DOE/CF-0164
Volume 3 Part 2

Department of Energy
FY 2021 Congressional Budget Request

Nuclear Energy
Fossil Energy Research and Development
Naval Petroleum and Oil Shale Reserves
Strategic Petroleum Reserve
Northeast Home Heating Oil Reserve
Office of Indian Energy Policy and Programs
Advanced Tech. Vehicles Manufacturing Loan Program
Title 17—Innovative Tech. Loan Guarantee Program
Tribal Energy Loan Guarantee Program

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DEPARTMENT OF ENERGY
Appropriation Summary
FY 2021
(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs. FY 2020 Enacted	
				$	%
Department of Energy Budget by Appropriation					
Energy Efficiency and Renewable Energy	2,379,000	2,777,277	719,563	-2,057,714	-74.09%
Electricity	156,000	190,000	195,045	5,045	2.66%
Cybersecurity, Energy Security and Emergency Response	120,000	156,000	184,621	28,621	18.35%
Nuclear Energy*	1,180,000	1,340,000	1,042,131	-297,869	-22.23%
Uranium Reserve	0	0	150,000	150,000	0.00%
Interim Storage and Nuclear Waste Fund Oversight	0	0	27,500	27,500	0.00%
Fossil Energy Research and Development	740,000	750,000	730,601	-19,399	-2.59%
Strategic Petroleum Reserve	235,000	195,000	187,081	-7,919	-4.06%
Naval Petroleum and Oil Shale Reserve	10,000	14,000	13,006	-994	-7.10%
Strategic Petroleum Reserve Petroleum Account	10,000	10,000	0	-10,000	-100.00%
Northeast Home Heating Oil Reserve	10,000	10,000	0	-10,000	-100.00%
Total, Fossil Energy Petroleum Reserve Accounts	**265,000**	**229,000**	**200,087**	**-28,913**	**-12.63%**
Total, Fossil Energy Programs	**1,005,000**	**979,000**	**930,688**	**-48,312**	**-4.93%**
Uranium Enrichment Decontamination and Decommissioning (D&D) Fund	841,129	881,000	806,244	-74,756	-8.49%
Energy Information Administration	125,000	126,800	128,710	1,910	1.51%
Non-Defense Environmental Cleanup	310,000	319,200	275,820	-43,380	-13.59%
Science	6,585,000	7,000,000	5,837,806	-1,162,194	-16.60%
Artificial Intelligence Technology Office	0	0	4,912	4,912	0.00%
Advanced Research Projects Agency - Energy	366,000	425,000	-310,744	-735,744	-173.12%
Departmental Administration	165,858	161,000	136,094	-24,906	-15.47%
Indian Energy Policy and Programs	18,000	22,000	8,005	-13,995	-63.61%
Inspector General	51,330	54,215	57,739	3,524	6.50%
International Affairs	0	0	32,959	32,959	0.00%
Title 17 Innovative Technology Loan Guarantee Program	12,311	29,000	-160,659	-189,659	-654.00%
Advanced Technology Vehicles Manufacturing Loan Program	5,000	5,000	0	-5,000	-100.00%
Tribal Energy Loan Guarantee Program	1,000	2,000	-8,500	-10,500	-525.00%
Total, Credit Programs	**18,311**	**36,000**	**-169,159**	**-205,159**	**-569.89%**
Total, Energy Programs	**13,320,628**	**14,467,492**	**10,057,934**	**-4,409,558**	**-30.48%**
Federal Salaries and Expenses	410,000	434,699	454,000	19,301	4.44%
Weapons Activities	11,100,000	12,457,097	15,602,000	3,144,903	25.25%
Defense Nuclear Nonproliferation	1,930,000	2,164,400	2,031,000	-133,400	-6.16%
Naval Reactors*	1,788,618	1,648,396	1,684,000	35,604	2.16%
Total, National Nuclear Security Administration	**15,228,618**	**16,704,592**	**19,771,000**	**3,066,408**	**18.36%**
Defense Environmental Cleanup	6,024,000	6,255,000	4,983,608	-1,271,392	-20.33%
Nuclear Energy	146,090	153,408	137,800	-15,608	-10.17%
Other Defense Programs	860,292	906,000	1,054,727	148,727	16.42%
Total, Environmental and Other Defense Activities	**7,030,382**	**7,314,408**	**6,176,135**	**-1,138,273**	**-15.56%**
Total, Atomic Energy Defense Activities	**22,259,000**	**24,019,000**	**25,947,135**	**1,928,135**	**8.03%**
Southwestern Power Administration	10,400	10,400	10,400	0	0.00%
Western Area Power Administration	89,372	89,196	89,372	176	0.20%
Falcon and Amistad Operating and Maintenance Fund	228	228	228	0	0.00%
Colorado River Basins Power Marketing Fund	0	-42,800	-21,400	21,400	**-50.00%**
Total, Power Marketing Administrations	**100,000**	**57,024**	**78,600**	**21,576**	**37.84%**
Total, Energy and Water Development and Related Agencies	**35,656,628**	**38,527,516**	**36,083,669**	**-2,443,847**	**-6.34%**
Excess Fees and Recoveries, FERC	-16,000	-16,000	-9,000	7,000	-43.78%
Title XVII Loan Guarantee Program Section 1703 Negative Credit Subsidy Receipt	-107,000	-15,000	-49,000	-34,000	226.67%
Sale of Northeast Home Heating Oil Reserve	0	0	-75,000	-75,000	0.00%
Sale of Oil from Strategic Petroleum Reserve**	0	0	-589,000	-589,000	0.00%
Total, Funding by Appropriation	**35,533,628**	**38,512,516**	**35,361,669**	**-3,150,847**	**-8.18%**
DOE Budget Function	**35,533,628**	**38,512,516**	**35,361,669**	**-3,150,847**	**-8.18%**
NNSA Defense (050) Total	15,228,618	16,704,592	19,771,000	3,066,408	18.36%
Non-NNSA Defense (050) Total	7,030,382	7,314,408	6,176,135	-1,138,273	-15.56%
Defense (050)	*22,259,000*	*24,019,000*	*25,947,135*	*1,928,135*	*8.03%*
Science (250)	6,585,000	7,000,000	5,837,806	-1,162,194	-16.60%
Energy (270)	6,689,628	7,493,516	3,576,728	-3,916,788	-52.27%
Non-Defense (Non-050)	*13,274,628*	*14,493,516*	*9,414,534*	*-5,078,982*	*-35.04%*

