Advanced Computing and Simulation**	**3,900**	**0**	**55,000**

DOE leads the world in the development and application of high performance computing and science based computational simulation. Maintaining and applying this capability is a priority of the American Competitiveness Initiative. The goal of the Advanced Computing and Modeling and Simulation program element is to develop and apply capabilities developed in the Office of Science's Advanced Simulation and Computing Research (ASCR) program and NNSA's Advanced Simulation and Computing (ASC) program to advance the state of the art in nuclear energy applications thereby using the power of massively parallel science based computing to improve the safety, performance and economics of nuclear reactors and potential fuel recycling and waste disposition systems.

This effort is being planned and executed in collaboration with NNSA, and the ASCR, Basic Energy Sciences and Nuclear Physics programs in the Office of Science to build on the capabilities and expertise developed through the multi-billion dollar investment in those programs in recent years. This activity will be executed through the DOE national laboratory system in collaboration with domestic industry and with foreign partners. It will engage our leading research universities in the development of models and methods as well as provide training of students in fields relevant to the nuclear enterprise. These activities will leverage computational and experimental assets, resources, capabilities and experience throughout DOE to avoid duplication and to reduce development times.

This effort began in mid- FY 2007 and was focused on the high priority of developing advanced simulation codes for fast reactor design and fuel performance. These efforts will continue into FY 2008 under the Fuel Cycle Research and Facilities.

(dollars in thousands)

In FY 2009, the Department will significantly expand the Modeling and Simulation (M&S) activities and broaden the scope of problems for which simulation tools are being developed. The principal focus is to put together the "code teams" that will develop the advanced applications codes for each of the areas of interest. The experience of the ASC program and the ASCR shows that each code team requires support at the level of $5M to over $30M per year depending upon the complexity of the application being developed. Fully integrated reactor codes that combine neutronics, structural mechanics and thermo-hydraulics into one code with high resolution in 3-dimensions will be similar to the most complex challenges facing the ASC code and over time the program will pursue multiple approaches to the problem, to reduce risk, and to ensure that physics models are developed that are optimized for each of the principle classes of problems to be solved. Such codes currently do not exist, but the benefit in terms of reactor cost and safety performance will be enormous, and even a 5% resulting savings in the cost of construction of future reactors would repay investments many times over.

Likewise, current experience shows that the qualification of a new fuel type can take 20 years and cost over $200M because of the cycle required for in-core irradiation testing. The application of science–based, massively parallel codes may substantially reduce both the cost and time required, while providing a much more optimized fuel design to be submitted for final certification testing. Such developments will be essential to making the development of transmutation fuels for recycling reactors feasible.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Expand code team efforts to develop a fast reactor design code to couple thermal-hydraulics, neutronics and structural mechanics with 3-dimmensional capabilities.
- Improve the fidelity of thermo-mechanical codes used for fuel modeling and improving the models of multi-component materials used in reactor fuels.
- Develop methods to model the performance of advanced waste forms in adverse geological environments for very long-term storage and disposition.
- Initiate the development of simulation codes to model the SNF separations process allowing for improvement of the design of a recycling facility.

	FY 2007	FY 2008	FY 2009
Transmutation Education	**24,185**	**0**	**1,000**

Transmutation education supports the development of new U.S. scientists and engineers needed to develop transmutation and advanced nuclear energy technologies through university fellowships and applied research. Transmutation Education activities include the successful university fellowship program, which is developing new U.S. scientists and engineers for the fields of transmutation and advanced nuclear fuel cycle technologies.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

In FY 2007, the Department:

- Awarded eight fellowships as a continuation of the AFCI fellowship program.
- Funded additional university research activities including those by University of Nevada – Las Vegas (UNLV), University of Nevada – Reno (UNR), and the Idaho Accelerator Center (IAC). UNLV conducted student research on GNEP relevant subjects, including a new radiochemistry doctoral program. UNR studied GNEP transportation and materials issues, while the IAC was actively involved in safeguards research and development.
- Awarded NERI grants competitively to universities of a university consortium for GNEP related research.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Continue only the AFCI Fellowship program under this category, including expansion with the addition of a PhD. Fellowship.
- Perform additional university research activities within the various AFCI/GNEP research and development activities.

	FY 2007	FY 2008	FY 2009
Advanced Fuel Cycle Facility	**9,000**	**0**	**10,383**

The AFCF will be a first-of-a-kind, world-class nuclear fuel cycle research, development, and demonstration facility. It will have engineering-scale capabilities that will be used to develop and demonstrate advanced proliferation-resistant fuel recycling technologies. The AFCF will demonstrate these technologies as part of integrating the non-reactor portion of the nuclear fuel cycle, an important element to the cost-effective commercialization of these technologies. Fuel cycle operations will include: remote fabrication of various transmutation fuels and targets; advanced aqueous and electrochemical separations; and advanced waste forms. AFCF will also provide a test bed capability for advanced nuclear material accounting and control systems, one of the primary technologies for significantly reducing nuclear weapon proliferation risks. Many of the technologies developed by AFCI/GNEP on the laboratory scale are expected to be demonstrated at a larger scale by the AFCF.

In the long term, the AFCF is required for the U.S. to regain a leadership role in the nuclear fuel cycle. This is essential if the U.S. is to influence and promote the non-proliferation goals of GNEP. Moreover, the AFCF is needed to continually improve the performance and cost-effectiveness of an integrated fuel cycle and help the U.S. maintain competitiveness in the global nuclear market. While upgrades to existing DOE facilities can support this role to a limited degree over the next 10 to 20 years, this facility can accelerate the evolutionary, as well as revolutionary, improvement to nuclear the commercial applications of advancement of fuel recycling technologies. This facility will continue to depend on a robust laboratory-scale R&D program by talented researchers from around the DOE complex in order to feed viable candidate technologies for demonstration prior to commercial applications.

A phased construction plan for AFCF is envisioned. During the first phase, those facilities that support separations of LWR SNF into its reusable and waste components will be built, as well as those for fuel fabrication and waste processing. It is important that these technologies be successfully demonstrated on an engineering scale for ultimate commercial deployment and waste volume reduction. Phase I will also include the remote manufacture of lead test assemblies. These are experimental fast reactor fuels—fabricated from the separated products of used commercial LWR fuel—and will be placed inside a fast reactor for qualification and validation. This is a necessary step for the development of viable commercial fast reactor fuels for advanced recycling reactors that will get the maximum energy value from the fuel while simultaneously reducing waste and proliferation risks. This capability will be needed to continually improve the commercial application of GNEP technology introduced by the CFTC and evolutionary improvements over the coming decades.

The second phase of construction will focus on building those facilities required for the separations and recycling of used fast reactor fuel, most notably that coming from an advanced recycling reactor. The composition of this fuel will differ from the used LWR fuel that was recycled in the first phase and may require different treatment technologies. The fast reactor fuels may be in metallic form (although other forms are currently being evaluated). If such is the case, an electrochemical approach to fuels separation may be required, and would be developed in the AFCF. If the optimal fuel forms are not metallic, then other recycling approaches must be considered, including that used for LWR fuel.

The facility is being sized to cover the range of research, development and demonstration activities envisioned by GNEP over the next 50 years. The Aqueous Separations Module, for example, is being evaluated for processing LWR used fuel at a throughput rate of 10 to 75 metric tons per year and is being sized for a suite of promising advanced separations processes.

In the near term, the AFCF will focus on demonstrating fabrication of transmutation fuels and targets at a scale necessary prior to commercialization. When built and operational, it will be the only facility in the world capable of providing this capability. Because of this unique capability, the AFCF will be a user facility through which many working partnerships will be established. These partnerships will include participants from all DOE laboratories (a robust scientist exchange program is anticipated), industry, universities, foreign governments and labs, and regulatory agencies (for independent analyses).

In FY 2007, the Department:

- Continued work on the AFCF and 30 percent of the conceptual design was completed. Key elements of this design are the four key technology areas of AFCF: remote transmutation fuel/target fabrication, advanced aqueous separations, electrochemical processing, and advanced waste forms. The FY 2007 AFCF design work was instrumental in identifying near term technology development requirements associated with each of the advanced technology areas.

- Established a quality assurance program and produced over three hundred flow sheets, drawings, and engineering works that supported an initial facility hazards analysis and design trades studies.
- Highlighted the need to integrate the existing DOE laboratory capabilities—and potential upgrades or expansion of existing facilities--with the future increased capabilities of AFCF. While DOE will benefit from the upgrade of existing laboratory facilities, the increased throughput and system integration provided by a new, appropriately-sized engineering-scale AFCF can support the efficient demonstration of multiple advanced GNEP technologies over the coming decades, such as remotely fabricated uranium-transuranic transmutation fuel/targets, and support commercial deployment with acceptable risks and without multiple "single purpose" pilot demonstration facilities.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Continue conceptual design work on the AFCF. This work advances the design of modules such as those used for advanced aqueous and electrochemical separations, advanced waste forms development, as well as the balance of plant. The conceptual design could be up to 60 percent complete at the end of the fiscal year.

	FY 2007	FY 2008	FY 2009
Consolidated Fuel Treatment Center	**8,000**	**0**	**18,000**

The CFTC, previously called the Recycling Demonstration Program, will provide the critical steps and support necessary to recycle used nuclear fuel in the U.S. on a scale of commercial significance. The recycling program carried out at the CFTC aims to recover additional energy value from used nuclear fuel by recycling re-useable materials and to reduce the volume and toxicity of waste slated for disposal in a geologic repository. Ultimately the CFTC will include four sub-projects to improve the overall efficiency of the fuel cycle: LWR spent fuel separations facility, transmutation fuel fabrication facility, transmutation fuel separation facility, and advanced recycling reactor startup fuel fabrication facility.

This capability will support a sustained nuclear renaissance by providing domestic and international fuel services and improved waste and product management. Recycled products could be reused in existing LWR and eventually in new advanced recycling reactors that consume the longest-lived and most radiotoxic isotopes. The use of advanced recycling reactors will reduce the amount and hazards of the remaining high-level waste requiring disposal in a geologic repository and result in new waste forms and management approaches more commensurate with their reduced hazards. Approaches considered by AFCI/GNEP in the recycling of used nuclear fuel will employ proliferation-resistant technologies to support GNEP objectives. The program will engage with industry partners to establish spent fuel separations capability as a cornerstone for U.S. nuclear energy leadership.

In FY 2007, the Department:

- Initiated the competitive industrial engagement necessary to start design activities on

engineering- and commercial-scale nuclear fuel recycling center concepts that will meet GNEP proliferation-resistance, waste management, and product management objectives. This initial industry competition focused specifically in areas that support an informed 2008 Secretarial decision through cooperative agreements with several industry teams. A May 2007 Funding Opportunity Announcement offered industry the opportunity to propose work to initiate conceptual designs, develop business models, prepare technology roadmaps, and submit communications plans for a nuclear fuel recycling center based on their experience.
Four industry teams were selected and cooperative agreements negotiated. Selection of industry teams was based upon the expectation of public-private cost sharing. These industry engagement efforts will also explore the possibility of private financing and may identify additional technical and programmatic opportunities that improve the GNEP business model. Based on the level of industry interest expressed to date, the Department is confident that industry involvement in engineering- or commercial-scale application of spent fuel chemical separations technology will result in a viable deployment approach for GNEP.

- Performed engineering alternative studies (EAS) were also performed in FY 2007, including one of a commercial scale SNF recycling facility that examined the environmental impacts, cost and schedule of building a nuclear fuel recycling center and identified areas of process improvement and risk mitigation. Follow-on EAS investigated opportunities to refine requirements and reduce costs for the used nuclear fuel recycling facility. In addition, several data input reports were issued to support the development of the GNEP Programmatic Environmental Impact Statement.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Assume that the Secretary of Energy will decide to pursue nuclear fuel recycling at some level.
- Continue involvement of industry in leading the development and implementation of a program for recycling used nuclear fuel.
- Support the continued industry development of concepts for one or more technology solutions, such as an aqueous process and an electro-chemical process, to achieve the separation and recycling of used nuclear fuel. The conceptual design activity encompasses activities such as system descriptions, flowsheets, and material balances. The work products developed by industry through the cooperative agreements will also be used to modify the planning for the used nuclear fuel recycling center as needed to achieve a flexible approach that promotes an industry led effort that achieves the waste reduction, energy recycling, and non-proliferation goals of GNEP.
- Continue to evaluate design alternatives from engineering alternative studies, based on the concepts provided by industry, in areas where uncertainties exist in the areas of technical maturity and cost analysis. Efforts beyond the DOE cooperative agreements with industry will rely substantially upon industry investment to further develop conceptual designs. The DOE GNEP research and development efforts on CFTC technology described in the above sections will support the industry-led conceptual design activities in FY 2009.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

Advanced Burner Reactor	**8,750**	**0**	**18,000**

The ABR is a fast-spectrum reactor capable of consuming transuranics and other actinides in support of a closed nuclear fuel cycle. In addition to eliminating these materials from LWR SNF, reducing both heat and waste loads on a geologic repository; the ABR will produce electricity. Reducing the volume, heat-loading, and radiotoxicity of nuclear waste could exponentially increase the capacity of the geological repository at Yucca Mountain. The ability to transmute and destroy transuranics in the ABR is the principal long-term waste management benefit of GNEP.

Input from industry and international partners confirm the feasibility of deploying a prototype fast reactor in the 2020-2025 timeframe. With the shutdown of the FFTF and EBR-II in the 1990s, there are no fast spectrum reactors currently operating in the U.S.

The ABR project will be implemented through two closely integrated paths. An industry-led path will design and build a prototype reactor, which will demonstrate transmutation, qualify advanced reactor fuels and materials, demonstrate advanced design and safety features, and employ modern reactor safeguards. A complimentary path, led by the national laboratories, has two objectives. In the near-term, it will identify and deliver the most promising technologies for incorporation into the prototype ABR. In addition, the labs will conduct the long-term research and engineering to assure that subsequent commercial ABRs will be economically competitive with modern light water reactors. The Department will collaborate with international and industry partners on both paths.

In FY 2007, the Department:

- Awarded cooperative agreements to multiple industry consortia to develop the cost, scope and schedule for conceptual design studies for an initial fast spectrum reactor. The design, cost and schedule information developed will help to determine the optimal technical parameters for the reactor prototype (size, power level, conversion ratio, etc.).

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, the Department will:

- Select the most promising reactor technology(s) to proceed with conceptual design.
- Continue to work closely with the NRC to facilitate the development of an appropriate regulatory framework and compliance strategy for advanced fast-spectrum reactors.
- Focus on international collaboration on fast-spectrum reactor development.
- Collaborate with the Japan Atomic Energy Agency (JAEA) and the French Atomic Energy Commission (Commissariat à l'énergie atomique) (CEA) on the harmonization of sodium fast reactor prototypes and shared infrastructure development and utilization in accordance with a Memorandum of Understanding established in FY 2008. A more formal agreement is planned for FY 2009 to collaborate on a U.S. based prototype reactor.
- Continue to facilitate future deployment of advanced reactors through supporting policy, incentives, regulations and proposed legislation.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
GNEP Technology Development	**17,930**	**0**	**0**

The GNEP Technology Development activity provides support to each of the three GNEP projects (the engineering- to commercial-scale demonstration nuclear fuel recycling center, advanced recycling reactor, and AFCF), driven by the development and design needs of each project.

The technology development activities described below are fully integrated with the design and construction schedules for each of these projects.

In FY 2007, the Department:

- Established initial technology development needs based on initial engineering alternatives and design concepts considered by each project. This included assessments of the technical maturity level for each of the major technology area (e.g., SFR main systems and components for the ABR) and gap analyses developed to determine priority development and supporting infrastructure needs.
- Developed engineering alternatives, and design concepts for use as a benchmark in evaluating industry input for the CFTC and ABR project technology development needs.

In FY 2008, funding and accomplishments are included in the Fuel Cycle Research and Facilities program.

In FY 2009, funding associated with key Technology Development efforts are directly within the components of the research and development program.

	FY 2007	FY 2008	FY 2009
GNEP Global partnership Development	**0**	**0**	**4,500**

Global partnership development is required to accomplish the international goals embodied within GNEP. Those goals include developing advanced technologies for recycling SNF for deployment in facilities that do not separate pure plutonium, with a long term goal of ceasing separation of plutonium and eventually eliminating stocks of separated civilian plutonium; take advantage of the best available fuel cycle approaches for utilization of energy resources; develop and deploy, advanced fast reactors that consume transuranic elements from recycled spent fuel; establish international supply frameworks to enhance reliable, cost-effective fuel services and supplies to the world market; promote development of advanced, more proliferation resistant nuclear power reactors appropriate for the power grids of developing countries and regions; in cooperation with the International Atomic Energy Agency (IAEA), continue to develop enhanced nuclear safeguards to effectively and efficiently monitor nuclear materials and facilities, to ensure nuclear energy systems are used only for peaceful purposes.

GNEP international engagement has been exceptionally well received around the world. The five fuel cycle nations (France, Japan, Russia, China, and the United States) and fourteen other nations have all signed the "GNEP Statement of Principles," the goal of which is "the expansion of nuclear energy in a safe and secure manner that supports clean development without air pollution or greenhouse gases, while reducing the risk of nuclear proliferation."

(dollars in thousands)

In support of the Statement of Principles, the United States has signed “Civil Nuclear Energy Bilateral Action Plans” with France, Japan, Russia, and China. These Action Plans outline GNEP cooperative R&D on advanced reactors, exportable small and medium power reactors, nuclear fuel cycle technologies, and non-proliferation, with the focus on achieving the long-term GNEP vision – expansion of nuclear power in a manner, which reduces the risk of proliferation. The most significant agreed upon areas of cooperation are: the development of technologies for recycling SNF that do not separate pure plutonium, and establishment of a framework for “Reliable Fuel Services” which eliminate the need for countries to establish their own enrichment and reprocessing capability.