* Funding does not reflect statutory transfer of funds from Naval Reactors to Nuclear Energy for maintenance and operation of the Advanced Test Reactor ($85.5M in FY19; $88.5M in FY20).

**Includes a $50M sale from the Northeast Gasoline Supply Reserve.

Nuclear Energy

Nuclear Energy

Nuclear Energy

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Nuclear Energy
Proposed Appropriation Language

Nuclear Energy

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, [$1,493,408,000] $1,179,931,000, to remain available until expended: Provided, That of such amount, [$80,000,000] $75,131,000 shall be available until September 30, [2021] 2022, for program direction. (Energy and Water Development and Related Agencies Appropriations Act, 2020.)

Nuclear Energy
($K)

FY 2019 Enacted[1, 2]	FY 2020 Enacted[1, 3]	FY 2021 Request
1,326,090	1,493,408	1,179,931

Overview

Nuclear energy is a key element of United States (U.S.) energy independence, energy dominance, electricity grid resiliency, national security, and clean baseload power. America's nuclear energy sector provides approximately 55 percent of the nation's annual clean electricity production, and generates about 20 percent of U.S. electricity from a fleet of 96 operating units in 29 states. America's nuclear energy sector also plays key national security and global strategic roles for the U.S., including nuclear nonproliferation.

The U.S. pioneered the development and peaceful use of nuclear power to produce around-the-clock, emission-free electricity as well as the development of the civilian nuclear fuel cycle. However, the Department recognizes that the U.S. nuclear energy sector is under historic downward pressure, has lost a tremendous amount of its once dominant global market share, and has seen a significant degradation in its manufacturing base. In addition, the U.S. no longer has an operating U.S.-owned (or U.S.-technology-based) fast spectrum test reactor.

The Department believes it is not too late, and indeed possible, to reverse the downward trajectory of our nation's nuclear energy sector and once again become dominant. Accordingly, the Department's fiscal year (FY) 2021 nuclear energy budget request funds an array of programs that will support reviving and expanding our nuclear energy sector and position it once again for dominance in the future.

The Office of Nuclear Energy (NE) focuses on three major mission areas; the nation’s existing nuclear fleet, the development of advanced nuclear reactor concepts, and fuel cycle technologies. Utilizing the Department’s greatest strengths, NE emphasizes early stage research and development (R&D) and limited later-stage R&D where there are unique challenges, mobilizing our significant national laboratory capabilities, and implementing targeted R&D partnerships with the U.S. nuclear industry.

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] Funding does not reflect the mandatory transfer of $85.5M from Naval Reactors for operation of the Advanced Test Reactor.
[3] Funding does not reflect the mandatory transfer of $88.5M from Naval Reactors for operation of the Advanced Test Reactor.

Highlights and Major Changes in the FY 2021 Budget Request

- The Nuclear Waste Policy Act (NWPA) of 1982 made the Department of Energy (DOE) responsible for the United States' (U.S.) spent nuclear fuel and high-level nuclear waste and the Department remains committed to fulfilling the Federal Government's legal and moral obligations to properly manage and dispose of that material. DOE will support the Administration's development of a durable, predictable yet flexible plan that addresses more efficiently storing waste temporarily in the near term, followed by permanent disposal. Integrated elements of this effort are reflected in an FY 2021 funding request of $60 million for Used Nuclear Fuel Disposition Research and Development (R&D), an increase of $55 million over the FY 2020 request, and the efforts to move towards implementation of a robust interim storage option funded under the new Interim Storage and Nuclear Waste Fund Oversight budget. The Department recognizes that legislative changes are needed to implement elements of the proposed approach, and looks forward to working with Congress on a solution.
- On February 22, 2019, the Department approved Critical Decision (CD) 0, *Approve Mission Need*, for the Versatile Test Reactor (VTR) project. The VTR project team is working towards completion of CD-1, *Alternative Selection and Cost Range*, by the end of the third quarter of FY 2020 with completion of National Environmental Policy Act (NEPA) documents and initiation of long lead procurements in the fourth quarter of FY 2021. In anticipation of these efforts the Department has established a new NE R&D program, the Versatile Test Reactor Project. Concurrently, the pre-construction research and development subprogram Versatile Advanced Test Reactor, within the Reactor Concepts Research, Development and Demonstration (RC RD&D) program transitioned to an infrastructure investment project effort funded under the new VTR program.
- The FY 2021 request for the Advanced Reactor Demonstration program provides funding for the R&D portions of the program. In FY 2021, the program will continue execution of the FY 2020 demonstration awards.
- The Radiological Facilities Management program will procure Training, Research, Isotopes, General Atomics (TRIGA) fuel elements in FY 2021. This effort will ensure supported U.S. universities have access to a lifetime supply of fuel for their TRIGA research reactors.
- The FY 2021 Request maintains most of the budget structure changes enacted in the Consolidated Appropriations Act. However, due to the complexities introduced by these changes, the Department has chosen to retain the traditional structure for its Idaho Facilities Management and Radiological Facility Management programs.
- The Office of Nuclear Energy (NE) will also participate and coordinate in the following Departmental crosscuts: the Harsh Environment Materials Initiative, the Advanced Energy Storage Initiative and the Critical Minerals Initiative. These crosscuts are in the Nuclear Energy Enabling Technologies (NEET) program.

Nuclear Energy
Funding by Congressional Control ($K)
(Non-Comparable)

	FY 2019 Current[1,2]	FY 2020 Enacted[1,3]	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted ($)	FY 2021 Request vs FY 2020 Enacted (%)
Integrated University Program	**5,000**	**5,000**	**0**	**-5,000**	**-100%**
STEP Research & Development (R&D)	**5,000**	**5,000**	**0**	**-5,000**	**-100%**
Reactor Concepts Research, Development & Demonstration (RD&D)					
Advanced SMR R&D	100,000	100,000	10,000	-90,000	-90%
Light Water Reactor Sustainability	47,000	47,000	30,500	-16,500	-35%
Advanced Reactor Technologies	111,500	55,000	71,000	+16,000	+29%
Versatile Advanced Test Reactor	65,000	65,000	0	-65,000	-100%
Reactor Concepts RD&D	**323,500**	**267,000**	**111,500**	**-155,500**	**-58%**
Fuel Cycle Research and Development					
Mining, Conversion and Transportation	0	2,000	2,000	0	0%
Civil Nuclear Enrichment	30,200	40,000	40,000	0	0%
Materials Recovery and Waste Form Development	36,700	30,000	12,000	-18,000	-60%
Advanced Fuels	112,708	0	0	0	0%
Accident Tolerant Fuels	0	95,600	36,000	-59,600	-62%
TRISO and Graphite Qualification	0	30,000	34,000	+4,000	+13%
Fuel Cycle R&D	0	20,000	3,000	-17,000	-85%
Systems Analysis and Integration	6,376	0	0	0	0%
MPACT	4,716	0	0	0	0%
Used Nuclear Fuel Disposition R&D	50,715	62,500	60,000	-2,500	-4%
Integrated Waste Management System	22,500	25,000	0	-25,000	-100%
Fuel Cycle R&D	**263,915**	**305,100**	**187,000**	**-118,100**	**-39%**

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] Funding does not reflect the mandatory transfer of $85.5M from Naval Reactors for operation of the Advanced Test Reactor.
[3] Funding does not reflect the mandatory transfer of $88.5M from Naval Reactors for operation of the Advanced Test Reactor.