The second phase of GNEP international engagement was introduced at the 2nd GNEP Ministerial meeting, hosted by Secretary of Energy Bodman, and the Ministers from France, Japan, Russia and China, on September 16, 2007, in Vienna, Austria. Thirty-six countries were invited to become GNEP partners, and to date, nineteen nations have signed the “Statement of Principles.” A GNEP steering Group of Partner Nations was established to manage GNEP working groups on nuclear infrastructure and reliable nuclear fuel services. The Steering Group held its first meeting December 11-13, 2007 in Vienna, Austria and the United States was elected to chair the Steering Group with vice-chairs from France, Japan, and China.

In FY 2009, the Department will:

- Support international engagement on GNEP principles.

	FY 2007	FY 2008	FY 2009
Fast Neutron Test Capability	**4,000**	**0**	**10,000**

The purpose for developing a fast-neutron test capability is to be able to perform the irradiation testing of advanced fuels and materials under prototypical fast reactor conditions. Currently, the U.S. has no capability of this kind and must therefore rely on the use of foreign reactors. Such reliance will limit the pace at which we will be able to develop the necessary fuels, targets, and materials because of limited irradiation space and time available in the reactor facilities. This activity includes the design, fabrication, and installation of a fast-neutron source at an existing DOE accelerator facility or nuclear reactor. This project is being managed as the acquisition of a major item of equipment.

As directed by Congress, funding was provided in prior years to the AFCI program to determine which test capabilities are needed and to complete pre-conceptual and conceptual design. The options considered include building this capability at the Los Alamos Neutron Science Center at Los Alamos National Laboratory, modifying the ATR at INL, and using the High Flux Isotope Reactor at Oak Ridge National Laboratory. Mission Need is planned in FY 2008 using carryover funds, to pursue identification of options. An Alternative Selection and Cost Range will be requested by the first quarter of FY 2009.

In FY 2009, the Department will:

- Select facility alternatives and establish the cost range.
- Begin preliminary site preparation, design activities, and procurement of long-lead items.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**0**	**1,000**

The FY 2009 amount shown is an estimate of the requirement for the continuation of the SBIR and STTR program.

Total, Advanced Fuel Cycle Initiative	**166,092**	**0**	**301,500**

Explanation of Changes

	FY 2009 vs. FY 2008 ($000)
Separations Research and Development The increase from $0 to $59,217,000 provides appropriate advanced R&D activities to support qualification of the flowsheet to be utilized in GNEP processing through the conduct of multiple end-to-end tests using actual LWR spent fuel and the shift from technology efforts.	+59,217
Advanced Fuels Research, Development, and Testing The increase from $0 to $53,000,000 for expanded fuels research and the shift from technology efforts.	+53,000
Transmutation Research and Development The increase from $0 to $53,400,000 incorporates longer-term activities for the advanced recycling reactor such as nuclear physics data, advanced materials research and advanced integrated or compact components and incorporates grid appropriate reactor research and the shift from technology efforts.	+53,400
Systems Analysis/Advanced Computing and Simulation The increase from $0 to $73,000,000 results from expansion of the Advanced Computing and Modeling and Simulation program element to use the power of massively parallel science based on computing to improve the safety, performance and economics of nuclear reactors.	+73,000
Transmutation Education The increase from $0 to $1,000,000 reflects a new approach under which universities faculty and students are directly involved in GNEP projects through a competitive solicitation process and funding coming directly from AFCI research and development programs.	+1,000

	FY 2009 vs. FY 2008 ($000)
Advanced Fuel Cycle Facility	
The increase from $0 to $10,383,000 represents additional conceptual design activities in support of the 2008 Secretarial decision on the GNEP path forward.	+10,383
Consolidated Fuel Treatment Center	
The increase from $0 to $18,000,000 reflects continuation of the industry led deployment studies that helped to inform the Secretary's decision on the GNEP path forward and to facilitate the legal, regulatory, and policy changes needed to achieve a flexible approach that promotes an industry led effort that achieves the waste reduction, energy recycling, and non-proliferation goals of GNEP.	+18,000
Advanced Burner Reactor	
The increase from $0 to $18,000,000 reflects continuation of the industry led deployment studies that helped to inform the Secretary's decision on the GNEP path forward and an increase in the international collaboration on SFR prototypes.	+18,000
GNEP Global Partnership Development	
The increase from $0 to $4,500,000 is necessary to implement work with other nations to implement the global aspects of GNEP.	+$4,500
Fast Neutron Test Capability	
The increase from $0 to $10,000,000 provides the funds necessary to continue development of a fast neutron test source.	+10,000
SBIR/STTR	
The increase from $0 to $1,000 provides an overall increase in AFCI R&D funding.	+1,000
Total Funding Change, Advanced Fuel Cycle Initiative	**+301,500**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

Major Items of Equipment

(dollars in thousands)

	Total Project Cost (TPC)	Total Estimated Cost (TEC)	Prior-Year Appro-priation	FY 2007	FY 2008	FY 2009	Completion Date
Fast Neutron Test Capability	50-95M	84,000	0	4,000	0	10,000	FY 2013
Total, Major Items of Equipment				4,000	0	10,000	

Fuel Cycle Research and Facilities

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Fuel Cycle Research and Facilities					
Advanced Fuel Cycle Initiative	0	181,000	-1,647	179,353	0
MOX Fuel Fabrication Facility	0	281,349	-2,560	278,789	0
Total, Fuel Cycle Research and Facilities	0	462,349	-4,207	458,142	0[a]

Public Law Authorizations:
P.L. 110-5, Revised Continuing Appropriations Resolution, 2007
P.L. 110-161, The Consolidated Appropriations Act, 2008

Mission

The mission of the Fuel Cycle Research and Facilities program is to develop fuel cycle technologies that will support the economic and sustained production of nuclear energy and produce fuel for nuclear reactors from spent nuclear fuel and surplus weapon-grade plutonium.

The Advanced Fuel Cycle Initiative (AFCI) is focused on implementing the Global Nuclear Energy Partnership (GNEP), which is our nation’s comprehensive initiative that supports the safe, secure expansion of nuclear power both internationally and domestically. Internationally, GNEP is working to establish a framework to ensure that nuclear power expansion can be achieved appropriately with reduced risk of nuclear weapons proliferation. Domestically, GNEP is developing the advanced technologies and facilities needed to change the nuclear fuel cycle to one in which spent nuclear fuel (SNF) is recycled. Once deployed, this new approach will allow the United States (U.S.) to separate SNF into waste and usable components, allowing reactors to extract additional energy, and providing options for more effective management of the residual waste. AFCI is developing these new technologies so that they may be deployed as part of the nuclear fuel cycle to support operation of current nuclear power plants, Generation III+ advanced light water reactors (LWR), and Gen IV advanced reactors.

The Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) program will dispose of surplus weapon-grade plutonium by fabricating it into fuel for use in nuclear reactors. Once irradiated, the plutonium is no longer readily useable for nuclear weapons. The disposal of the material will meet the U.S. commitments made in the Plutonium Management and Disposition Agreement with Russia. NE will fund the design, construction and operation of a MFFF. The MFFF will be built at the Department’s Savannah River Site (SRS) near Aiken, South Carolina. In August 2007, the National Nuclear Security Administration initiated construction of the facility.

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[a] Beginning in FY 2009, funding for the Advanced Fuel Cycle Initiative is requested within the Nuclear Energy Research and Development and the Mixed Oxide Fuel Fabrication Facility is requested within the Other Defense Activities appropriation.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for energy security, nuclear security, scientific discovery, environmental responsibility and management excellence), plus 16 Strategic Goals that tie to the Strategic Themes. The Fuel Cycle Research and Facilities program supports the following goals:

Strategic Theme 1, Energy Security: Promoting America's energy security through reliable, clean, and affordable energy

Strategic Goal 1.2, Environmental Impacts of Energy: Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Strategic Theme 2, Nuclear Security: Ensuring America's nuclear security

Strategic Goal 2.2, Weapons of Mass Destruction: Prevent the acquisition of nuclear and radiological materials for use in weapons of mass destruction and other acts of terrorism.

The Fuel Cycle Research and Facilities program has two GPRA Unit Program goals which contribute to Strategic Goals 1.2 and 2.2 in the "goal cascade":

GPRA Unit Program Goal 1.2.14.00: Develop New Nuclear Generation Technologies - By 2015, enable industry to construct and operate new nuclear power plants, promoting safe, reliable and carbon-free energy production, through the standardization of Generation III+ plant designs, the successful demonstration of nuclear plant permitting and licensing processes, the advancement of Gen IV plant technologies, the construction of pilot-scale hydrogen production experiments, and the commencement of proliferation-resistant spent nuclear fuel (SNF) recycling technology demonstration activities.

GPRA Unit Program Goal 2.2.43.00: Fissile Materials Disposition – Eliminate surplus Russian plutonium and surplus U.S. plutonium.

Contribution to GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)

The AFCI supports near-term technology development and demonstration activities that advance the goals of the National Energy Policy and Energy Policy Act of 2005 by developing the enabling technologies needed to reduce high level waste volume and separate and transmute long-lived, highly radiotoxic elements. These activities directly support the vision and goals of GNEP. In addition to advanced fuel cycle R&D activities, the program will develop an Advanced Burner Reactor, which will be a prototype for future commercial plants and incorporate advanced design features to improve performance, reduce cost and improve safeguards. A nuclear fuel recycling center will employ state-of-the-art technologies to provide proliferation-resistant LWR separations capability. Finally, AFCF will provide technology development capability to support fast reactor design and development of transmutation fuel and/or transmutation targets.

Contribution to GPRA Unit Program Goal 2.2.43.00 (Fissile Materials Disposition)

The MFFF program (Program Goal 2.2.43) contributes to Strategic Goal 2.2 by converting surplus U.S. weapon-grade plutonium into fuel for commercial LWRs. After irradiation, the plutonium would no longer be directly usable.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.2, Environmental Impacts of Energy			
GPRA Unit Program Goal 1.2.14.00, Develop New Nuclear Generation Technologies			
Advanced Fuel Cycle Initiative	0	179,353	0
Total, GPRA Unit Program Goal 1.2.14.00, Develop New Nuclear Generation Technologies	0	179,353	0
Strategic Goal 2.2, Weapons of Mass Destruction			
GPRA Unit Program Goal 2.2.43.00, Fissile Materials Disposition			
MOX Fuel Fabrication Facility	0	278,789	0
Total, GPRA Unit Program Goal 2.2.43.00, Fissile Materials Disposition	0	278,789	0
Total, Strategic Goals 1.2 and 2.2 (Fuel Cycle Research and Facilities)	0	458,142	0

Annual Performance Results and Target

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)					
Advanced Fuel Cycle Initiative					
Complete fabrication and irradiation of advanced light water reactor (LWR) proliferation-resistant transmutation fuel samples, and initiate post-irradiation examination of the samples. (MET TARGET)	Issue preliminary report on the post-irradiation examination (PIE) of actinide-bearing metal and nitride transmutation fuels in the Advanced Test Reactor (ATR). (MET TARGET)	Complete research and development activities that allow the AFCI program to support the Secretary of Energy's determination of the need for a second geologic repository for spent nuclear fuel (SNF) by FY 2008. (MET TARGET)	Complete research and development activities, focused on advanced fuel separations technology development and demonstration, to support the Secretary of Energy's determination of the need for a second geologic repository for SNF by FY 2008. (MET TARGET)	Determine a path forward for GNEP in 2008 by creating a technology development document on recycling technology options, including their readiness and risks, the state of technology development achieved to date, future research and development, and economic evaluations needed to achieve the GNEP vision	
Achieve variance of less than 10 percent from cost and schedule baselines for AFCI activities. (MET TARGET)	Conduct laboratory-scale test of group actinide separation process (plutonium, neptunium, americium and curium extracted together) with actual LWR spent fuel and report preliminary results. (MET TARGET)			Determine a path forward for GNEP in 2008 by completing trade-off studies of new versus existing facilities for an Advanced Fuel Cycle Facility, including economic evaluations.	
Issue the report on the demonstration of a laboratory-scale separation of americium/curium from SNF to support the development of advanced fuel cycles for enhanced repository performance. (MET TARGET)				Determine a path forward for GNEP in 2008 by completing initial industry design studies for the Advanced Burner Reactor, including an evaluation of the development costs for the various prototype options.	
				Determine a path forward for GNEP in 2008 by completing technical and economic evaluations of four industry-led conceptual design studies for a nuclear fuel recycling center.	

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 2.2.43 (Fissile Materials Disposition)					
Mixed Oxide (MOX) Fuel Fabrication Facility					
	Cumulative percentage of the design, construction, and cold start-up activities completed for the MOX Fuel Fabrication Facility (MFFF) (Long-term Output) R:13% T: 13%	Cumulative percentage of the design, construction, and cold start-up activities completed for the MFFF (Long-term Output) R: 17% T: 17%	Cumulative percentage of the design, construction, and cold start-up activities completed for the MFFF (Long-term Output) R:24 % T: 24%	Cumulative percentage of the design, construction, and cold start-up activities completed for the MFFF (Long-term Output) T: 30%	

Means and Strategies

The Fuel Cycle Research and Facilities program will use various means and strategies to achieve its GPRA Unit Program goals. However, various external factors may impact the ability to achieve these goals. The program also performs collaborative activities to help meet its goals.

The Department will implement the following means:

- AFCI will collaborate with industry to: 1) define the most commercially viable designs and business models under which advanced fuel cycle technologies could be deployed, 2) provide industry representation on appropriate expert review panels and 3) ultimately construct AFCI/GNEP facilities.

- NE will maintain contracts with industry to construct, license, and operate the MFFF and contracts with a nuclear utility to use the fuel.

- NE will follow the established principles and procedures of DOE O 413.3, "Program and Project Management for the Acquisition of Capital Assets" for both AFCI and MFFF activities.

The Department will implement the following strategies:

- Partnering with the private sector, national laboratories, universities, and international partners to develop and deploy advanced nuclear technologies to increase the use of nuclear energy in the U.S.

- Leading the international community in pursuit of advanced nuclear technology that will benefit the U.S. with enhanced safety, improved economics, and reduced production of wastes.

- Conducting international cost-shared R&D in the AFCI/GNEP program.

- Constructing a U.S. MFFF at the Savannah River Site in which to fabricate fuel from surplus U.S. weapon-grade plutonium for use in nuclear reactors.

- Irradiation of the fuel fabricated from the U.S. weapon-grade plutonium after which it will not be readily useable in a nuclear weapon.

- Initiate an external review of the MFFF construction baseline and revise the project plan as appropriate.

These strategies will result in the efficient and effective management of NE programs - thus putting the taxpayer's dollars to more productive use.

The following external factors could affect NE's ability to achieve its strategic goal:

- Deployment of advanced fuel cycle technologies will depend upon policy decisions that will determine the implementation of advanced spent fuel reprocessing technologies (e.g. the Secretary of Energy's 2008 decision on GNEP) as well as reducing risks and establishing an appropriate business case for private sector investment and commercial deployment.

- All nuclear energy research programs rely heavily on data produced through collaborations with foreign nations. Should vital data from foreign partners prove unavailable, an increased U.S. effort in technology development would be required.

U.S. policy could change and therefore affect the ability of NE to dispose of U.S. surplus weapon-grade plutonium or alter the mission of the program.

In carrying out the program's mission, NE performs the following collaborative activities:

- Participation in international experiments related to the development of advanced fuel cycle technologies is being performed in support of AFCI/GNEP objectives.

- NE will collaborate with other programs within the Department, such as the Office of Science, the Office of Civilian Radioactive Waste Management, and the National Nuclear Security Administration, all of whom have roles supporting AFCI/GNEP.

- NE will collaborate with National Nuclear Security Administration (NNSA), and their national laboratories, on the overall effort to destroy U.S. surplus weapon-grade plutonium. NNSA is responsible for two other key components of the effort: the Pit Disassembly and Conversion Facility and the Waste Solidification Building.

Validation and Verification

To validate and verify program performance, NE conducts various internal and external reviews and audits. NE's programmatic activities are subject to periodic review by Congress, the Government Accountability Office, the Department's Inspector General, the Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency, state environmental and health agencies, the Defense Nuclear Facilities Safety Board, and the Department's Office of Engineering and Construction Management. In addition, NE provides continual management and oversight of its R&D programs—the NP 2010 program, the Gen IV, NHI, and AFCI. Periodic internal and external program reviews evaluate progress against established plans. These reviews provide an opportunity to verify and validate performance. Monthly, quarterly, semi-annual and annual reviews, consistent with program management plans and project baselines, are held to ensure technical progress, cost and schedule adherence, and responsiveness to program requirements.

The Department obtains advice on the direction of nuclear energy programs from the independent Nuclear Energy Advisory Committee (NEAC). NEAC, a formal Federal advisory committee, provides expert advice on long-range plans, priorities, and strategies for the nuclear technology R&D and research infrastructure activities of NE. NEAC has several active subcommittees examining various aspects of nuclear technology R&D. Reports issued by these subcommittees that address the future of nuclear energy include: the "Long-Term Nuclear Technology Research and Development Plan", the "Nuclear Science and Technology Infrastructure Roadmap", "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010", "A Technology Roadmap for Generation IV Nuclear Energy Systems", "Report of the Subcommittee on Nuclear Laboratory Requirements", and "An Evaluation of the Proliferation Resistant Characteristics of Light Water Reactor Fuel with the Potential for Recycle in the United States".

In FY 2006, as a follow-up action assigned as part of this assessment, NE contracted with the National Academy of Sciences (NAS) to conduct an extensive, comprehensive, and independent evaluation of R&D and Infrastructure program goals and plans, including the process for establishing program priorities and oversight. The evaluation resulted in a detailed set of policy and research recommendations and associated priorities for an integrated agenda of research activities to support the long-term commercial energy option to provide diversity in energy supply. A pre-publication version of the report was issued in October 2007; the final report is scheduled for publication in January 2008. NE continues to review the report findings, and is working with OMB to develop a viable strategy for implementing the committee's recommendations.

In FY 2007, the General Accountability Office began a comprehensive audit of GNEP. Once released, the findings will help inform the AFCI/GNEP implementation strategy.

Program Assessment Rating Tool (PART)

The Department has implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. NE's R&D programs have incorporated feedback from OMB into the FY 2009 Budget Request, and have taken the necessary steps to continue to improve performance.

For AFCI, an overall PART score of 76 was achieved with top scores of 100 in Section I, Program Purpose & Design, and Section III, Program Management. These scores are attributable to the continued use of effective program management practices. A score of 90 was achieved for Section II, Strategic Planning reflecting the need to improve the linkage between budget and performance data at the Departmental level. A score of 53 was achieved for Section IV, Program Results/Accountability, indicating the need to better demonstrate the cost effectiveness of the program. To address these findings, the program revised its near and long-term goals, and is working to increase cost effectiveness by continuing to increase international cost-shared R&D costs through expanded collaborations.

In addition, the AFCI program was found to rely upon process oriented, output based metrics that did not indicate whether the program is successful or demonstrating meaningful progress. These programs revised their performance measures in FY 2006 to capture progress made on the programs' core elements. By focusing on a future outcome, the measure allows for trending of annual progress toward a consistent objective.

OMB gave the Fissile Materials Disposition program (which includes the MFFF) scores of 100 percent on the Program Purpose and Design, and Strategic Planning Sections; 88 percent on the Program Management Section; and 50 percent on the Program Results and Accountability Section. Overall, the OMB rated the FMD program 73 percent, the second highest rating of "Moderately Effective." The OMB assessment found that the program demonstrates proper planning and management, but performance results are limited and program cost and schedule performance is mixed. The OMB also found that the FMD program follows agency project management requirements. In response to the OMB findings, the FMD program is validating cost and schedule baseline to measure performance and maintain change control during construction, and completing certification of project control systems by the responsible federal agency to ensure accurate performance measurement

Advanced Fuel Cycle Initiative

Funding Schedule by Activity

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		
Advanced Fuel Cycle Initiative			
Separations Research and Development	0	37,773	0
Advanced Fuels Research, Development and Testing	0	35,304	0
Transmutation Research and Development	0	15,949	0
Systems Analysis/Advanced Computing and Simulation	0	40,124	0
Transmutation Education	0	4,000	0
Advanced Fuel Cycle Facility	0	4,000	0
Consolidated Fuel Treatment Center	0	13,000	0
Advanced Burner Reactor	0	11,710	0
GNEP Technology Development	0	16,100	0
SBIR/STTR	0	1,393	0
Total, Advanced Fuel Cycle Initiative	0[a]	179,353	0[b]

Description

The mission of the Advanced Fuel Cycle Initiative (AFCI) is to develop fuel cycle technologies that will support the economic and sustained production of nuclear energy while minimizing waste and satisfying requirements for a controlled, proliferation-resistant nuclear materials management system. Prior to FY 2008, the AFCI program was included in the Nuclear Energy Research and Development (NE R&D) program. In FY 2008, the AFCI program is included in the Fuel Cycle Research and Facilities as appropriated. Beginning in FY 2009, the AFCI program will be requested under the NE R&D budget.

Further discussion of the AFCI program is addressed in the AFCI portion of the NE R&D budget.

Detailed Justification

	FY 2007	FY 2008	FY 2009
	(dollars in thousands)		
Separations Research and Development	**0**	**37,773**	**0**

The goal of the Separations Research and Development (R&D) activity is to develop advanced aqueous and electrochemical separations technology alternatives capable of treating the existing and projected inventory of SNF and fast reactor recycle fuel in a safe, efficient and proliferation-resistant

[a] In FY 2007, the Advanced Fuel Cycle Initiative was included in the Nuclear Energy Research and Development program. In FY 2008, AFCI is included in the Fuel Cycle Research and Facilities program.

[b] Beginning in FY 2009, the Advanced Fuel Cycle Initiative program will be requested under the Nuclear Energy Research and Development program.

manner. The U.S., which developed essentially all separations technologies currently deployed in the world, has not been directly involved in civilian spent fuel processing since 1974. The central purpose of Separations Research and Development is to support that effort though R&D on processes that do not separate plutonium and providing technologies for industrial applications. Vigorous efforts will be required to achieve those aims. Information developed under this activity will be used to help inform a recommendation to the Secretary of Energy in 2008 on the future course of GNEP. The current suite of advanced aqueous processes has potential for meeting proliferation-resistant separations objectives, while improving the waste management associated with current aqueous separations technologies. However, electrochemical processing (referred to previously as pyroprocessing) may be better suited to address the requirements of sodium-bonded metallic fast reactor fuels. This R&D provides alternatives for important parts of the separations processes where a high or moderate risk is present. This task also supports long-term R&D for next-generation facilities. Data for modeling and simulation validation is developed under this activity.

This program will:

- Significantly reduce the volume and hazard of spent nuclear fuel that must be stored in a repository.
- Allow actinides in spent nuclear fuel to be used as a future fuel for either or both LWR and ABR in a safe and proliferation resistant manner.
- Provide a way that long lived actinides can be consumed so the ultimate waste products are less radiotoxic.
- Support GNEP in producing an energy source that has a very low emission of greenhouse gases.
- Develop and test advanced monitoring and accountability technologies that will strengthen nuclear nonproliferation.
- Improve simulation technologies that will reduce separations costs and improve reliability.
- Develop advanced waste forms.

Before separations can be adopted by industry on a commercial scale the technology must be proven to provide the needed separations in a cost-effective manner, while reducing proliferation problems associated with the PUREX process. Issues such as extracting strontium/cesium for separate decay storage; finding better processes for extracting americium and curium; developing equipment for materials accountability; and finding better waste forms for gaseous effluents including tritium, carbon-14 and iodine-129 are examples of where improvements are desirable. A long term R&D program will take on each of the issues to make the process increasingly efficient for the future. In the very short term the program has emphasized activities which will give the Secretary better information for the 2008 decision on GNEP direction for the future. Currently the program is focused on Advanced Proliferation-Resistant Aqueous Fuel Treatment and Other Separation Processes including Electrochemical Processing.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
▪ **Advanced Proliferation-Resistant Aqueous Fuel Treatment**	**0**	**22,773**	**0**

Laboratory-scale experiments have proven the advanced, aqueous-based UREX+ technologies to be capable of removing uranium from spent fuel at purity levels of up to 99.999 percent and essentially free of high-level radioactive contaminants. The resulting material (uranium, which comprises approximately 95% of SNF) could theoretically be disposed of as low-level waste or retained for use as reactor fuel. If spent fuel were processed in this manner, the volume of high-level waste requiring disposal in a geologic repository could be significantly reduced, potentially lowering the cost of storage and disposal of the remaining high-level waste and significantly increasing the technical capacity of a geologic repository.

Additional research is continuing to evaluate aqueous chemical treatment methods to separate selected actinide and fission product isotopes from the process stream after the uranium has been removed. Certain long-lived fission products (i.e., iodine-129 and technetium-99) are significant contributors to the potential dose from a repository and the long-term radiotoxicity of spent fuel, and could also be separated for transmutation or incorporation into new waste forms for safe disposal. Other gaseous radionuclides will be collected and safely sequestered. Materials now considered high-level wastes in LWR spent fuel processing facilities, such as fuel element hulls and end boxes from chop-leach dissolution, may be decontaminated sufficiently to qualify as low-level waste or even recycled for reuse in new fuel elements.

In FY 2008, the Department is:

- Continuing the end-to-end demonstrations of recycling technologies. The demonstrations are expected to produce separated transuranics for use in the transmutation fuel development program and waste products for waste form fabrication.
- Integrating laboratory-scale tests of the separations process selected for the recycling demonstration prototype; process demonstration of various advanced separations technologies capable of isolating transuranics (collectively or individually); the collection and recovery of various volatile fractions from the shearing of spent fuel, the oxidation of spent uranium dioxide fuel and its subsequent dissolution, including alternate storage methods for rare fission gases such as krypton-85 separated from inert xenon, for tritium and for carbon-14; and the development of advanced waste forms for iodine and technetium and other long-lived radionuclides.
- Initiating tests on the application of advanced aqueous separations processes to the recycle of high burn-up fast reactor oxide fuel, using spent fuel from the Fast Flux Test Facility (FFTF). High burn-up metal fuel is also available for electrochemical treatment.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

- Testing advanced safeguards instrumentation will also being tested under simulated conditions to identify candidates for later testing in either a recycling demonstration prototype or the Advanced Fuel Cycle Facility (AFCF), depending upon the ultimate design of these facilities.
- Conducting research in collaboration with the Department's Office of Science, to understand the basic chemistry of aqueous separations, including the structure and stability of various organic complexes.

	FY 2007	FY 2008	FY 2009
Other Separations Processes (Including Electrochemical processing)	**0**	**15,000**	**0**

Electrochemical processing (previously referred to as pyroprocessing) is a proliferation-resistant non-aqueous approach used to separate the actinides in spent fuel from fission products. AFCI electrochemical processing activities support reduction of nuclear waste radiotoxicity by separating minor actinides from spent fuel coming from metal-fueled fast reactors for recycle. While using electrochemical processing to treat spent fuel from the Experimental Breeder Reactor-II (EBR-II), electrochemical process improvements have been made, which increase its applicability to other advanced reactor fuels.

In FY 2008, the Department is:

- Continuing R&D on advanced recycle processes for fast reactor spent fuel. Such processes must be capable of separating uranium and transuranics from fission products in fuel with very high radioactivity, thus requiring remote handling.
- Conducting advanced recycle process activities required including: treatment of fast reactor metal fuels, laboratory-scale liquid cadmium cathode (LCC) testing of group actinide recovery, high throughput electrorefining, the investigation of crucible materials for LCC applications; advanced sampling methods for electrochemical processing technologies; reductive extraction of actinides and electrolytic drawdown from salt waste; americium separation from curium using electrochemical methodologies as part of the EuroPart cooperative program; and advanced processing methods for spent oxide reactor fuel, using high burnup fast reactor spent oxide fuel from the FFTF; cold testing; irradiated fuel testing and integrated electrochemical modeling as part of an ongoing International Nuclear Energy Research Initiative (I-NERI) project with the Korea Atomic Energy Research Institute.
- Developing engineering-scale oxide reduction equipment, also in collaboration with South Korean researchers.
- In collaboration with the Department's Office of Science, research is being conducted to better understand the basic chemistry of electrochemical processing.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

Advanced Fuels Research, Development, and Testing	**0**	**35,304**	**0**

The goal of the Advanced Fuels Research, Development, and Testing activity is to develop, fabricate, and test transmutation fuels and transmutation targets using recycled SNF. While a portion of this fuel development effort is aimed at producing transmutation fuels for use in LWRs, most of this effort is being directed at producing fuels suited for use in fast reactors which offer the best opportunity to transmute (consume) most of the transuranics in the recycled fuel efficiently and safely. Advanced transmutation fuels fabricated from LWR spent fuel are the critical, linchpin components of the AFCI/GNEP concept. These advanced fuel designs will permit extracting vast amounts of currently unavailable energy from spent fuel materials while doing so in a proliferation-resistant manner and increasing the load capacity of the Yucca Mountain repository by as much as fifty-fold. This activity also supports long-term R&D for next-generation nuclear reactors (i.e., Generation IV), including generating data which can be used to validate modeling and simulation activities.

Currently, advanced transmutation fuels are fabricated in small batches (e.g. one to four fuel pins) using bench-scale facilities primarily at Idaho National Laboratory, and include nitride fuels, dispersion fuels, sphere-pac fuels, inert matrix fuels and transmutation targets. Advanced fuel development work is focused on near term R&D in support of qualifying transmutation fuel and targets for an advanced burner reactor. In addition, this Advanced Fuel Research, Development and Testing work is closely integrated with the technology development activities that support the engineering and design of the planned AFCF. The AFCF will be capable of fabricating sufficient transmutation fuel for lead test assemblies. These lead test assemblies will be irradiated in an advanced burner reactor and will provide the performance data needed by the Nuclear Regulatory Commission (NRC) for transmutation fuel qualification.

Much of the advanced fuels irradiation testing and examination work is being done in the Advanced Test Reactor (ATR) thermal neutron source at the Idaho National Laboratory (INL). Irradiation testing at the ATR is shifting from less precise, un-instrumented tests which estimate conditions at the fuel sample to more precise instrumented tests. These instrumented tests will provide valuable data on irradiation conditions at the fuel sample and will reduce development time and costs while improving the efficiency of the advanced transmutation fuels. Irradiations will also take place domestically when a fast neutron source is available. In addition, the cost, scope and schedule to provide a transient test capability are being developed.

Research efforts in advanced fuels are being leveraged through several ongoing and planned international research collaborations. Two U.S. origin fast reactor transmutation fuel irradiation tests (FUTURIX-FTA and MI) have been initiated in the French Phenix reactor. In addition, discussions for an international arrangement for transmutation fuel irradiation tests in the Japanese JOYO fast reactor and in fast test reactors in Russia have been initiated. This international cooperation is necessary since the U.S. does not have a fast reactor in which to perform these irradiations.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

In FY 2008 the Department is:

- Completing the post irradiation examinations of high burn-up transmutation fuel irradiated in the ATR and initiating fabrication of oxide transmutation fuel which, along with the metal transmutation fuels fabricated the prior year, is to undergo irradiation testing in the ATR.
- Continuing the two U.S. origin fast reactor transmutation fuel irradiation tests (FUTURIX-FTA and MI) in the French Phenix reactor.
- Negotiating agreements for fuel irradiation tests in foreign fast test reactors and post irradiation examinations with Russia and Japan.
- Providing support for fuels computational modeling as well as support for the development of instrumentation and controls for safeguarding nuclear materials during fuel fabrication.
- Developing cost, scope, and schedule for a transient test capability which will enable the testing of advanced fuels in atypical reactor conditions.

	FY 2007	FY 2008	FY 2009
Transmutation Research and Development	**0**	**15,949**	**0**

Transmutation, as it applies to AFCI/GNEP, converts long-lived radioactive isotopes into shorter-lived, and therefore, produces less radiotoxic long-lived isotopes. As a result, transmutation can lower the radiotoxicity of spent nuclear fuel to below that of natural uranium ore by reducing the time for decay from hundreds of millennia to as little as centuries. The Transmutation R&D effort is focused on long-term R&D to reduce operational uncertainties, improve transmutation system performance, and reduce costs through development of advanced technologies. The effort is focused on fast reactors because the transmutation of transuranics is best performed in fast reactors.

Because capital investment in reactors is the dominant cost of any nuclear fuel cycle, the work described here is a critical component to assure an economically viable closed fuel cycle. To reduce the cost of future fast reactors, a variety of innovative solutions are being researched. Reduced uncertainty on the physics behavior of the reactor can eliminate unwarranted design margins that are costly and add little or no value. Improved materials that perform better and longer are needed. The Transmutation R&D Program is a long-term program that will address these issues. Its success will largely determine if industry will deploy fast reactors beyond the initial ABR and ultimately determine the success of the GNEP fuel cycle vision.

It is envisioned that this program will expand from its current bench scale R&D effort to a full scale research and development effort that can develop and demonstrate the needed components, physics, and safety technologies that will provide the desired breakthroughs. This will be accomplished by expanding existing facilities, developing key domestic facilities, leveraging program knowledge by exchanging information with the international fast reactor programs, and performing joint research in foreign facilities with unique capabilities.

In FY 2008, the Department is:

- Continuing design concept studies to assess the impact of cost reduction technologies.
- Conducting additional evaluation and refinement of physics cross sections for actinide isotopes to support the advanced transmutation reactor fuel cycle.

	(dollars in thousands)	
FY 2007	FY 2008	FY 2009

- Completing mechanical testing and analysis of structural materials irradiated in the FFTF; the development and qualification of advanced structural materials for use in fast spectrum transmutation systems.
- Conducting validation testing of existing fast reactor design methods; and coordination of international activities dealing with liquid metal fast reactor coolant and transmutation systems.
- Initiating additional activities to reconstitute domestic sodium technology infrastructure by the specification and design of a sodium component testing facility.
- Continuing coordination of international activities dealing with transmutation systems.
- Integrating advanced modeling and simulation activities with results of materials and physics experiments and utilize improved reactor simulation methods for further reactor cost reduction and safety benefits.

	FY 2007	FY 2008	FY 2009
Systems Analysis/Advanced Computing and Simulation	**0**	**40,124**	**0**

Systems Analysis/Advanced Computing and Simulation includes Systems Analysis and Integration and Advanced Computing and Simulation.