	FY 2019 Current[1,2]	FY 2020 Enacted[1,3]	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted ($)	FY 2021 Request vs FY 2020 Enacted (%)
Nuclear Energy Enabling Technologies					
Crosscutting Technology Development	50,000	25,000	28,000	+3,000	+12%
Modeling and Simulation Hub	27,585	0	0	0	0%
NE Advanced Modeling & Simulation	31,000	35,000	30,000	-5,000	-14%
Nuclear Science User Facilities	44,000	30,000	28,000	-2,000	-7%
Transformational Challenge Reactor	0	23,450	30,000	+6,550	+28%
Nuclear Energy Enabling Technologies	**152,585**	**113,450**	**116,000**	**+2,550**	**+2%**
ORNL Infrastructure	20,000	0	0	0	0%
Research Reactor Infrastructure	9,000	0	11,500	+11,500	+100%
Radiological Facilities Management	**29,000**	**0**	**11,500**	**11,500**	**+100%**
Advanced Reactor Demonstration Program					
National Reactor Innovation Center	0	20,000	10,000	-10,000	-50%
Demonstration 1	0	80,000	0	-80,000	-100%
Demonstration 2	0	80,000	0	-80,000	-100%
Risk Reduction for Future Demonstrations	0	30,000	0	-30,000	-100%
Regulatory Development	0	15,000	7,500	-7,500	-50%
Advanced Reactors Safeguards	0	5,000	2,500	-2,500	-50%
Subtotal, Advanced Reactors Demonstration Program	**0**	**230,000**	**20,000**	**-210,000**	**-91%**
Versatile Test Reactor Project					
Other Project Costs	0	0	33,000	+33,000	+100%
21-E-200, Versatile Test Reactor	0	0	262,000	+262,000	+100%
Versatile Test Reactor Project	**0**	**0**	**295,000**	**295,000**	**+100%**
Infrastructure					
INL Facilities Operations & Maintenance	0	280,000	0	-280,000	-100%
ORNL Infrastructure Facilities O&M	0	20,000	0	-20,000	-100%
Research Reactor Infrastructure	0	9,000	0	-9,000	-100%
Construction					
16-E-200, Sample Preparation Laboratory	0	25,450	0	-25,450	-100%
Subtotal, Infrastructure	**0**	**334,450**	**0**	**-334,450**	**-100%**

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] Funding does not reflect the mandatory transfer of $85.5M from Naval Reactors for operation of the Advanced Test Reactor.
[3] Funding does not reflect the mandatory transfer of $88.5M from Naval Reactors for operation of the Advanced Test Reactor.

	FY 2019 Current[1, 2]	FY 2020 Enacted[1, 3]	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted ($)	FY 2021 Request vs FY 2020 Enacted (%)
Idaho Facilities Management					
Operations & Maintenance	288,000	0	208,000	+208,000	+100%
16-E-200, Sample Preparation Laboratory	30,000	0	18,000	+18,000	+100%
Idaho Facilities Management	**318,000**	**0**	**226,000**	**+226,000**	**+100%**
Idaho Sitewide Safeguards and Security	**146,090**	**153,408**	**137,800**	**-15,608**	**-10%**
International Nuclear Energy Cooperation	**3,000**	**0**	**0**	**0**	**0%**
Program Direction	**80,000**	**80,000**	**75,131**	**-4,869**	**-6%**
Total, Nuclear Energy R&D	**1,326,090**	**1,493,408**	**1,179,931**	**-313,477**	**-21%**
Federal FTEs	283	287	272	-15	-5%

SBIR/STTR:

- FY 2019 Transferred: SBIR $23,120; STTR $3,251
- FY 2020 Projected: SBIR $19,378; STTR $2,725
- FY 2021 Request: SBIR $12,304; STTR $1,730

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] Funding does not reflect the mandatory transfer of $85.5M from Naval Reactors for operation of the Advanced Test Reactor.
[3] Funding does not reflect the mandatory transfer of $88.5M from Naval Reactors for operation of the Advanced Test Reactor.

Nuclear Energy
Funding ($K)
(Comparable)

	FY 2019 Current[1, 2]	FY 2020 Enacted[1, 3]	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted ($)	FY 2021 Request vs FY 2020 Enacted (%)
Integrated University Program	5,000	5,000	0	-5,000	-100%
STEP R&D	5,000	5,000	0	-5,000	-100%
Reactor Concepts RD&D	323,500	267,000	111,500	-155,500	-58%
Fuel Cycle Research and Development	263,915	305,100	187,000	-118,100	-39%
Nuclear Energy Enabling Technologies	152,585	113,450	116,000	2,550	+2%
Radiological Facilities Management	29,000	29,000	11,500	-17,500	-60%
Advanced Reactor Demonstration Program	0	230,000	20,000	-210,000	-91%
Versatile Test Reactor Project	0	0	295,000	295,000	100%
Idaho Facilities Management					
Operations & Maintenance	288,000	280,000	208,000	-72,000	-26%
16-E-200, Sample Preparation Laboratory	30,000	25,450	18,000	-7,450	-29%
Idaho Facilities Management	318,000	305,450	226,000	-79,450	-26%
Idaho Sitewide Safeguards and Security	146,090	153,408	137,800	-15,608	-10%
International Nuclear Energy Cooperation	3,000	0	0	0	0%
Program Direction	80,000	80,000	75,131	-4,869	-6%
Total, Nuclear Energy R&D	1,326,090	1,493,408	1,179,931	-313,477	-21%

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] Funding does not reflect the mandatory transfer of $85.5M from Naval Reactors for operation of the Advanced Test Reactor.
[3] Funding does not reflect the mandatory transfer of $88.5M from Naval Reactors for operation of the Advanced Test Reactor.