	FY 2007	FY 2008	FY 2009
▪ **Systems Analysis and Integration**	**0**	**18,000**	**0**

The Systems Analysis and Integration activity examines the possible combinations of nuclear technologies to optimize the technical, economic, and environmental aspects of the fuel cycle as a whole, from mining to waste disposal. This includes an administrative function centered at INL to manage the integration process so that all technical activities of AFCI are coordinated and integrated. Systems Analysis develops and applies evaluation tools to formulate, assess, and guide program activities to evaluate various combinations of reactor types, reprocessing techniques, and waste disposal systems to meet program goals and objectives.

In addition to optimization, Systems Analysis and Integration is also focused on the evaluation and down-selection of the most promising spent fuel treatment technologies, fuels technologies, reactors, and advanced fuel cycle deployment strategies acquired from AFCI and Generation IV R&D activities. Proliferation resistance analyses conducted by the NNSA and efforts conducted under the Safeguards Technology campaign are factored in as a high-priority, ongoing activity, especially in the area of advanced separations technologies.

Additionally, Systems Analysis and Integration investigates optimal systems architecture to reduce the burden on potential future geologic repositories by removing the uranium and major heat-generating components of SNF, and optimizing the destruction of actinides to reduce the time it takes for the radiotoxicity of the waste to decay to levels comparable to the radiotoxicity of uranium ore. A systematic analysis of fuel cycle performance is performed for promising options, the results of which assist the Department in effectively prioritizing program R&D and establishing requirements for proposed projects. In a related activity, Systems Analysis and Integration produces the annual "AFCI Comparison Report" for Congress, which compares various separations, fuels and reactor technologies being researched by the AFCI and

Generation IV programs against the goals and objectives of those programs.

Systems Analysis and Integration also includes cost analysis activities and establishing consistent cost bases for use in evaluating the advanced fuel cycle technologies. To this end, the "Advanced Fuel Cycle Cost Basis Report" provides a comprehensive set of cost data for use in evaluating various AFCI and Generation IV technology deployment options. The report and its associated modeling efforts are intended to aid the evaluation of those elements that dominate nuclear fuel cycle costs, and help develop more efficient and less costly fuel cycle systems.

In FY 2008, the Department is:

- Focusing on completing analyses and developing information for the 2008 Secretarial decision on the path forward for GNEP. The GNEP Integrated Waste Management Strategy is to be delivered, and the GNEP technology roadmap will be submitted as an annual Report to Congress.
- Initiating new project management tools and procedures by the TIO. Systems analyses of the initial GNEP facilities are being completed and the GNEP deployment systems analysis updated.

	FY 2007	FY 2008	FY 2009
▪ **Advanced Computing and Simulation**	**0**	**22,124**	**0**

DOE leads the world in the development and application of high performance computing and science based computational simulation. Maintaining and applying this capability is a priority of the American Competitiveness Initiative. The goal of the Advanced Computing and Modeling and Simulation program element is to develop and apply capabilities developed in the Office of Science's Advanced Simulation and Computing Research (ASCR) program and NNSA's Advanced Simulation and Computing (ASC) program to advance the state of the art in nuclear energy applications thereby using the power of massively parallel science based computing to improve the safety, performance and economics of nuclear reactors and potential fuel recycling and waste disposition systems.

This effort is being planned and executed in collaboration with NNSA, and the ASCR, Basic Energy Sciences and Nuclear Physics programs in the Office of Science to build on the capabilities and expertise developed through the multi-billion dollar investment in those programs in recent years. This activity will be executed through the DOE national laboratory system in collaboration with domestic industry and with foreign partners. It will engage our leading research universities in the development of models and methods as well as provide training of students in fields relevant to the nuclear enterprise. These activities will leverage computational and experimental assets, resources, capabilities and experience throughout DOE to avoid duplication and to reduce development times.

This effort began in mid- FY 2007 and was focused on the high priority of developing advanced simulation codes for fast reactor design and fuel performance. These efforts will continue into FY 2008.

(dollars in thousands)

In FY 2009, the Department will significantly expand the Modeling and Simulation (M&S) activities under the Nuclear Energy Research and Development budget and broaden the scope of problems for which simulation tools are being developed. The principal focus is to put together the "code teams" that will develop the advanced applications codes for each of the areas of interest. The experience of the ASC program and the ASCR shows that each code team requires support at the level of $5M to over $30M per year depending upon the complexity of the application being developed. Fully integrated reactor codes that combine neutronics, structural mechanics and thermo-hydraulics into one code with high resolution in 3-dimensions will be similar to the most complex challenges facing the ASC code and over time the program will pursue multiple approaches to the problem, to reduce risk, and to ensure that physics models are developed that are optimized for each of the principle classes of problems to be solved. Such codes currently do not exist, but the benefit in terms of reactor cost and safety performance will be enormous, and even a 5% resulting savings in the cost of construction of future reactors would repay investments many times over.

Likewise, current experience shows that the qualification of a new fuel type can take 20 years and cost over $200M because of the cycle required for in-core irradiation testing. The application of science–based, massively parallel codes may substantially reduce both the cost and time required, while providing a much more optimized fuel design to be submitted for final certification testing. Such developments will be essential to making the development of transmutation fuels for recycling reactors feasible.

In FY 2008, the Department is:

- Focusing on the high priority of developing advanced simulation codes for fast reactor design and fuel performance.

	FY 2007	FY 2008	FY 2009
Transmutation Education	**0**	**4,000**	**0**

Transmutation education supports the development of new U.S. scientists and engineers needed to develop transmutation and advanced nuclear energy technologies through university fellowships and applied research. Transmutation Education activities include the successful university fellowship program, which is developing new U.S. scientists and engineers for the fields of transmutation and advanced nuclear fuel cycle technologies.

In FY 2008, the Department is:

- Continuing the AFCI Fellowship program with both masters and doctoral fellowships awarded.
- Performing additional university research activities within the various AFCI/GNEP research and development activities.
- Funding only NERI grants previously awarded in FY 2006 and FY 2007.

	FY 2007	FY 2008	FY 2009
Advanced Fuel Cycle Facility	**0**	**4,000**	**0**

The AFCF will be a first-of-a-kind, world-class nuclear fuel cycle research, development, and demonstration facility. It will have engineering-scale capabilities that will be used to develop and demonstrate advanced proliferation-resistant fuel recycling technologies. The AFCF will demonstrate these technologies as part of integrating the non-reactor portion of the nuclear fuel cycle, an important element to the cost-effective commercialization of these technologies. Fuel cycle operations will include: remote fabrication of various transmutation fuels and targets; advanced aqueous and electrochemical separations; and advanced waste forms. AFCF will also provide a test bed capability for advanced nuclear material accounting and control systems, one of the primary technologies for significantly reducing nuclear weapon proliferation risks. Many of the technologies developed by AFCI/GNEP on the laboratory scale are expected to be demonstrated at a larger scale by the AFCF.

In the long term, the AFCF is required for the U.S. to regain a leadership role in the nuclear fuel cycle. This is essential if the U.S. is to influence and promote the non-proliferation goals of GNEP. Moreover, the AFCF is needed to continually improve the performance and cost-effectiveness of an integrated fuel cycle and help the U.S. maintain competitiveness in the global nuclear market. While upgrades to existing DOE facilities can support this role to a limited degree over the next 10 to 20 years, this facility can accelerate the evolutionary, as well as revolutionary, improvement to nuclear the commercial applications of advancement of fuel recycling technologies. This facility will continue to depend on a robust laboratory-scale R&D program by talented researchers from around the DOE complex in order to feed viable candidate technologies for demonstration prior to commercial applications.

A phased construction plan for AFCF is envisioned. During the first phase, those facilities that support separations of LWR SNF into its reusable and waste components will be built, as well as those for fuel fabrication and waste processing. It is important that these technologies be successfully demonstrated on an engineering scale for ultimate commercial deployment and waste volume reduction. Phase I will also include the remote manufacture of lead test assemblies. These are experimental fast reactor fuels—fabricated from the separated products of used commercial LWR fuel—and will be placed inside a fast reactor for qualification and validation. This is a necessary step for the development of viable commercial fast reactor fuels for advanced recycling reactors that will get the maximum energy value from the fuel while simultaneously reducing waste and proliferation risks. This capability will be needed to continually improve the commercial application of GNEP technology introduced by the CFTC and evolutionary improvements over the coming decades.

The second phase of construction will focus on building those facilities required for the separations and recycling of used fast reactor fuel, most notably that coming from an advanced recycling reactor. The composition of this fuel will differ from the used LWR fuel that was recycled in the first phase and may require different treatment technologies. The fast reactor fuels may be in metallic form (although other forms are currently being evaluated). If such is the case, an electrochemical approach to fuels separation may be required, and would be developed in the AFCF. If the optimal fuel forms are not metallic, then other recycling approaches must be considered, including that used for LWR fuel.

The facility is being sized to cover the range of research, development and demonstration activities envisioned by GNEP over the next 50 years. The Aqueous Separations Module, for example, is being evaluated for processing LWR used fuel at a throughput rate of 10 to 75 metric tons per year and is being sized for a suite of promising advanced separations processes.

In the near term, the AFCF will focus on demonstrating fabrication of transmutation fuels and targets at a scale necessary prior to commercialization. When built and operational, it will be the only facility in the world capable of providing this capability. Because of this unique capability, the AFCF will be a user facility through which many working partnerships will be established. These partnerships will include participants from all DOE laboratories (a robust scientist exchange program is anticipated), industry, universities, foreign governments and labs, and regulatory agencies (for independent analyses).

In FY 2008, the Department is:

- Continuing conceptual design work with focus on the transmutation fuel/target fabrication area of AFCF. FY 2008 work will result in the completion of 50 percent of the conceptual design, completion of key strategic trade studies, and will include development of cost and schedule range estimates in support of the Secretarial Record of Decision in 2008.

	FY 2007	FY 2008	FY 2009
Consolidated Fuel Treatment Center	**0**	**13,000**	**0**

The CFTC, previously called the Recycling Demonstration Program, will provide the critical steps and support necessary to recycle used nuclear fuel in the U.S. on a scale of commercial significance. The recycling program carried out at the CFTC aims to recover additional energy value from used nuclear fuel by recycling re-useable materials and to reduce the volume and toxicity of waste slated for disposal in a geologic repository. Ultimately the CFTC will include four sub-projects to improve the overall efficiency of the fuel cycle: LWR spent fuel separations facility, transmutation fuel fabrication facility, transmutation fuel separation facility, and advanced recycling reactor startup fuel fabrication facility.

This capability will support a sustained nuclear renaissance by providing domestic and international fuel services and improved waste and product management. Recycled products could be reused in existing LWR and eventually in new advanced recycling reactors that consume the longest-lived and most radiotoxic isotopes. The use of advanced recycling reactors will reduce the amount and hazards of the remaining high-level waste requiring disposal in a geologic repository and result in new waste forms and management approaches more commensurate with their reduced hazards. Approaches considered by AFCI/GNEP in the recycling of used nuclear fuel will employ proliferation-resistant technologies to support GNEP objectives. The program will engage with industry partners to establish spent fuel separations capability as a cornerstone for U.S. nuclear energy leadership.

In FY 2008, the Department is:

- Accepting industry's first set of deliverables resulting from the cooperative agreements. These documents (initial conceptual designs, business models, technology roadmaps, and communications plans) will provide data to support the Secretary's decision on closing the fuel cycle and identify areas that would benefit from specific R&D activities. Follow on work may be awarded to selected industry teams to continue conceptual design development. The design data needs identified by industry will be evaluated and incorporated into the prioritization for technology development activities being performed by the national laboratories to respond appropriately to the critical near-term technology development needs identified by industry.

Advanced Burner Reactor	**0**	**11,710**	**0**

The ABR is a fast-spectrum reactor capable of consuming transuranics and other actinides in support of a closed nuclear fuel cycle. In addition to eliminating these materials from LWR SNF, reducing both heat and waste loads on a geologic repository; the ABR will produce electricity. Reducing the volume, heat-loading, and radiotoxicity of nuclear waste could exponentially increase the capacity of the geological repository at Yucca Mountain. The ability to transmute and destroy transuranics in the ABR is the principal long-term waste management benefit of GNEP.

Input from industry and international partners confirm the feasibility of deploying a prototype fast reactor in the 2020-2025 timeframe. With the shutdown of the FFTF and EBR-II in the 1990s, there are no fast spectrum reactors currently operating in the U.S.

The ABR project will be implemented through two closely integrated paths. An industry-led path will design and build a prototype reactor, which will demonstrate transmutation, qualify advanced reactor fuels and materials, demonstrate advanced design and safety features, and employ modern reactor safeguards. A complimentary path, led by the national laboratories, has two objectives. In the near-term, it will identify and deliver the most promising technologies for incorporation into the prototype ABR. In addition, the labs will conduct the long-term research and engineering to assure that subsequent commercial ABRs will be economically competitive with modern light water reactors. The Department will collaborate with international and industry partners on both paths.

In FY 2008, the Department is:

- Completing the initial design studies needed to inform the GNEP path forward. As one of the deliverables under the cooperative agreement, the industry teams will provide input to an overall GNEP technology roadmap which will determine the technology development required (both near-term and longer-term) to support ABR deployment. The roadmap will define what needs to be done, who will do it (industry or government), when it is required and appropriate contingency plans or off-ramps. Options for fuel types and fabrication (or acquisition) will be evaluated. In addition to the technology roadmap, industry will provide input to the business model for GNEP, which will assure that the ABR project is part of an overall sound plan to commercialize a closed fuel cycle. The business model will consider the risks, incentives, revenues, and market considerations needed to establish the appropriate framework for an effective industry and government partnership. The establishment of an appropriate regulatory framework and a compliance strategy for licensing commercial ABRs will be coordinated between DOE, NRC and industry.
- Pursuing international collaboration activities, as well as support for the NEPA process.

GNEP Technology Development	**0**	**16,100**	**0**

The GNEP Technology Development activity provides support to each of the three GNEP projects (the engineering- to commercial-scale demonstration nuclear fuel recycling center, advanced recycling reactor, and AFCF), driven by the development and design needs of each project.

The technology development activities described below are fully integrated with the design and construction schedules for each of these projects.

In FY 2008, the Department is:

- Conducting activities to support the used nuclear fuel recycling center including technetium extraction, conversion and waste form process development. Engineering studies and /or technology development activities in response to feedback from industry identifying design and technology risks are also expected to be initiated in FY 2008.
- Supporting ABR by establishing the functional and operating requirements for the prototype; beginning to restore the domestic infrastructure required to design, fabricate and test sodium components; and validating the analytical tools used for reactor design. Engineering analysis and trade studies will be used to identify the biggest cost drivers and most promising technologies to reduce the costs to design, construct and operate future commercial ABRs, as well as improve plant performance. Examples include: reactor fuel handling machines, intermediate heat exchangers, advanced liquid metal pumps, reactor control technologies, and balance of plant technologies unique to fast reactor applications.
- Supporting AFCF technology development activities including design of advanced fuel cycle systems to be installed in AFCF. Much of the work will involve fabrication of transmutation fuels and targets that have high radiation fields and, as a result, will need to be performed remotely in hot cells. Work required to modify existing hot cells and install remote fuel fabrication equipment is also included. Also included is feedstock preparation of the minor actinides, americium and curium. Other AFCF work will involve the development of instrumentation and control logic for nuclear material control and accountability. Instruments will be tested in a representative environment. Finally, domestic and international irradiation fuel tests will be required as part of the AFCF technology development activity.
- Establishing an agreement a nuclear utility to develop an increased-scale fuel recycling concept on-site.

	FY 2007	FY 2008	FY 2009
SBIR/STTR	**0**	**1,393**	**0**

The FY 2008 amount shown is an estimate of the requirement for the continuation of the SBIR and STTR program.

Total, Advanced Fuel Cycle Initiative	**0**	**179,353**	**0**

Explanation of Changes

	FY 2009 vs. FY 2008 ($000)
Advanced Fuel Cycle Initiative Funding requested under the Nuclear Energy Research and Development program in FY 2009.	**-179,353**

Mixed Oxide Fuel Fabrication Facility

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Mixed Oxide (MOX) Fuel Fabrication Facility			
MOX Construction	0	231,721	0
MOX Other Project Cost Activities	0	47,068	0
Total, MOX Fuel Fabrication Facility	0	278,789	0

Description

The program goal is to eliminate U.S. weapons-grade plutonium declared surplus to national security needs.

The Consolidated Appropriations Bill, 2008 funds the Mixed Oxide (MOX) Fuel Fabrication Facility within the Nuclear Energy appropriation. Previously, all MOX funding was included in Defense Nuclear Nonproliferation. This project is considered central to meeting the U.S. nonproliferation objectives as described in Defense Nuclear Nonproliferation.

U.S. Plutonium Disposition

In September 2000, the United States and Russia signed a Plutonium Management and Disposition Agreement, which commits each country to dispose of 34 metric tons of surplus weapon-grade plutonium (68 metric tons total – enough material for approximately 17,000 nuclear weapons). In 2006, both the U.S. and Russian Governments reaffirmed their commitment to implement the 2000 Agreement for disposing their plutonium as MOX fuel in nuclear reactors. This is a key element of the U.S. Government's nonproliferation strategy to address the potential threat of diversion of materials that can be used in nuclear weapons. In addition to the obvious nonproliferation benefits, proceeding with the U.S. plutonium disposition will help reduce storage costs for nuclear materials, reduce safeguards and security costs, and support the Department's efforts to consolidate nuclear materials within the DOE Complex.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
MOX Construction	**0**	**231,721**	**0**

The Mixed Oxide Fuel Fabrication Facility (MFFF) will provide the United States with the capability to fabricate MOX fuel elements suitable for use in commercial nuclear reactors from plutonium oxide derived from surplus weapon-grade plutonium. The facility will contain the following key functional areas: shipping and receiving, storage, chemical processing oxide blending, pellet manufacturing, fuel rod manufacturing, fuel bundle assembly, fuel bundle storage, and a laboratory. In addition, a number of supporting facilities will be built including an administration building, material receipt warehouse, technical support building, emergency and standby diesel generator buildings, and a chemical reagent building. DOE awarded a contract to a private consortium, Duke Engineering Services, COGEMA, Inc., and Stone & Weber (DCS) in 1999. DCS, through a series of corporate buyouts, is now Shaw AREVA MOX Services. The contract required DCS to design and obtain a Nuclear Regulatory Commission (NRC) license for the MFFF, which is being built at the SRS. Three options are included in the base contract, which can be awarded separately: 1) construction and cold start-up; 2) hot start-up, operations, and irradiation services; and 3) deactivation.

In FY 2008, the Department is:

- Continuing construction activities such as installing additional floors to the MFFF.
- Continuing installation of procured equipment.
- Continuing installing of mechanical and electrical utilities.
- Continuing procurement of processing equipment.

In FY 2009, funding for MOX Construction is requested in the Other Defense Activities.

MOX Other Project Cost Activities	**0**	**47,068**	**0**

MOX Other Project Cost Activities support project activities, such as, management oversight, design reviews, and facility start-up testing.

In FY 2008, the Department is:

- Continuing management oversight and licensing for construction activities, planning for start-up and operation of the MFFF, supporting design and testing of the Aqueous Polishing process contained within the MOX project supporting environmental permitting and monitoring and supporting the NRC review of the operating licensing application for the MFFF.

In FY 2009, funding for MOX Other Project Costs is requested in the Other Defense Activities.

Total, MOX Fuel Fabrication Facility	**0**	**278,789**	**0**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
MOX Fuel Fabrication Facility	
Funding for this project is requested within the Other Defense Activities in FY 2009.	**-278,789**

Capital Operating Expenses and Construction Summary
Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appro-priations	FY 2007	FY 2008	FY 2009	Unappro-priated Balance
99-D-143, Mixed Oxide Fuel Fabrication Facility, Savannah River Site	3,938,628	1,167,560	262,500	231,721	417,808	1,859,039
Total, Construction Project			262,500	231,721	417,808	

Infrastructure

Funding Profile by Subprogram

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Infrastructure					
Radiological Facilities Management	46,775	48,561	-442	48,119	38,700
Idaho Facilities Management	84,435	117,000	-1,065	115,935	104,700
Total, Infrastructure	131,210	165,561	-1,507	164,054	143,400

Public Law Authorizations:
P.L. 110-5, Revised Continuing Appropriations Resolution, 2007
P.L. 110-161, The Consolidated Appropriations Act, 2008

Mission

The mission of the Infrastructure program within Nuclear Energy appropriation is to manage the planning, acquisition, operation, maintenance, and disposition of nuclear facilities and infrastructure to conduct advanced nuclear energy research and to provide radioisotope power systems for space exploration and national security.

The Infrastructure program includes Radiological Facilities Management and Idaho Facilities Management (IFM). The Radiological Facilities Management program is funded under the Nuclear Energy appropriation. Beginning in FY 2009, the Medical Isotopes program included in the Radiological Facilities Management program transfers to the Office of Science. Prior to FY 2008, the IFM Program was funded in both the Energy Supply and Conservation and the Other Defense Activities appropriations. Beginning in FY 2008, funds for these programs were solely in the Nuclear Energy appropriation.

The Infrastructure program keeps mission supporting DOE facilities and infrastructure in a user-ready status. Activities supported by this program include: operation and maintenance of reactors, hot cells, and infrastructure needed to carry out research and development in support of Nuclear Energy programs; construction of power systems for national security missions and space exploration; and testing of new fuels and core components for the Naval Nuclear Propulsion Program. DOE enables advances in science by making its nuclear facilities available to national and international users. The Department does not subsidize programmatic costs incurred by non-DOE users.

The Idaho National Laboratory (INL) plays a lead role in the Global Nuclear Energy Partnership, the Generation IV Nuclear Energy Systems Initiative, the Next Generation Nuclear Power Plant Program, the Nuclear Hydrogen Initiative, Space and Defense Power Systems, testing of naval reactor fuels and reactor core components, and a range of national security technology programs. While the laboratory focuses its research and development on nuclear energy programs, it is also maintaining its multi-program national laboratory status to serve a variety of current and planned Department and national research and development missions.

Two important research reactors currently operating at this site are the Advanced Test Reactor (ATR) and its supporting ATR Critical Facility. ATR is one of the world's largest and most sophisticated test reactors. ATR currently conducts virtually all irradiation testing for Navy reactor fuels and core components and is vital to achieving the Department's Strategic Goal of providing the U.S. Navy with safe, militarily effective, nuclear propulsion plants and ensuring their continued safe and reliable operation. The Navy mission is projected to continue until at least mid-century. A series of independent studies have shown that the ATR can operate until mid-century and potentially beyond. The increased deployment of new light water reactor designs, the need to improve performance and extend the licensed life of existing light water reactors, and the maturing of advanced reactor technologies all require an expanded fuel and materials irradiation capability for use by the Office of Nuclear Energy. The ATR is ideally suited to provide this test capability for the projected NE nuclear energy programs in much the same way as it has for the Office of Naval Reactors (NR) program. These two programs are working closely and cooperatively to schedule work, fairly distribute the costs associated with maintaining and operating the ATR, and more fully exploit the testing potential of the reactor.

In FY 2007, DOE designated the ATR to be a national scientific user facility. This action was taken to allow additional research and development to be conducted by Universities and industry using irradiation locations that are not currently used by NE or NR. The costs associated with using vacant irradiation locations within the core, will be charged to the sponsoring organization in accordance with DOE pricing policies for user facilities. The user facility concept will benefit the long term viability of the ATR and will enhance NE irradiation test programs by involving a larger and more diverse group of experimenters.

The IFM Program supports the Energy Policy Act of 2005, the Atomic Energy Act of 1954, and Federal Acquisition Regulation 35 by maintaining and operating the INL site infrastructure that supports advanced nuclear energy technology research and development and multi-program use. Key activities conducted under these programs include ensuring that all landlord facilities meet essential safety and environmental requirements and are maintained at user-ready levels. Other key activities include managing all special nuclear materials contained in these facilities and managing some aspects of the site's environmental monitoring, facility decommissioning and disposition, and waste management activities.

The FY 2009 funding request associated with Radiological Facilities Management maintains the basic facilities and associated personnel at Idaho National Laboratory, Oak Ridge National Laboratory and Los Alamos National Laboratory, whereas mission specific development or hardware fabrication costs are provided by the user agencies (e.g., NASA). This arrangement is essential in order to preserve the basic capability regardless of periodic fluctuations in the demand of the end product users. In FY 2009, NE will complete activities associated with the assembly and testing of generators for national security applications and for the National Aeronautics and Space Administration (NASA) Mars Science Laboratory (MSL) mission, and deliver the unit to NASA for launch. In FY 2009, the program will fabricate fresh fuel and ship spent fuel from two university reactors; fuel will be fabricated for at least one university reactor; and highly enriched uranium (HEU) fuel will be removed and shipped from the three university reactors.

The FY 2009 funding request associated with Idaho Facilities Management will continue to ensure that the Department's unique facilities, required for advanced nuclear energy technology research and development, are maintained and operated such that they are available to support national priorities. The program will continue to fund routine maintenance to assure that programmatic facilities and equipment can be operated safely and reliably. IFM will maintain and operate essential ATR support activities to be available and ready to support ATR operations, including upgrades to correct degrading reliability in these essential systems and assessments to determine what is need to ensure the long term sustainability of the ATR.

Strategic and GPRA Unit Program Goals

The Department's Strategic Plan identifies five Strategic Themes (one each for energy security, nuclear security, scientific discovery, environmental responsibility and management excellence) plus 16 Strategic Goals that tie to the Strategic Themes. The Infrastructure program supports the following goal:

Strategic Theme 1, Energy Security: Promoting America's energy security through reliable, clean, and affordable energy

Strategic Goal 1.2, Environmental Impacts of Energy: Reduce greenhouse gas emissions and other environmental impacts (water use, land use, criteria pollutants) from our energy production and use.

The Infrastructure program has one GPRA Unit Program goal which contributes to Strategic Goals 1.2 in the "goal cascade":

GPRA Unit Program Goal 1.2.15.00: Maintain and Enhance National Nuclear Infrastructure - Maintain, enhance, and safeguard the Nation's nuclear infrastructure capability to meet the Nation's energy, space exploration, and national security needs.

Contribution to GPRA Unit Program Goal 1.2.15.00 (Maintain and Enhance National Nuclear Infrastructure)

The Infrastructure program contributes to this goal by ensuring that the Department's unique facilities, required for advanced nuclear energy technology research and development, are maintained and operated such that they are available to support national priorities. Key activities conducted under this program include ensuring that all NE facilities meet essential safety and environmental requirements and are maintained at user-ready levels. Other key activities include managing all special nuclear materials contained in these facilities and the disposition of DOE materials under NE ownership.

Funding by Strategic and GPRA Unit Program Goal

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Strategic Goal 1.2, Environmental Impacts of Energy			
GPRA Unit Program Goal 1.2.15.00, Maintain and Enhance National Nuclear Infrastructure			
Radiological Facilities Management	46,775	48,119	38,700

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Idaho Facilities Management	84,435	115,935	104,700
Total, Strategic Goal 1.2 (Infrastructure)	131,210	164,054	143,400

Annual Performance Results and Targets

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
GPRA Unit Program Goal 1.2.15.00 (Maintain and Enhance National Nuclear Infrastructure)					
Infrastructure					
Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Radiological Facilities Management and Idaho Facilities Management programs. (MET TARGET)	*Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Radiological Facilities Management and Idaho Facilities Management programs. (MET TARGET)*	*Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Radiological Facilities Management and Idaho Facilities Management programs. (MET TARGET)*	*Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Radiological Facilities Management (RFM) and Idaho Facilities Management (IFM) programs at INL. (MET TARGET)*	*To ensure unique nuclear facilities are available to support critical Departmental missions, achieve cumulative variance of less than 10 percent from cost and schedule baselines at Idaho National Laboratory for Idaho Facilities Management program facilities and activities (which include facilities used by the Radiological Facilities Management program), consistent with safe operations.*	*To ensure unique nuclear facilities are available to support critical Departmental missions, achieve cumulative variance of less than 10 percent from cost and schedule baselines at Idaho National Laboratory for Idaho Facilities Management program facilities and activities (which include facilities used by the Radiological Facilities Management program), consistent with safe operations.*
Radiological Facilities Management					
Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines. (MET TARGET)	Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (MET TARGET)	Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (MET TARGET)	Maintain operability of key Radiological Facilities Management and Idaho Facilities Management-funded facilities to enable accomplishment of Nuclear Energy, other DOE and Work-for-Others milestones by achieving a Facility Operability Index of 0.9 or greater. (MET TARGET)	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and Radiological Facilities Management program facilities.	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and Radiological Facilities Management program facilities.
Safely operate each key nuclear facility within 10 percent of the approved plan, shutting down reactors if they are not operated within their safety envelope and expediting remedial action. (MET TARGET)	Consistent with safe operations, maintain and operate key nuclear facilities so the unscheduled operational downtime will be kept to less than 10 percent, on average, of total scheduled operating time. (MET TARGET)				
Demonstrate the operational capability of radioisotope	Maintain and operate radioisotope power systems				

FY 2004 Results	FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets
power systems infrastructure by fabricating flight quality products at each of the major facilities (i.e., at least eight iridium clad vent sets at ORNL and at least eight encapsulated Pu-238 fuel pellets at LANL), and by processing at least 2 kilograms of scrap Pu-238 at LANL. (MET TARGET)	facilities with less than 10 percent unscheduled downtime from approved baseline. (MET TARGET)				
Idaho Facilities Management					
Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (Same target used for Radiological Facilities Management). (MET TARGET)	Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (Same target used for Radiological Facilities Management). (MET TARGET)	Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (Same target used for Radiological Facilities Management). (MET TARGET)	Maintain operability of key Radiological Facilities Management and Idaho Facilities Management-funded facilities to enable accomplishment of Nuclear Energy, other DOE and Work-for-Others milestones by achieving a Facility Operability Index of 0.9 or greater. (MET TARGET)	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and Radiological Facilities Management program facilities.	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and Radiological Facilities Management program facilities.

Means and Strategies

The Infrastructure program will use various means and strategies to achieve its GPRA Unit Program goals. However, various external factors may impact the ability to achieve these goals. The program also performs collaborative activities to help meet its goals.

The Department will implement the following means:

- Ensure that mission essential systems, resources, and services are identified, maintained, and operated in compliance with DOE, Federal, and State safety and environmental requirements in a secure and cost-effective manner. The Idaho Facilities Management has established an INL Ten Year Site Plan to accomplish this that will be updated semi-annually and approved by the DOE.

- Maintain the unique infrastructure and capability to deliver advanced radioisotope power systems for space and national security missions.

- Aggressively implement contracting reforms, including fixed price competitive bidding, earned value management, capital planning processes in accord with DOE Order 413.3A, independent external evaluations, etc., to ensure that the infrastructure program is operating effectively and efficiently to meet the Department's highest priority program needs.

The Department will implement the following strategies:

- Idaho Facilities Management mission essential facilities will be identified in the INL Ten Year Site Plan. Detailed work planning and funding requests will be based on this Plan that will be updated semi-annually.

- Meet periodically throughout the year with INL, Nuclear Regulatory Commission, NNSA and the Test, Research, and Training Reactor Management Group (TRTR) to review university research reactor activities; discuss program issues; and solicit input, advice and guidance.

The following external factors could affect NE's ability to achieve its strategic goal:

- Idaho Facilities Management Key External Factors: Increased nuclear energy R&D would impact the focus and direction of the Idaho Facilities Management Program, but not necessarily impact its overall costs and long-term liabilities. On the other hand, increased nuclear energy R&D needs resulting from new mission initiatives could require accelerated recapitalization and revitalization to support enhanced use of research facilities, new construction and earlier enhancement of the existing infrastructure.

In carrying out the program's mission, NE performs the following collaborative activities:

- Coordinates with national security agencies and NASA in developing radioisotope power systems for their use to ensure proposed systems and technologies satisfy the necessary technical requirements identified by customers for identified mission scenarios.

- Coordinates with the National Nuclear Security Administration to convert the university research reactors with highly enriched uranium to low enriched uranium.

Validation and Verification

To validate and verify program performance, NE will conduct various internal and external reviews and audits. NE's programmatic activities are subject to periodic review by the Congress, the General Accountability Office, the Department's Inspector General, the Nuclear Regulatory Commission, the U.S. Environmental Protection Agency, state environmental and health agencies, and the Department's Office of Engineering and Construction Management. In addition, NE provides continual management and oversight of its vital field infrastructure programs—the Radiological Facilities Management program and the Idaho Facilities Management program. Periodic internal and external program reviews evaluate progress against established plans. These reviews provide an opportunity to verify and validate performance. Monthly, quarterly, semi-annual and annual reviews, consistent with program management plans, are held to ensure technical progress, cost and schedule adherence, and responsiveness to program requirements.

In FY 2006, as a follow-up action assigned as part of this assessment, NE contracted with the National Academy of Sciences (NAS) to conduct an extensive, comprehensive, and independent evaluation of R&D and Infrastructure program goals and plans, including the process for establishing program priorities and oversight. The evaluation resulted in a detailed set of policy and research recommendations and associated priorities for an integrated agenda of research activities to support the long-term commercial energy option to provide diversity in energy supply. A pre-publication version of the report was issued in October 2007; the final report is scheduled for publication in January 2008. NE continues to review the report findings, and is working with OMB to develop a viable strategy for implementing the committee's recommendations.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. NE's Infrastructure program has incorporated feedback from OMB into the FY 2009 Budget Request and has taken the necessary steps to continue to improve performance.

The results of the FY 2006 review are reflected as follows:

The assessment found that the program is effectively targeted through the formal INL Ten Year Site Plan that identifies the mission-essential infrastructure and facilities, planned annual work scope, and performance measures for the laboratory. An overall PART score of 49 was achieved with a perfect 100 score for Section I, Program Purpose & Design; a score of 89 for Section II, Strategic Planning; a perfect 100 score for Section III, Program Management; and a score of 0 for Section IV, Program Results/Accountability since the program is too new to have demonstrated accomplishments. The assessment also found that the program needed to collect timely and credible performance information to manage the Idaho Facilities Management program in providing effective and efficient infrastructure support to INL's program missions. The program has developed measures to track its performance against cost and schedule baselines for FY 2007 and beyond. Further, the program has developed a Facility Operability Index measure that assesses the operability of key indicator facilities required for the achievement of NE, other DOE and Work-For-Others milestones.

Radiological Facilities Management

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Radiological Facilities Management			
Space and Defense Infrastructure	30,650	30,371	35,000
Medical Isotopes Infrastructure	15,634	14,828	0
Enrichment Facility Infrastructure	491	0	0
Research Reactor Infrastructure	0	2,920	3,700
Total, Radiological Facilities Management	46,775	48,119	38,700

Description

The mission of the Radiological Facilities Management program is to maintain nuclear facilities, primarily those housing large gloveboxes, hot cells, and their associated support facilities in a safe, environmentally-compliant and cost-effective manner to support national priorities. The Radiological Facilities Management program funds the management of the Department's vital resources and capabilities at Office of Nuclear Energy (NE) managed facilities at Idaho National Laboratory (INL), Oak Ridge National Laboratory (ORNL), and Los Alamos National Laboratory (LANL). Beginning in FY 2009, the Medical Isotopes program transfers to the Office of Science.