NE FY 2021 PRB Crosswalk [1]

	Radiological Facilities Management		Idaho Facilities Management		Other NE R&D	Total
	ORNL Infrastructure	Research Reactor Infrastructure	Operations & Maintenance	Construction		
FY 2020 Budget Structure						
Infrastructure						
ORNL Nuclear Facilities O&M	0	0	0	0	0	0
INL Facilities Operations and Maintenance	0	0	208,000	0	0	208,000
Research Reactor Infrastructure	0	11,500	0	0	0	11,500
Construction	0	0	0	18,000	0	18,000
Subtotal, Infrastructure	0	11,500	208,000	18,000	0	237,500
Other NE R&D	0	0	0	0	942,431	942,431
Total, Nuclear Energy R&D	0	11,500	208,000	18,000	942,431	1,179,931

[1] The Further Consolidated Appropriations Act, 2020, included a number of budget structure changes intended to assist the Office of Nuclear Energy to focus on needed research, development and demonstration that supports the current nuclear fleet and enables a future for nuclear power. Most of these changes have been carried through to the FY 2021 budget. However, due to the complexities introduced by these changes, the Department has chosen to retain the traditional structure for its Idaho Facilities Management and Radiological Facility Management programs.

Integrated University Program

Overview

No funding is requested in the FY 2021 Budget for the Integrated University Program (IUP).

All Department awards are fully funded in the year funding is received. As a result, multi-year student research fellowships do not require support by out-year funds after the appropriation year.

Integrated University Program
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Integrated University Program				
Integrated University Program	5,000	5,000	0	-5,000
Total, Integrated University Program	**5,000**	**5,000**	**0**	**-5,000**

Integrated University Program
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Integrated University Program:	
No funding is requested to continue this program in FY 2021.	-5,000
Total, Integrated University Program	**-5,000**

Integrated University Program
Funding ($K)

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Integrated University Program $5,000,000	**$0**	**-$5,000,000**
• Support nuclear science and engineering study and research by fully funding 30 multi-year student fellowships and 45 single-year scholarships in the nuclear energy field of study.	• No funding is requested to continue this program in FY 2021.	• No funding is requested to continue this program in FY 2021.

Supercritical Transformational Electric Power Research and Development

Overview

The Supercritical Transformational Electric Power Research and Development (STEP R&D) initiative was a collaborative Department of Energy (DOE) project to develop and scale up advanced Supercritical Carbon Dioxide (sCO_2) Brayton cycle energy conversion technology to facilitate commercial development. As a result of the large incentive for industry development of this technology, The Office of Nuclear Energy does not support the sCO_2 program in FY 2021. DOE resources are being focused on earlier-stage research across the nuclear energy programs.

This technology has the potential to significantly reduce costs of energy production by improving the efficiency of converting thermal energy to electrical energy using traditional steam-Rankine cycle systems, which are used for roughly 80% of the world's electricity generation. sCO_2 Brayton cycle technology utilizes smaller equipment and will be simpler to operate compared to Rankine cycle technology, resulting in lower capital and operating costs. These improvements could make advanced nuclear energy technologies more cost competitive. Extensive systems testing has significantly lowered the technical risk for this technology and any remaining commercialization efforts should be left to industry to resolve.

Any remaining early stage research on Brayton cycle energy conversion technology issues specific to advanced nuclear energy applications could be continued within the Reactor Concepts, Research, Development and Demonstration (RD&D) program.

Highlights of the FY 2021 Budget Request

No funding is requested for the STEP R&D initiative, consistent with the Department's decision to shift scale up of the technology to the private sector.

Supercritical Transformational Electric Power Research and Development
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Supercritical Transformational Electric Power Research and Development				
Supercritical Transformational Electric Power Research and Development	5,000	5,000	0	-5,000
Total, Supercritical Transformational Electric Power Research and Development	**5,000**	**5,000**	**0**	**-5,000**

SBIR/STTR:

- FY 2019 Transferred: SBIR $160; STTR $22
- FY 2020 Projected: SBIR $160; STTR $22
- FY 2021 Request: SBIR $0; STTR $0

Supercritical Transformational Electric Power Research and Development
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Supercritical Transformational Electric Power Research and Development:	
No funding is requested in the FY 2021 Budget.	-5,000
Total, Supercritical Transformational Electric Power Research and Development	**-5,000**

Supercritical Transformational Electric Power Research and Development

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Supercritical Transformational Electric Power Research and Development $5,000,000	**$0**	**-$5,000,000**
• Identify/validate materials to satisfy the performance requirements for components in a commercial scale system. • Finalize build for seals test rig and test mechanical lift of seals in super critical Carbon Dioxide (sCO_2) at 4400 psi and 700C in order to support the commercialization of a 10 Mega Watt sCO_2 Re-compression Closed Brayton Cycle. • Upgrade and maintain the Development Platform with new subsystems and upgraded infrastructure. • Identification and support of sCO_2 program variables; systems and concurrent engineering, systems modeling, requirements test plans and validation plans, Technology Readiness Level management, system metrics, technology roadmapping, communities of practice management, research and development planning. • Perform Lowest Cost of Electricity optimization of the sCO_2 Brayton cycle to inform design parameters while considering cross-cutting heat sources. • Complete design guidelines for Printed Circuit Heat Exchanger including a materials tradeoff analysis. • Demonstrate the viability for sCO_2 Power System qualification for grid connection by scoping the work needed to support the new on-the-grid Kirtland First initiative. • Perform activities necessary to close out federal program and prepare technology for transition to industry.	• No funding is requested.	• No funding is requested in the FY 2021 Request. This technology is sufficiently mature for industry to adopt and further develop it.