These funds assure that the infrastructure for the above mentioned NE nuclear facilities meets essential safety and environmental requirements and is maintained at or above minimum safe levels. Beginning in FY 2009, costs required to raise LANL facilities from minimum safe to operable user-ready levels will be paid for by other Federal agency users. Programmatic activities, including production and research, are also funded by other Federal agency users.

In FY 2009, the program will complete activities associated with the assembly and testing of generators for national security applications and for the National Aeronautics and Space Administration (NASA) Mars Science Laboratory (MSL) mission, and deliver the unit to NASA for launch. The program will also continue to maintain the unique facilities and capabilities facilities at INL, ORNL and LANL that enable the Department to provide the radioisotope power systems for space exploration and national security applications. The FY 2009 funding request maintains the basic facilities and associated personnel, whereas mission specific development or hardware fabrication costs are provided by the user agencies (e.g., NASA). This arrangement is essential in order to preserve the basic capability regardless of periodic fluctuations in the demand of the end product users.

In FY 2009, the program will fabricate fresh fuel and ship spent fuel from two university reactors. In addition, fuel will be fabricated for at least one university reactor (others may be fabricated, as requested). Highly enriched uranium (HEU) fuel will be removed and shipped from the three university reactors. The Department provides fresh reactor fuel to universities and disposes of spent fuel from university reactors. Currently, there are 27 operating university research reactors at 27 institutions in the United States. Many of these facilities have permanent fuel cores and, therefore, do not require regular fuel shipments. However, DOE supplies approximately a dozen universities with fresh fuel and shipments of spent fuel as needed.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Space and Defense Infrastructure	**30,650**	**30,371**	**35,000**
▪ **Idaho National Laboratory (INL)**	**8,200**	**9,000**	**10,040**
• **Radioisotope Power Systems Assembly Operations**	**8,000**	**8,500**	**9,340**

The Department maintains the facilities at INL in an operational status and the user agencies fund mission specific assembly or testing operations. The focus in FY 2009 is the assembly and testing of generators for national security applications and for the National Aeronautics and Space Administration (NASA) Mars Science Laboratory (MSL) mission. A set of generators for a national security application is scheduled to be delivered to the customer in FY 2009. The new Multi-Mission Radioisotope Thermoelectric Generator radioisotope power system (RPS) will be used by NASA for the first time on the MSL rover scheduled for launch in September-October 2009. The fueling operations for the RPS flight unit for the MSL mission will be conducted from FY 2008 through FY 2009, and the unit will be delivered to NASA in FY 2009 for launch. The Department's funding will support the continuation of safe and reliable assembly operations for two independent programs at INL.

• **Capital Equipment for Radioisotope Power System Assembly Operations**	**200**	**500**	**700**

In order to sustain the facility in an operational status, capital equipment funding is required for routine maintenance and infrastructure support.

▪ **Los Alamos National Laboratory (LANL)**	**13,800**	**12,321**	**15,410**
• **Pu-238 Encapsulation and Scrap Recovery Facilities**	**12,500**	**12,000**	**13,030**

The Department maintains and operates dedicated Pu-238 processing, encapsulation, and scrap recovery facilities within the Plutonium Facility (PF-4) at Technical Area 55 (TA-55) at LANL. These unique facilities provide the only U.S. capability to purify, pelletize and encapsulate the Pu-238 so that it can be used in radioisotope power systems. These facilities will be available at least through FY 2014 to help meet agency missions. The FY 2009 funding request will maintain the basic capabilities and infrastructure for these facilities in minimum safe status. If expanded effort is required to produce material for specific missions or applications, the funding for this extra effort is provided by the user agencies.

• **Capital Equipment for the Pu-238 Facilities**	**1,300**	**321**	**2,380**

Maintenance of the Pu-238 facilities requires regular upgrades and replacement of gloveboxes and equipment in the processing, encapsulation, and scrap recovery lines. Increased maintenance, upgrading of gloveboxes and other equipment will take place in FY 2009.

▪ **Oak Ridge National Laboratory (ORNL)**	**4,650**	**4,750**	**5,160**
• **Iridium Fabrication Facilities for Radioisotope Power Systems**	**4,150**	**4,250**	**4,410**

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

The Department maintains a unique infrastructure and capability at ORNL to fabricate iridium cladding and carbon insulators used to encapsulate and contain the Pu-238 pellets used in radioisotope power systems. These heat source components are necessary for the safe operation of the radioisotope power systems. FY 2009 funding will allow continued safe and reliable operation of the facility.

	FY 2007	FY 2008	FY 2009
• **Capital Equipment for Iridium Fabrication Facilities**	**500**	**500**	**750**

In FY 2009, ORNL will replace an aging arc melting furnace and a hot forming press.

	FY 2007	FY 2008	FY 2009
▪ **Other Activities**	**4,000**	**4,300**	**4,390**
• **Safety/Program Analysis and Testing Infrastructure**	**4,000**	**4,300**	**4,390**

The Department maintains an analytical and testing infrastructure that enables the Department to analyze the performance and ensure the safety of the radioisotope power systems for various applications. This capability allows the operation and update of sophisticated analytical codes that can analyze the behavior of materials and systems under potential accident environments. These codes will also predict performance under different operational conditions for various types of systems. The Department funding maintains the capability and infrastructure, but if additional mission specific analysis or testing is required, the user agency provides the funding for these mission specific efforts. In FY 2009, the Department will complete the MSL launch approval safety assessment activities for the NASA MSL 2009 mission, and continue the process of updating analysis techniques and computer codes to address the evolution of launch vehicles and analysis standards. This allows the Department to provide accurate and detailed projections for risks related to missions using nuclear power systems and materials.

	FY 2007	FY 2008	FY 2009
Medical Isotopes Infrastructure	**15,634**	**14,828**	**0**
▪ **Oak Ridge National Laboratory (ORNL)**	**7,165**	**7,428**	**0**
• **Building 3047 Hot Cells**	**3,100**	**0**	**0**

As part of the ORNL consolidation and facility revitalization, all isotope processing has been transferred at the end of FY 2006. FY 2007 funding was used to remove remaining equipment and supplies and cleanup of the hot cells to prepare for decontamination and decommissioning and to start up the hot cells activities in building 4501 and 7920.

	FY 2007	FY 2008	FY 2009
• **Buildings 4501 and 7920 Hot Cells**	**0**	**3,664**	**0**

All isotope processing activities have been transferred from Building 3047 to Buildings 4501 and 7920. The Department will maintain these facilities in a safe and environmentally compliant condition for processing, packaging, and shipment of radioisotopes and other related services needed in medical diagnostic and therapeutic applications, homeland security applications, and other scientific research used by Federal and non-Federal entities. Activities include facility and shipping container maintenance, radiological monitoring, facility

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

inspections, isotope inventory and shipment scheduling and delivery tracking. Isotope customers pay the cost of isotope processing in these facilities. Beginning in FY 2009, these activities transfer to the Office of Science.

• **Buildings 9204-3 and 5500 – Chemical and Materials Laboratories**	**3,000**	**3,764**	**0**

The Department maintains the two laboratories in a safe and environmentally compliant condition for the processing, packaging, and shipment of stable isotopes and other services needed in medical diagnostic and therapeutic applications and other scientific research used by Federal and non-Federal entities. Activities include facility maintenance and inspections and customer order and account tracking system maintenance (E-Government). Over the next several years, the Department will continue to phase out the Calutrons in Building 9204-3 at Y-12. Beginning in FY 2009, these activities transfer to the Office of Science.

• **Isotope Production**	**715**	**0**	**0**

FY 2007 funding provided for the Department's isotope business management including isotope order processing, billing, official quotations, shipping schedules, cash collections, advance payments, and accounting for products and services provided by all Department isotope producing sites. Business trend analyses, surveys, and tracking responses to customer inquiries are also centralized at ORNL. This E-Government isotope business management information system not only expedites customer orders, but also saves several hundreds of thousands of dollars of administration expenses annually. Starting in FY 2008, funds for these activities are included in the other ORNL activity lines.

• **Capital Equipment**	**350**	**0**	**0**

In FY 2007, upgraded the National Regulatory Commission license for one type of shipping container to a type BU-96 to enable shipment of a larger number of isotope products to customers and between isotope producing sites.

▪ **Los Alamos National Laboratory (LANL)**	**3,214**	**3,650**	**0**
• **Isotope Production Facility/TA-48 Hot Cell, Building RC-1**	**3,214**	**3,650**	**0**

The Department maintains facilities in a safe and environmentally compliant condition for the production, processing, packaging, and shipment of radioisotopes and other services needed in medical diagnostic and therapeutic applications, and other scientific research used by Federal and non-Federal entities. Activities include maintenance, radiological monitoring, and facility inspections. Isotope customers will pay the full cost of isotope processing in these facilities. Beginning in FY 2009, these activities transfer to the Office of Science.

▪ **Sandia National Laboratories (SNL)**	**1,800**	**0**	**0**
• **TA-5 ACRR & Hot Cells**	**1,800**	**0**	**0**

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009

The Isotope Program no longer has a programmatic need for the Annular Core Research Reactor (ACRR) and associated hot cells. The National Nuclear Security Administration (NNSA) is now the only user of the ACRR. The transfer to NNSA of the ACRR and hot cells was completed by the end of FY 2007.

▪ **Brookhaven National Laboratory (BNL)**	**2,905**	**3,200**	**0**
• **Brookhaven Linear Isotope Producer (BLIP) Building 931 and Hot Cell Building 801**	**2,905**	**3,200**	**0**

The Department maintains the BLIP Building 931 and Hot Cell Building 801 facilities in a safe, environmentally compliant condition and state of readiness for the production of radioisotopes and other services needed in medical diagnostic, therapeutic applications, and other scientific research used by Federal and non-Federal entities. Activities include maintenance, radiological monitoring, and facility inspections. Isotope customers will pay the full cost of isotope processing in this facility. Beginning in FY 2009, these activities transfer to the Office of Science.

▪ **Other Activities**	**550**	**550**	**0**
• **Associated Nuclear Support**	**550**	**550**	**0**

This funding provides for requirements applicable to isotope producing sites. Such items include certification of isotope shipping casks, independent financial audits of the revolving fund, and other related expenses. Beginning in FY 2009, these activities transfer to the Office of Science.

Enrichment Facility Infrastructure	**491**	**0**	**0**
▪ **Oak Ridge Operations Office**	**491**	**0**	**0**

Funding provides for oversight and monitoring of the maintenance of DOE leased assets at the Paducah Gaseous Diffusion Plant site in accordance with the DOE-United States Enrichment Corporation June 17, 2002 Memorandum of Agreement. Beginning in FY 2008, Oak Ridge Operations Office will assume direct responsibility for these oversight and monitoring activities.

Research Reactor Infrastructure	**0**	**2,920**	**3,700**
▪ **Idaho National Laboratory (INL)**	**0**	**2,920**	**3,700**

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
The Department is responsible for providing fresh reactor fuel to universities and disposing of spent fuel from university reactors. In FY 2007, the Department funded these activities in the University Reactor Infrastructure and Education Assistance program. Beginning in FY 2008 funds are requested in the Radiological Facilities Management program to continue to provide fuel services to universities that have recurring fuel needs. In FY 2009, the program will fabricate fresh fuel and ship spent fuel from Massachusetts Institute of Technology (MIT) and the University of Missouri (MURR) reactors. In addition, Training, Research, Isotopes, General Atomics (TRIGA) fuel will be fabricated for the McClellan reactor (University of California – Davis) and others as requested. Highly enriched uranium (HEU) fuel will be removed and shipped from the Oregon State, Washington State and University of Wisconsin reactors.			
Total, Radiological Facilities Management	**46,775**	**48,119**	**38,700**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Space and Defense Infrastructure	
▪ **Idaho National Laboratory (INL)**	
• **Radioisotope Power Systems Assembly Operations** The increase from $8,500,000 to $9,340,000 represents escalation and maintenance deferred from FY 2008.	+840
• **Capital Equipment for Radioisotope Power System Assembly Operations** The increase from $500,000 to $700,000 represents an increased need for capital equipment in FY 2009.	+200
▪ **Total, Idaho National Laboratory**	+1,040
▪ **Los Alamos National Laboratory (LANL)**	
• **Pu-238 Encapsulation and Scrap Recovery Facilities** The increase from $12,000,000 to $13,030,000 is due to maintenance deferred from FY 2008.	+1,030
• **Capital Equipment for the Pu-238 Facilities** The increase from $321,000 to $2,380,000 is required to replace equipment needed to maintain the facility in a safe and reliable condition.	+2,059
▪ **Total, Los Alamos National Laboratory**	+3,089

Oak Ridge National Laboratory (ORNL)

	FY 2009 vs. FY 2008 ($000)
• **Iridium Fabrication** The increase from $4,250,000 to $4,410,000 is due to reduced materials testing support capability in FY 2008 and maintenance deferred into FY 2009.	+160
• **Capital Equipment for Iridium Fabrication Facilities** The increase from $500,000 to $750,000 will allow for the replacement of both an aging arc melting furnace and a hot forming press.	+250
▪ **Total, Oak Ridge National Laboratory**	+410
▪ **Other Activities**	
• **Safety/Program Analysis and Testing Infrastructure** The increase from $4,300,000 to $4,390,000 represents escalation to maintain analytical capabilities required to support both a national security and NASA mission.	+90
Total, Space and Defense Infrastructure	**+4,629**
Medical Isotopes Infrastructure	
▪ Decrease of $14,828,000 is due to the Medical Isotopes Infrastructure program being transferred to the Office of Science in FY 2009.	-14,828
Total, Medical Isotopes Infrastructure	**-14,828**
Research Reactor Infrastructure	
▪ **Idaho National Laboratory (INL)**	
• **Research Reactor Infrastructure** The increase from $2,920,000 to $3,700,000 will provide for restoration of fuel inventory for MIT and MURR reactors, the removal and shipment of HEU cores from the FY 2008 conversion of Oregon State and Washington State's reactors from HEU to low enriched uranium fuel, the fabrication of TRIGA fuel elements for several university reactors, and the removal and shipment of the HEU core from the University of Wisconsin reactor scheduled to be converted during FY 2009.	+780
Total Funding Change, Radiological Facilities Management	**-9,419**

Capital Operating Expenses and Construction Summary
Capital Operating Expenses

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Capital Equipment	2,350	1,321	3,830
Total, Capital Operating Expenses	2,350	1,321	3,830

Isotope Production and Distribution Program Fund

Funding Schedule by Activity

In FY 2007 and FY 2008, no funds were requested for the Isotope Production and Distribution Fund. Beginning in FY 2009, the Isotopes Production and Distribution Program Fund is being transferred to the Office of Science. Isotopes are currently produced and processed at three facilities: Los Alamos National Laboratory, Brookhaven National Laboratory, and Oak Ridge National Laboratory. Each of the sites' production expenses for processing and distributing isotopes will be offset by revenue generated from sales.

Description

The Isotope Program (Isotope Production and Distribution Program Fund) produces and sells radioactive and stable isotopes, byproducts, surplus materials, and related isotope services world wide. The Isotope Program operates under a revolving fund established by the 1990 Energy and Water Appropriations Act (Public Law 101-101), as modified by Public Law 103-316. Each isotope is priced such that the customer pays the cost of production.

In FY 2007 and FY 2008, the Program's fiscal year appropriation was received via transfer from the Radiological Facilities Management Program. The appropriation was used to maintain and upgrade the infrastructure that is needed to assure continued reliable production, with the production costs borne by the customers. No Radiological Facilities Management program funds were expended on the development or production of isotopes.

The combination of the annual direct appropriation and revenues from isotope sales are deposited in the Isotope Production and Distribution Program Fund, the revolving fund. The fund's revenue and expenses are audited annually consistent with Government Auditing Standards and other relevant acts, such as the Chief Financial Officers Act of 1990 and the Government Performance and Results Act of 1993.

The Department has supplied isotopes and related services for more than 50 years. These isotope products and services are used by medical institutions, universities, research organizations, and industry for a wide array of uses and applications. These isotope products and services are also provided to many Federal agencies either directly or indirectly. For example, isotopes are provided to the National Institutes of Health and their grantees, Environmental Protection Agency, and Homeland Security.

As the range of available isotopes and the recognized uses for them have increased, new or improved isotope products have contributed to progress in medical research and practice, new industrial processes, and scientific investigation. Substantial national and international infrastructures have been built around the use of isotopes and are dependent on the Department's products and services. Isotopes are used for hundreds of research, biomedical, homeland security, and industrial applications that benefit society every day, for example, heart imaging, cancer therapy, smoke detectors, neutron detectors, explosive detection, oil exploration, and tracers for climate change.

Isotope applications are widely used in medical research, diagnosis, and therapies, which are a growing component of the U.S. health care system. The use of medical isotopes reduces health care costs and improves the quality of patient care. It is estimated that one in every three people treated at a hospital makes use of a radioisotope in their laboratory tests, diagnoses, or therapy. Each day, over 40,000 medical patients receive nuclear medicine procedures in the United States. Such nuclear procedures are among the safest diagnostic tests available. They save millions of dollars each year in health care costs and enhance the quality and effectiveness of patient care by avoiding costly exploratory surgery and similar procedures. For example, it has been demonstrated that the use of myocardial perfusion imaging in emergency department chest pain centers can reduce duration of stay on average from 1.9 days to 12 hours. Therefore, an adequate supply of medical and research isotopes is essential to the Nation's health care system, and to basic research and industrial applications that contribute to national economic competitiveness.

Isotope uses in Homeland Security applications are also increasing. Some isotope applications are: radiation portal monitors used to find unshielded or lightly shielded radiological material; imaging systems used to find densely shielded material; systems to detect presence of nitrogen-based chemical explosives; and other forms of explosive detection.

For the future, the Department foresees more than moderate growth in isotope demand, coupled with possible needs for new isotope products for homeland security, medicine, and industry. In order to satisfy the needs of its customers, the program seeks to meet supply requirements for year-round availability of isotopes for scientific and medical research and, in particular, for human clinical trials. The program's production capability may be called upon for initial ramp-up of production of major new isotope products until market forces bring in private producers who are willing to invest and produce the needed isotopes.

Idaho Facilities Management

Funding Schedule by Activity

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
Idaho Facilities Management			
INL Operations and Infrastructure	78,405	115,935	104,700
INL Construction	6,030	0	0
Total, Idaho Facilities Management	84,435	115,935	104,700

Description

The Idaho Facilities Management (IFM) Program operates and maintains the three main engineering and research campuses at the Idaho National Laboratory (INL). The three main engineering and research campuses are: (1) the Reactor Technology Complex (RTC) which includes the Advanced Test Reactor (ATR) and supporting infrastructure, (2) the Materials and Fuels Complex (MFC), and (3) the Research and Education Campus (REC). The RTC and MFC are located at the INL site, an 890 square mile reservation west of Idaho Falls, and the REC is located within Idaho Falls. The Radiological and Environmental Sciences Laboratory (RESL) is a testing facility that is operated by the Office of Nuclear Energy (NE).

The IFM Operations and Infrastructure activity includes nine subprogram activities: (1) Base Operations; (2) Routine Maintenance and Repair; (3) ATR Infrastructure; (4) ATR Operations; (5) ATR Life Extension Program; (6) RESL; (7) Essential State Environmental Compliance; (8) Idaho Facilities and Infrastructure Revitalization Program; and (9) Capital Equipment.

The IFM program supports National Energy Policy goals by maintaining and operating facilities dedicated to advanced nuclear energy technology research and development. The Atomic Energy Act of 1954, Chapter 4, Sections 31, 32, and 33, mandates that the Department conduct research and development for nuclear energy. Section 955 of the Energy Policy Act of 2005 directs the Secretary of Energy to operate and maintain civilian nuclear infrastructure and facilities to support nuclear energy activities, including the development of revitalization priorities and a timeline and proposed budget for the completion of deferred maintenance on plants and equipment. It also requires the development of a comprehensive plan for INL facilities. Federal Acquisition Regulation (FAR) 35.002 requires the Department to support its laboratories so that they remain available to respond quickly to Department requirements. IFM is one of the three programs that respond to FAR 35.002 in the Department. The others are (1) the National Nuclear Security Administration’s (NNSA) Readiness in Technical Base and Facilities Program and (2) the Office of Science’s Landlord Program.

The INL Ten Year Site Plan (TYSP) is intended to identify annual budget requirements for the IFM Program over an extended period based upon program requirements for DOE programs including: the Global Nuclear Energy Partnership; the Next Generation Nuclear Plant Program; the Generation IV Nuclear Energy Systems Initiative; the Nuclear Hydrogen Initiative; Space and Defense Power Systems; and the Naval Reactors Program. The plan meets the requirements of DOE Order 430.1B, *Real Property Asset Management*.

In FY 2009, IFM will continue to ensure that the Department's unique facilities, required for advanced nuclear energy technology research and development, are maintained and operated such that they are available to support national priorities. In FY 2009, priorities include ensuring facilities are available to conduct post irradiation testing of ATR test articles and fuel and materials development. In addition, the program will continue to fund routine maintenance to assure that programmatic facilities and equipment can be operated safely and reliably. IFM will maintain and operate essential ATR support activities to be available and ready to support ATR operations. The ATR operations program will undertake maintenance upgrades to its control and console display systems to correct degrading reliability in these essential systems. Associated with ATR Life Extension, the program will conduct a Material Condition Assessment (MCA) to determine remaining functional service life of selected plant components and to identify critical spare parts that will need to be purchased.

IFM program does not provide funding to support the facilities or technical base readiness of other DOE, federal or private sector work conducted at the INL nor does it support general site wide infrastructure.

IFM program does not fund major items of equipment, specialized facilities or line item projects that directly support a specific NE program. These acquisitions are the responsibility of the sponsoring program office.

Prior to FY 2008, the IFM Program was funded in both the Energy Supply and Conservation and the Other Defense Activities appropriations. Beginning in FY 2008, IFM is solely funded under the Nuclear Energy appropriation.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
INL Operations and Infrastructure	**78,405**	**115,935**	**104,700**
▪ **Base Operations**	**33,775**	**56,500**	**56,550**

The Base Operations for MFC and REC provides the technical and operational staff, equipment, materials and services necessary to keep essential Research and Development facilities and systems in a state of readiness to support the NE mission at INL. Readiness includes training and qualification programs, maintenance of procedures, safety documentation and technical manuals, and the R&D and support equipment operations. Readiness assures compliance with federal, state and local regulations and the availability of facilities to do programmatic work. Beginning in FY 2008, funding to support the RTC campus is requested under ATR Infrastructure, as the RTC infrastructure primarily supports the ATR Program. As in prior years, the FY 2009 priorities are to assure that essential facilities remain available and ready to support all NE R&D program requirements including post irradiation testing, fuel and materials development, and process development.

▪ **Routine Maintenance and Repair**	**5,639**	**6,000**	**6,000**

The IFM routine maintenance and repair program provides the funding necessary to conduct a program of condition assessment, servicing and repair of R&D and support systems and equipment for facilities at MFC and REC. Routine maintenance is required to assure that programmatic facilities and equipment can be operated safely and reliably. Beginning in FY 2008, funding for RTC operations and routine maintenance and repair activities is requested in ATR Infrastructure since this campus directly and almost exclusively supports the operation of the ATR. In FY 2009, the program continues to focus on maintaining critical systems to support NE operations. INL has many systems that have exceeded their normal service life and these types of systems require more extensive routine maintenance, more frequent repairs and are often not supported by manufacturer's parts or service programs.

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
▪ **ATR Infrastructure**	**7,606**	**5,600**	**5,600**

The ATR Infrastructure program provides the technical and operational staff, equipment, materials and services necessary, to keep essential support facilities and systems located at RTC in a state of readiness to support the operation of the ATR. The ATR Infrastructure program encompasses light labs, machining and assembly shops, calibration and instrumentation labs, and other ATR support activities at RTC. FY 2009 priorities will continue to maintain and operate essential ATR support activities to be available and ready to support ATR operations.

	FY 2007	FY 2008	FY 2009
▪ **ATR Operations**	**7,000**	**29,122**	**26,500**

ATR Operations provides funding for ATR operations including the conduct of activities required to plan, analyze, load and unload test assemblies, to manage the reactor fuel inventory, as well as the actual operation and maintenance of the reactor. Maintaining and operating the ATR in a state of regulatory compliance and readiness to perform a spectrum of irradiation services requires an extensive human infrastructure of engineers, scientists, qualified reactor operators, specialized maintenance staff, planners and technicians and the equipment, facilities and supplies necessary to support their work. NE has assessed the ATR and has found it to be a viable test facility capable of supporting additional DOE, commercial and university based research on the behavior of nuclear fuels and materials in a reactor environment. It also has a largely undeveloped capability to produce isotopes for medical research and industrial applications. In FY 2009, the ATR operations program will undertake maintenance upgrades to its control and console display systems to correct degrading reliability in these essential systems. At the requested level of funding in FY 2009, the INL will have the resources necessary to operate the ATR safely and reliably.

	FY 2007	FY 2008	FY 2009
▪ **ATR Life Extension Program (LEP)**	**16,000**	**3,100**	**3,100**

In FY 2009, a Material Condition Assessment (MCA) will be conducted to determine remaining functional service life of selected plant components and to identify critical spare parts that will need to be purchased. The ATR MCA will use lessons learned from the U.S. Nuclear Regulatory Commission and Electric Power Research Industry. The seismic qualifications as well as the Probabilistic Risk Assessment of the ATR will be updated to assure system performance and inform operations decisions. Also, the ATR's design requirements and

physical plant configuration will be assessed against the safety authorization basis to inform plant improvements.

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
▪ **Radiological and Environmental Sciences Laboratory (RESL)**	**0**	**2,450**	**2,450**

Beginning in FY 2008, funding is included for RESL activities, which were previously funded by the Office of Environment, Safety and Health. RESL is a DOE-owned and operated laboratory located at the Central Facilities Area. Its core mission capabilities are in analytical chemistry and in radiation measurements and calibrations. RESL serves as a radiological standards reference laboratory for DOE, conducting measurement quality assurance programs to assure that key DOE activities are completed in a safe and environmentally responsible manner. RESL is responsible for the DOE Laboratory Accreditation Program and the Mixed Analyte Performance Evaluation Program. The program provides unbiased technical data and analysis for DOE oversight of worker radiation protection and analytical services at DOE sites. By assuring the quality and stability of key laboratory measurement systems throughout DOE and by providing expert technical assistance to improve those systems, RESL helps assure the accuracy and reliability of data that protect workers, the public, and the environment. Funding covers technical support to the Federal staff at RESL, laboratory supplies, and capital equipment.

	FY 2007	FY 2008	FY 2009
▪ **Essential State Environmental Compliance**	**4,000**	**4,000**	**4,000**

Perform remedial actions for NE legacy waste agreed to in Voluntary Consent Orders between the Department and the State of Idaho.

	FY 2007	FY 2008	FY 2009
▪ **Idaho Facilities and Infrastructure Revitalization Program (IFIRP)**	**4,385**	**7,663**	**0**

The IFIRP is a program to fund the replacement of R&D and support equipment and integrated systems which have exhibited excessive routine maintenance or that can no longer be maintained. These are normally complicated and costly tasks that have developed over time and are difficult to accommodate within routine maintenance and repair budgets. Replacing these systems reduces the cost of maintenance, improves reliability and can often reduce operating cost by employing energy efficient technology. No funding is requested in FY09 due to higher priority requirements.

	FY 2007	FY 2008	FY 2009
▪ **Capital Equipment**	**0**	**1,500**	**500**

This funding primarily provides replacements for aged, deteriorated items of capital equipment, and procurement of new capital equipment to meet emerging requirements. This includes such things as shop machines, vehicles, heavy equipment, and general purpose laboratory equipment. Capital Equipment planning goals are provided in the INL TYSP in accordance with Department Order 430.1B, Real Property Asset Management.

	FY 2007	FY 2008	FY 2009
INL Construction	**6,030**	**0**	**0**
▪ **06-E-200, Nuclear Energy Project Engineering and Design (PED) for the Remote Treatment Program (RTP)**	**6,030**	**0**	**0**

The RTP at the MFC was initiated to address near-term waste management needs stemming from the nuclear research legacy waste at the MFC which was the Argonne West site operated by the Office of Science prior to the creation of the INL in 2005. PED funding for the RTP is not requested in FY 2009 due to higher priority requirements.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Total, Idaho Facilities Management	**84,435**	**115,935**	**104,700**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
INL Operations and Infrastructure	
▪ **Base Operations** The increase from $56,500,000 to $56,550,000 reflects variations in work scope from FY 2008 to FY 2009.	+50
▪ **ATR Operations** The decrease from $29,122,000 to $26,500,000 reflects additional funds provided in FY 2008 for ATR national scientific user facility infrastructure and transition activities. The FY 2008 level of funding for the national scientific user facility is not sustainable within the total IFM budget.	-2,622
▪ **Idaho Facilities and Infrastructure Revitalization Program (IFIRP)** The decrease from $7,663,000 to $0 reflects the need to provide funding for high priority nuclear safety basis work at the MFC and to sustain the ATR budget and work scope at approximately the FY 2008 level.	-7,663
▪ **Capital Equipment** The decrease from $1,500,000 to $500,000 reflects the need to provide funding for high priority nuclear safety basis work at MFC, and to sustain the ATR budget and work scope at approximately the FY 2008 level.	-1,000
Total Funding Change, Idaho Facilities Management	**-11,235**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2007	FY 2008	FY 2009
General Plant Projects (Revitalization) & Deferred Maintenance Reduction (IFIRP)	4,385	7,663	0
Capital Equipment	0	1,500	500
Total, Capital Operating Expenses	4,385	9,163	500

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appro-priations	FY 2007	FY 2008	FY 2009	Unappro-priated Balance
06-E-200, Nuclear Energy PED, Idaho	0	0	6,030	0	0	N/A
Total, Construction			6,030	0	0	

Program Direction

Funding Profile by Category

(dollars in thousands/whole FTEs)

	FY 2007	FY 2008	FY 2009
Idaho Operations Office			
Salaries and Benefits	0	25,189	25,765
Travel	0	996	996
Support Services	0	866	804
Other Related Expenses	0	5,625	5,111
Total, Idaho Operations Office	0[a]	32,676	32,676
Full Time Equivalents	0	197	197
Radiological and Environmental Sciences Laboratory			
Salaries and Benefits	0	2,325	2,440
Travel	0	65	65
Support Services	0	0	0
Other Related Expenses	0	384	394
Total, Radiological and Environmental Sciences Laboratory	0	2,774[b]	2,899
Full Time Equivalents	0	19	19
Oak Ridge Operations Office			
Salaries and Benefits	1,870	1,945	1,126
Travel	11	13	8
Support Services	0	52	27
Other Related Expenses	151	179	129
Total, Oak Ridge Operations Office	2,032	2,189	1,290[c]
Full Time Equivalents	14	14	8

a Excludes $30,844,000 for program direction expenses at the Idaho Operations Office and 197 Full Time Equivalents appropriated under Other Defense Activities. Beginning in FY 2008, funding for program direction expenses and Full Time Equivalents (FTEs) for the Idaho Operations Office is requested under the Nuclear Energy appropriation.

[b] FY 2008 and beyond includes funding for program direction expenses and 19 FTEs previously funded by the former Office of Environment, Safety and Health.

[c] Beginning in FY 2009, 6 FTEs and funding will be transferred to the Office of Science to support the High Flux Isotope Reactor.

	(dollars in thousands/whole FTEs)		
	FY 2007	FY 2008	FY 2009
Headquarters			
Salaries and Benefits	20,047	28,545	30,771
Travel	970	1,680	1,670
Support Services	3,310	6,504	4,262
Other Related Expenses	5,449	6,504	6,976
Total, Headquarters	29,776	43,233[a]	43,679[b]
Full Time Equivalents	161	189	187
Total Program Direction			
Salaries and Benefits	21,917	58,004	60,102
Travel	981	2,754	2,739
Support Services	3,310	7,422	5,093
Other Related Expenses	5,600	12,692	12,610
Total, Program Direction	31,808	80,872	80,544
Total, Full Time Equivalents	175	419	411

Mission

Program Direction provides the Federal staffing resources and associated costs required to provide overall direction and execution of the Office of Nuclear Energy (NE). NE promotes secure, competitive, and environmentally responsible nuclear technologies to serve the present and future energy needs of the country.

In addition to appropriated funds, NE also manages over $118 million dollars annually in work for others and reimbursable funding. This includes over $40 million annually from the National Aeronautics and Space Administration and the Department of Defense for the development of advanced radioisotope power systems for space exploration and national security missions.

NE's diverse programs are faced with significant human capital challenges in pursuing their growing mission requirements. Extensive downsizing several years ago resulted in numerous skill imbalances and adversely impacted NE's retention of technical and scientific specialists. Wherever possible, employees have been redeployed from lower priority programs to higher priority programs to meet growing mission needs. At this point, NE faces a variety of staffing challenges in managing its expanding programs.

[a] Includes funding for 16 FTEs for the MOX Fuel Fabrication Facilities/Fissile Materials Disposition program.

[b] Beginning in FY2009, 2 FTEs and funding will be transferred to the Office of Science to support the Medical Isotope program.

NE's human capital vision is to develop, recruit, and maintain a diverse organization of highly skilled professionals with the competency and motivation to contribute to the development and implementation of national energy policies and programs to help lead the United States in achieving its nuclear technology goals for the twenty-first century.

The NE Workforce Plan was updated in August 2007 to reflect mission changes and identify skills gaps. Like the rest of the Federal Government, NE is planning for workforce changes that are engendered by an aging workforce. The average age of the NE workforce is 49.6 years, higher than the 46.8 year average age of the Federal workforce overall. Currently 25 percent of the workforce is eligible for retirement and an additional 5 percent will be eligible by the end of FY 2009. Over the past several years, NE has been trying to address the issue of an aging workforce through the recruitment of entry-level engineering, scientific, and administrative positions. Continuation of this effort is essential.

Prior to FY 2007, the Idaho Operations Office Program Direction account was funded in the Other Defense Activities appropriations. Beginning in FY 2008 and beyond, funding for Idaho Operations Office is requested under the Nuclear Energy appropriation. Also beginning in FY 2008, the NE Program Direction account includes funding for16 FTEs associated with the Fissile Materials Disposition, MOX Fuel Fabrication Facilities program. In FY 2009, NE will transfer 6 FTEs at the Oak Ridge Operations Office associated with the management of the High Flux Isotope Reactor and 2 FTEs at headquarters associated with the Medical Isotope Program to the Office of Science.