Reactor Concepts Research, Development and Demonstration

Overview

The Reactor Concepts Research, Development and Demonstration (RD&D) program supports the conduct of early stage research and development (R&D) on existing and advanced reactor designs and technologies to enable industry to address technical challenges while maintaining the existing fleet of nuclear reactors and to promote the development of a robust pipeline of advanced reactor designs and technologies and supply chain capabilities. Program activities are designed to address technical, cost, safety enhancement, and security issues associated with the existing commercial light water reactor fleet and advanced reactor technologies, such as small modular reactors (SMR), fast reactors using liquid metal coolants, high temperature reactors using gas or liquid salt coolants, and microreactors.

In maximizing the benefits of nuclear power, work must be done to address the following challenges:

- Improving affordability of nuclear energy technologies;
- Enhancing safety and reducing technical risk;
- Minimizing proliferation risks of nuclear materials; and
- Enabling the improvement of the economic outlook for the United States (U.S.) nuclear industry.

Reactor Concepts RD&D is key to enabling the industry to reverse the downward market trajectory of our nation's nuclear energy sector and regaining a technological and market leadership role. Through cost-shared, early stage R&D, related technical assistance and direct-funded, cross-cutting early stage R&D, the Department will enable industry to accelerate the timeline for commercialization of new, advanced, and more financeable reactor technologies that will help revive and expand the domestic nuclear industry while advancing America's leadership role in the global nuclear sector.

The Reactor Concepts RD&D program continues to support R&D efforts focused on SMRs in FY 2021. The Advanced SMR R&D subprogram was initiated in FY 2019 and supports cost-shared, early stage design-related R&D, the results of which are intended to be widely applicable to many advanced reactor designs and adopted by nuclear technology development vendors for the purpose of accelerating the development of their technologies into the domestic and international markets, including countries that have expressed interest in near-term SMR deployment. Funding will be awarded competitively to multiple recipients to encourage domestic SMR technology development and to produce results that are widely applicable across the spectrum of nascent reactor concepts.

The Light Water Reactor Sustainability (LWRS) subprogram conducts research in support of light water reactor (LWR) technologies so that LWR-based commercial nuclear power plants can continue to provide safe, clean, and reliable energy. The goal is to enable industry to enhance the efficient and economical performance of current nuclear power plants while enabling their extended operation. The primary focus of the subprogram is on cost-shared, private-public partnerships to help industry resolve its highest priority and highest uncertainty technical issues that are not currently being addressed, where U.S. government partnership is appropriate. An example of such a partnership would be the R&D on methods of control room and plant modernization to address aging and obsolescence of existing analog instrumentation and controls to improve plant efficiency.

The Advanced Reactor Technologies (ART) subprogram conducts early stage R&D on advanced reactor technologies, including molten salt reactors, fast reactors, high temperature gas-cooled reactors, and supports work on generic topics that can apply to multiple advanced reactor concepts, including SMRs and microreactors. This subprogram focuses on efforts in the following areas: fundamental technologies and design methods for advanced reactors, interactions of diverse reactor coolants with materials and components, advanced energy conversion, analysis of reactor response to severe accidents, research to enhance safety and reduce regulatory risk, experimental validation of models, advanced materials development and codification, fuel development and graphite material qualification, and continued international collaborations.

Highlights of the FY 2021 Budget Request

The Reactor Concepts Research, Development & Demonstration program will continue to conduct research and development to address technical, cost, safety, and security enhancement challenges associated with the existing commercial light water reactor fleet and advanced reactor technologies.

Reactor Concepts Research, Development and Demonstration
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Reactor Concepts Research, Development and Demonstration				
Advanced Small Modular Reactor R&D	100,000	100,000	10,000	-90,000
Light Water Reactor Sustainability	47,000	47,000	30,500	-16,500
Advanced Reactor Technologies	111,500	55,000	71,000	+16,000
Versatile Advanced Test Reactor R&D	65,000	65,000	0	-65,000
Total, Reactor Concepts Research, Development and Demonstration	**323,500**	**267,000**	**111,500**	**-155,500**

SBIR/STTR:

- FY 2019 Transferred: SBIR $10,352; STTR $1,456
- FY 2020 Projected: SBIR $6,464; STTR $909
- FY 2021 Request: SBIR $3,568; STTR $502

Reactor Concepts Research, Development and Demonstration
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Advanced Small Modular Reactor R&D: The decrease from $100,000,000 to $10,000,000 reflects a focused emphasis on cost-shared, early stage, and limited later-stage, design-related research and development (R&D) relevant to a broad spectrum of advanced small modular designs while minimizing potential duplication of effort with the Advanced Reactor Technologies subprogram.	**-90,000**
Light Water Reactor Sustainability: The decrease from $47,000,000 to $30,500,000 reflects a focused emphasis on R&D supporting flexible plant operations and generation.	**-16,500**
Advanced Reactor Technologies: The increase from $55,000,000 to $71,000,000 expands program R&D on the highest priority early stage and limited later-stage advanced reactor R&D that will answer fundamental questions and enable advancement across the nuclear reactor industry. The increase also supports an increased emphasis on advanced reactor technology development.	**+16,000**
Versatile Advanced Test Reactor R&D: The decrease from $65,000,000 to $0 reflects the transition from an R&D effort to an infrastructure investment program funded under the Versatile Test Reactor Project.	**-65,000**
Total, Reactor Concepts Research, Development & Demonstration	**-155,500**

Reactor Concepts Research, Development and Demonstration
Advanced Small Modular Reactor R&D

Description

The Advanced Small Modular Reactor (SMR) Research and Development (R&D) subprogram is one key element of the Department's overall strategy to enable industry to reverse the downward market trajectory of our nation's nuclear energy sector and to reestablish dominance in the nuclear technology development arena. A range of significant technological challenges remain in developing advanced SMR designs. By continuing this Advanced SMR R&D effort in FY 2021, the Department intends to continue to leverage its appropriate federal role and notable R&D expertise to facilitate industry's development of advanced SMR designs that have the potential to provide safe and affordable energy generation options. The Department acknowledges the need to continue these activities in FY 2021 to help enable industry's acceleration of these innovative designs into the domestic and international markets, and believes this effort is essential to regaining a dominant position in the global market.

The Advanced SMR R&D subprogram will support early stage, design-related R&D, the results of which are intended to be widely applicable and adopted by domestic nuclear reactor vendors for the purpose of accelerating the development of their technologies. Specifically, Advanced SMR R&D will support early stage R&D that results in broad benefits to the U.S. nuclear energy sector that can serve as the basis for later-stage advanced SMR R&D that the private sector chooses to fund. In so doing, the Advanced SMR R&D subprogram will help to promote U.S. energy independence, electricity grid resiliency, national security and clean baseload power. Funding will continue to be awarded competitively to multiple recipients and this subprogram will seek to maximize leveraging of ongoing and planned R&D supported by the related Advanced Reactor Technologies subprogram.

In FY 2021, the subprogram funding will continue to focus on efforts to support early stage R&D on advanced small modular designs. The subprogram will support limited later-stage, design related R&D to support progress in the development of reactor designs. The subprogram will use the Industry Funding Opportunity Announcement to select projects that have high potential to accelerate the development of both emerging and more mature SMR designs.

Advanced Small Modular Reactor R&D
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Advanced Small Modular Reactor R&D		
$100,000,000	**$10,000,000**	**-$90,000,000**
• Support early stage research and development (R&D) to further advance small modular reactors (SMR) in areas such as: - Thermal hydraulics of natural circulation - Remote monitoring and operation - Source term evaluation - Siting feasibility • Award projects under the Industry Funding Opportunity Announcement (Industry FOA) to support the development of SMRs of various technology types, with an emphasis on innovative capabilities that have broad applicability. Awardees and specific technologies supported are To Be Decided (TBD), but will be focused on multiple designs that have higher potential for nearer-term commercialization. • Continue technology development that will broadly enable industry toward SMR deployment in the near term. • Support detailed planning and initiation of a project that employs an SMR module to conduct R&D addressing reactor and grid stability, integrated energy systems, microgrid development, and use of reactor process heat for industrial processes.	• Continue to support early stage R&D to further advance SMRs. • Continue to award projects under the Industry FOA to support the development of SMRs of various technology types, with an emphasis on innovative capabilities that have broad applicability. Awardees and specific technologies supported are TBD.	• The decrease reflects a focused emphasis on early stage R&D activities to support the development of an array of SMR designs.

Reactor Concepts Research, Development and Demonstration
Light Water Reactor Sustainability

Description

The Light Water Reactor Sustainability (LWRS) subprogram conducts research and development (R&D) on technologies and other solutions that can improve economics, sustain safety, and maintain the technical reliability of the current domestic fleet of commercial nuclear power plants. The LWRS subprogram will work with owner-operators to provide technical assistance as they develop the technical basis for second license renewals. In addition, the subprogram supports R&D to address current and future material issues facing the U.S. nuclear industry to ensure a viable, long-term source of nuclear power generation.

With the initial success of the lead plants' Subsequent License Renewal submittals in FY 2018, the focus for sustaining the existing fleet has shifted from extending their operational licenses to addressing economic challenges leading to premature shutdowns. LWRS will continue to collaborate with nuclear power plant owner-operators, vendors, suppliers, industry support organizations, other research organizations, and the Nuclear Regulatory Commission (NRC) to closely coordinate early stage research that both supports industry needs and maximizes taxpayer benefit.