Detailed Justification

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Salaries and Benefits	**21,917**	**58,004**	**60,102**

This account provides funding to support the salaries and benefits of the personnel associated with NE programs. Currently 25 percent of the workforce is eligible to retire and an additional 5 percent will be eligible by the end of FY 2009; therefore, it is essential that program direction resources are available to compete for needed skills. NE seeks to hire not only senior engineers and project managers for new and changing programs, but also to recruit junior staff for succession planning purposes; efforts to hire additional junior staff are ongoing. In addition to the Headquarters staff, NE funds field employees at the Idaho Operation Office (197), the Radiological and Environmental Sciences Laboratory (RESL) in Idaho (19), the Oak Ridge Operations Office (8), and three employees who support the U.S. Mission to the Organization for Economic Cooperation and Development (1); U.S. Mission to International Organization in Vienna (1); and the Department of Energy Tokyo Office (1). In FY 2007, due to the Continuing Resolution, the Idaho Operations Office was funded in the Other Defense Activities appropriation and RESL was funded under the former Office of Environment, Safety and Health. Beginning in FY 2008, this account includes funding for 16 FTEs associated with the MOX Fuel Fabrication Facilities/Fissile Materials Disposition program previously funded under the National Nuclear Security Administration (NNSA). Beginning in FY 2009, the Office of Science will fund 6 FTEs at the Oak Ridge Operations Office associated with the management of the High Flux Isotope Reactor and 2 FTEs associated with the Medical Isotope Program.

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Travel	**981**	**2,754**	**2,739**

Travel includes funding for transportation of Headquarters and Operations Office personnel associated with NE programs, their per diem allowances while in authorized travel status, and other expenses incidental to travel. The decrease in travel reflects the transfer of 6 FTEs at Oak Ridge and 2 FTEs at Headquarters to the Office of Science.

Support Services	**3,310**	**7,422**	**5,093**

Support Services includes funding for technical and management support services provided to NE Headquarters and the Operations Offices. The use of support services allows the Department to hire the best available industry experts to assist federal staff in managing the growing nuclear programs and complex activities. In addition to rapidly acquiring this expertise, using support services provides unlimited flexibility in team composition as the needs of NE evolve.

Other Related Expenses	**5,600**	**12,692**	**12,610**

The major expenditure in the Other Related Expenses category in FY 2009 is $4,275,000 million for the Headquarters Working Capital Fund (WFC). The Department's Chief Financial Officer established a WCF to provide funding for mandatory administrative costs, such as: building occupancy and telephone services; copying, printing and graphics; networking, desktop support; procurement management; payroll and personnel; corporate training services; and the project management career development program. The Other Related Expense category also includes support for NE's federal advisory committee, training, as well as the housing, office communications, supplies, miscellaneous expenses and International Cooperative Administrative Support Services (ICASS) expenses associated with the three employees assigned overseas. The increase in FY 2009 is primarily associated with the increase the WCF and escalation, offset by a reduction in other services at Idaho and by the transfer of other related expenses associated with the 6 FTEs at Oak Ridge and 2 FTEs at Headquarters to the Office of Science.

Total, Program Direction	**31,808**	**80,872**	**80,544**

Explanation of Funding Changes

	FY 2009 vs. FY 2008 ($000)
Salaries and Benefits The increase from $58,004,000 to $60,102,000 reflects a 3.4 percent escalation and funds for promotions, awards, and within-grade salary increases; (+$3,309,000) offset by the transfer to the Office of Science of 2 FTEs at Headquarters in support of the Medical Isotope Program and 6 FTEs at Oak Ridge Operation Office in support of the High Flux Isotope Reactor (-$1,211,000).	+2,098
Travel The decrease from $2,754,000 to $2,739,000 in travel reflects the transfer of travel funds associated with the 2 FTEs at Headquarters and 6 FTEs at Oak Ridge Operations Office	-15

	FY 2009 vs. FY 2008 ($000)
to the Office of Science (-$15,000).	
Support Services The decrease from $7,422,000 to $5,093,000 is due to the decrease in support required for NE programs ($-2,059,000) and the transfer of support services associated with the 6 FTEs at Oak Ridge Operations Office and 2 FTEs at Headquarters transferred to the Office of Science (-$270,000).	-2,329
Other Related Expenses The decrease from $12,692,000 to $12,610,000 is due to an increase in Working Capital Fund costs (+$587,000); offset by reduction in services at Headquarters ($-284,000) and Idaho Operations Offices ($-330,000) and the other related expenses associated with the 6 FTEs at Oak Ridge Operations Office and 2 FTEs at Headquarters transferred to the Office of Science ($-55,000).	-82
Total Funding Change, Program Direction	**-328**

Support Services by Category

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Technical Support			
Feasibility of Design Considerations	0	1,000	1,000
Development of Specifications	175	800	390
Economic and Environmental Analyses	245	330	300
Surveys Or Reviews of Technical Operations	155	1,315	528
Total, Technical Support	575	3,445	2,218
Management Support			
Automated Data Processing	1,400	1,675	1,400
Manpower Systems Analyses	200	300	200
Preparation of Program Plans	125	300	150
Training and Education	0	250	125
Reports and Analyses Management and General Administrative Services	1,010	1,452	1,000
Total, Management Support	2,735	3,977	2,875
Total, Support Services	3,310	7,422	5,093

Other Related Expenses by Category

	(dollars in thousands)		
	FY 2007	FY 2008	FY 2009
Other Related Expenses			
Working Capital Fund	2,600	3,688	4,275
Advisory and Assistance Services	215	200	100
Operations and Maintenance of Equipment	510	1,627	1,479
Printing and Reproduction	24	52	53
Training	159	414	364
Rent and Utilities	8	971	910
Communications, Utilities, Misc.	51	2,251	2,036
Supplies and Materials	43	118	110
Other Services	1,990	3,371	3,283
Total, Other Related Expenses	5,600	12,692	12,610

Legacy Management

Legacy Management

Legacy Management
Office of Legacy Management

Overview

Appropriation Summary by Program[a]

(dollars in thousands)

	FY 2007 Current Appropriation	FY 2008 Original Appropriation	FY 2008 Adjustments	FY 2008 Current Appropriation	FY 2009 Request
Other Defense Activities					
Legacy Management	30,935	156,379	-1,418	154,961	185,981
Total, Other Defense Activities	30,935	156,379	-1,418	154,961	185,981
Energy Supply and Conservation					
Legacy Management	33,187	0	0	0	0
Total, Energy Supply and Conservation	33,187	0	0	0	0
Legacy Management					
Legacy Management	0	34,183	-311	33,872	0
Total, Legacy Management	0	34,183	-311	33,872	0
Total, Other Defense Activities and Energy Supply and Conservation	64,122	190,562	-1,729	188,833	185,981

The Department of Energy's Legacy Management program is the final element of site remediation and closure after active remediation is complete – fulfilling the Department's commitments to ensure protection of human health and the environment and ensure all contractual obligations for former contractor employees are met. Within the Other Defense Activities appropriation, the activities under the Legacy Management program will provide the means to achieving these objectives.

In the past, Legacy Management (LM) was funded by the Other Defense Activities (ODA) Appropriation and, through FY 2007, by the Energy Supply and Conservation (ES&C) Appropriation. However, in the FY 2008 appropriation, a new appropriation account of "Legacy Management" was created and replaced the portion that had previously been within ES&C. FY 2009 funding is being requested only under the Other Defense Activities appropriation. This shift is because, after completing remediation, the distinction between ODA and ES&C sites becomes negligible and, after transferring the closure sites in FY 2008, the portion of the budget that would have been within the Legacy Management (formerly Energy Supply and Conservation) appropriation had decreased to less than 20 percent of the total budget request.

[a] Includes a rescission of $1,729,000 in accordance with P.L. 110-161, the FY 2008 Consolidated Appropriations Act.

GENERAL PROVISIONS

SEC. 301. CONTRACT COMPETITION.
(a) None of the funds in this or any other appropriations Act for fiscal year **[**2008 **]***2009* or any previous fiscal year may be used to make payments for a noncompetitive management and operating contract, or a contract for environmental remediation or waste management in excess of $100,000,000 in annual funding at a current or former management and operating contract site or facility, or award a significant extension or expansion to an existing management and operating contract, or other contract covered by this section, unless such contract is awarded using competitive procedures or the Secretary of Energy grants, on a case-by-case basis, a waiver to allow for such a deviation. The Secretary may not delegate the authority to grant such a waiver.
(b) *In this section:*
(*1*) *The term "noncompetitive management and operating contract" means a contract that was awarded more than 50 years ago without competition for the management and operation of Ames Laboratory, Argonne National Laboratory, Lawrence Berkeley National Laboratory, Livermore National Laboratory, and Los Alamos National Laboratory.*
(*2*) The term "competitive procedures" has the meaning provided in section 4 of the Office of Federal Procurement Policy Act (41 U.S.C. 403) and includes procedures described in section 303 of the Federal Property and Administrative Services Act of 1949 (41 U.S.C. 253) other than a procedure that solicits a proposal from only one source.
(*c*) *For all management and operating contracts other than those listed in subsection (b)(1), none of the funds appropriated by this Act may be used to award a management and operating contract, unless such contract is awarded using competitive procedures or the Secretary of Energy grants, on a case-by-case basis, a waiver to allow for such a deviation. The Secretary may not delegate the authority to grant such a waiver. At least 60 days before a contract award for which the Secretary intends to grant such a waiver, the Secretary shall submit to the Committees on Appropriations of the House of Representatives and the Senate a report notifying the Committees of the waiver and setting forth, in specificity, the substantive reasons why the Secretary believes the requirement for competition should be waived for this particular award.*
[(c) Within 30 days of formally notifying an incumbent contractor that the Secretary intends to grant such a waiver, the Secretary shall submit to the Subcommittees on Energy and Water Development of the Committees on Appropriations of the House of Representatives and the Senate a report notifying the Subcommittees of the waiver and setting forth, in specificity, the substantive reasons why the Secretary believes the requirement for competition should be waived for this particular award.**]**
SEC. 302. UNFUNDED REQUESTS FOR PROPOSALS. None of the funds appropriated by this Act may be used to prepare or initiate Requests For Proposals (RFPs) for a program if the program has not been funded by Congress.
SEC. 303. WORKFORCE RESTRUCTURING. None of the funds appropriated by this Act may be used to—
(1) develop or implement a workforce restructuring plan that covers employees of the Department of Energy; or

(2) provide enhanced severance payments or other benefits for employees of the Department of Energy, under section 3161 of the National Defense Authorization Act for Fiscal Year 1993 (Public Law 102-484; 42 U.S.C. 7274h).
SEC. 304. SECTION 3161 ASSISTANCE. None of the funds appropriated by this Act may be used to augment the funds made available for obligation by this Act for severance payments and other benefits and community assistance grants under section 3161 of the National Defense Authorization Act for Fiscal Year 1993 (Public Law 102-484; 42 U.S.C. 7274h) unless the Department of Energy submits a reprogramming **[**request**]** *notification* to the appropriate congressional committees.
SEC. 305. UNEXPENDED BALANCES. The unexpended balances of prior appropriations provided for activities in this Act may be available to the same appropriation accounts for such activities established pursuant to this title. Available balances may be merged with funds in the applicable established accounts and thereafter may be accounted for as one fund for the same time period as originally enacted.
SEC. 306. BONNEVILLE POWER AUTHORITY SERVICE TERRITORY. None of the funds in this or any other Act for the Administrator of the Bonneville Power Administration may be used to enter into any agreement to perform energy efficiency services outside the legally defined Bonneville service territory, with the exception of services provided internationally, including services provided on a reimbursable basis, unless the Administrator certifies in advance that such services are not available from private sector businesses.
SEC. 307. USER FACILITIES. When the Department of Energy makes a user facility available to universities or other potential users, or seeks input from universities or other potential users regarding significant characteristics or equipment in a user facility or a proposed user facility, the Department shall ensure broad public notice of such availability or such need for input to universities and other potential users. When the Department of Energy considers the participation of a university or other potential user as a formal partner in the establishment or operation of a user facility, the Department shall employ full and open competition in selecting such a partner. For purposes of this section, the term "user facility" includes, but is not limited to: (1) a user facility as described in section 2203(a)(2) of the Energy Policy Act of 1992 (42 U.S.C. 13503(a)(2)); (2) a National Nuclear Security Administration Defense Programs Technology Deployment Center/User Facility; and (3) any other Departmental facility designated by the Department as a user facility.
SEC. 308. INTELLIGENCE ACTIVITIES. Funds appropriated by this or any other Act, or made available by the transfer of funds in this Act, for intelligence activities are deemed to be specifically authorized by the Congress for purposes of section 504 of the National Security Act of 1947 (50 U.S.C. 414) during fiscal year **[**2008 **]***2009* until the enactment of the Intelligence Authorization Act for fiscal year **[**2008 **]***2009*.
[SEC. 309. LABORATORY DIRECTED RESEARCH AND DEVELOPMENT. Of the funds made available by the Department of Energy for activities at government-owned, contractor-operator operated laboratories funded in this Act or subsequent Energy and Water Development Appropriations Acts, the Secretary may authorize a specific amount, not to exceed 8 percent of such funds, to be used by such laboratories for laboratory-directed research and development: *Provided*, That the Secretary may also authorize a specific amount not to exceed 4 percent of such funds, to be used by the plant manager of

a covered nuclear weapons production plant or the manager of the Nevada Site Office for plant or site-directed research and development: *Provided further*, That notwithstanding Department of Energy order 413.2A, dated January 8, 2001, beginning in fiscal year 2006 and thereafter, all DOE laboratories may be eligible for laboratory directed research and development funding.**]**

[SEC. 310. YIELD RATE. For fiscal year 2008, except as otherwise provided by law in effect as of the date of this Act or unless a rate is specifically set by an Act of Congress thereafter, the Administrators of the Southeastern Power Administration, the Southwestern Power Administration, and the Western Area Power Administration, shall use the "yield" rate in computing interest during construction and interest on the unpaid balance of the costs of Federal power facilities. The yield rate shall be defined as the average yield during the preceding fiscal year on interest-bearing marketable securities of the United States which, at the time the computation is made, have terms of 15 years or more remaining to maturity.**]**

[SEC. 311. USE PERMIT. The Use Permit granted to the contractor for activities conducted at the Pacific Northwest National Laboratory by Agreement DE-GM05-00RL01831 between the Department of Energy and the contractor shall continue in effect during the term of the existing Operating Contract and the extensions or renewals thereof and shall be incorporated into any future management and operating contract for the Pacific Northwest National Laboratory and such Use Permit may not be waived, modified or terminated unless agreed to by both contractor and the Department of Energy.**]**

[SEC. 312. (a) ACROSS-THE-BOARD RESCISSIONS.—There is hereby rescinded—

(1) from discretionary accounts in this title that contain congressionally directed projects, an amount equal to 1.6 percent of the budget authority provided for fiscal year 2008 for such projects; and

(2) from all discretionary accounts in this title, an amount equal to 0.91 percent of the other budget authority provided for fiscal year 2008.

(b) DEFINITIONS.—For purposes of this section: (1) The term "congressionally directed project" means a congressional earmark or congressionally directed spending item specified in the list of such earmarks and items for this division that is included in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act).

(2) The term "other budget authority" means an amount equal to all discretionary budget authority, less the amount provided for congressionally directed projects.

(c) PROPORTIONATE APPLICATION TO OTHER PROGRAMS, PROJECTS, AND ACTIVITIES.—Any rescission made by subsection (a)(2) shall be applied proportionately—

(1) to each discretionary account; and

(2) within each such account, to each program, project, and activity (with programs, projects, and activities as delineated in the appropriation Act or accompanying reports for the relevant fiscal year covering such account).

(d) REPORT.—Within 30 days after the date of the enactment of this section, the Director of the Secretary of Energy shall submit to the Committees on Appropriations of the House of Representatives and the Senate a report specifying the account and amount of each rescission made pursuant to this section.**]**

SEC. *309. Section 312 of the Energy and Water Development Appropriations Act, 2004 (Pub. L. 108-137), is amended as follows: (1) In the first sentence by inserting between "the material" and "in the concrete silos", the words "formerly stored", by inserting before the period: "when such material is disposed at an Nuclear Regulatory Commission-regulated or Agreement State-regulated facility"; and (2) In the second sentence, striking "for the purpose" and everything that follows, and inserting; "after the material has been disposed at an NRC-regulated or Agreement materials being disposed as NRC-regulated or Agreement State-regulated facilities and shall not preclude the materials from otherwise being disposed at facilities operated by the Department of Energy so long as the materials meet the disposal facility's waste acceptance criteria." Not to exceed 5 per centum of any appropriation made available for Department of Energy activities funded in this Act or subsequent Energy and Water Development Appropriations Acts, not to exceed $5,000,000, may hereafter be transferred between such appropriations, but no such appropriation, except as otherwise provided, shall be increased or decreased by more than 5 per centum by any such transfers, and any such proposed transfers: Provided, That 15 days in advance of such transfer, notice shall be submitted to the Committees on Appropriations of the House and Senate.*

SEC. *310. Not to exceed 5 per centum of any appropriation made available for Department of Energy activities funded in this Act or subsequent Energy and Water Development Appropriations Acts may be transferred between such appropriations, but no such appropriation, except as otherwise provided, shall be increased or decreased by more than 5 per centum by any such transfers, and notification of such transfers shall be submitted promptly to the Committees on Appropriations of the House and Senate.*

SEC. *311. Section 311 of the Energy and Water Development Appropriations Act, 2008 is repealed. (Energy and Water Development and Related Agencies Appropriations Act, 2008.)*