Currently, the LWRS subprogram consists of the following primary technical areas of R&D:

- Materials Research: R&D to develop the scientific basis for understanding and predicting long-term environmental degradation behavior of materials in nuclear power plants. The R&D products will be used to define operational limits and aging mitigation approaches for materials in nuclear power plant systems, structures and components (SSCs) subject to long-term operating conditions, providing key input to both regulators and industry.
- Risk-Informed Systems Analysis: R&D to support decision-making related to economics, reliability, and safety by providing integrated plant systems analysis solutions to enhance economic competitiveness of the operating fleet. The R&D products in this area will be used to optimize plant economic performance and safety by incorporating plant impacts, physical aging, and degradation processes.
- Plant Modernization: R&D to address nuclear power plant economic viability in current and future energy markets through innovation, and efficiency gains through application of digital technologies. The R&D products will enable modernization of plant systems and processes across the industry while allowing companies to implement a technology-centric business model platform that supports improved performance at a lower cost.
- Flexible Plant Operations and Generation: R&D to establish the technical feasibility, and economic potential for dispatching thermal and electrical energy to diversify and increase revenue of light water reactors in the U.S. The R&D products will allow the existing fleet of nuclear reactors to more readily respond to increasing renewable energy production and demonstrate the ability to repurpose nuclear power reactors into a flexible energy sources for low-carbon industrial commodity production.
- Physical Security Research: R&D that will validate methods and tools which can be used to implement an updated, cost-effective physical security regime. The R&D products are expected to enable companies across the industry to reduce excessive conservatisms in security modeling, leverage automation as force multipliers, optimize security postures, and develop additional means to risk-inform approaches to evaluate security changes.

In FY 2021, the LWRS subprogram continues to leverage cost-shared, private-public partnerships and our national laboratory system to conduct early stage R&D to resolve highest priority and highest uncertainty issues that are not currently being addressed but where U.S. government partnership is appropriate. These high priority areas include developing the scientific bases for managing the aging of SSCs so nuclear power plants can continue to operate safely and cost-effectively and providing science and technology-based solutions to improve the current business model and associated practices.

Light Water Reactor Sustainability
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Light Water Reactor Sustainability $47,000,000	**$30,500,000**	**-$16,500,000**
• Materials Research – Integrate embrittlement model for high fluence conditions into Grizzly, a simulation tool, to provide a more accurate prediction of the age induced degradation of mechanical properties in the reactor pressure vessel. Optimize the welding process for nickel-based alloys, which could allow industry to avoid costly in core internal replacements. • Risk-Informed Systems Analysis – Develop component maintenance and testing optimization models to enable a risk-and-cost based decision-making process. Working with industry, apply methods and tools to enhance plant resiliency through new technologies to improve plant performance, operational flexibility in future energy markets, and reduce costs. • Plant Modernization – Conduct research on an online monitoring system at a commercial nuclear power plant and develop performance insights for their use by industry. Develop advanced automation concepts for control room operators using digital technologies to enhance system performance and reliability. • Flexible Plant Operations and Generation – Continue research and development (R&D) to support the integration of a hydrogen generation capability at an existing nuclear power plant in order to enable the plant's diversification. Begin to examine a second competitively-awarded pilot project to	• Materials Research – Complete environmental fatigue assessment of stainless steel and dissimilar metal weldments under relevant Light Water Reactor conditions. Continue development of a predictive model for cable degradation. • Risk-Informed Systems Analysis – Complete human-reliability analysis to credit FLEX in accident management and perform risk-informed analysis of a passive-cooling design. Develop the strategy to extend the implementation of fire Probabilistic Risk Assessment (PRA) tools for the existing fleet. • Plant Modernization – Complete development of asset risk models that will be applicable to a variety of existing reactor designs and will be made widely available to the industry to enable adoption of predictive maintenance strategies to replace time-based maintenance activities of plant equipment. Conduct early stage R&D on technologies that can enable online monitoring of plant equipment to replace labor-based approaches to equipment condition assessment at commercial nuclear power plants to reduce operating costs and improve equipment availability and reliability. • Flexible Plant Operations and Generation – Working with other applied energy offices, fund competitively selected industry-led projects for grid-integration with hydrogen technologies to enhance the stability of the power grid through	• The decrease reflects a greater emphasis on technologies that will allow the domestic nuclear industry to continue to operate safely and cost effectively, such as Flexible Plant Operations and Generation R&D as described.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
demonstrate the technology necessary to allow nuclear power plants to move flexibly between electricity and hydrogen generation during periods of peak renewable energy production.	responsive load and energy storage, in support of H2@Scale. • Physical Security - Develop the technical basis for potential future, industry-funded pilots of remote operated weaponry, increasing the operating fleet's security posture and allowing for the first implementation of automated weapons at an operating commercial nuclear power plant.	

Reactor Concepts Research, Development and Demonstration
Advanced Reactor Technologies

Description

The Advanced Reactor Technologies (ART) subprogram conducts early stage, essential research to reduce technical risk associated with advanced reactor technologies and systems. The specific scope is identified, with input from industry, with a goal of helping enable industry to develop and ultimately demonstrate advanced reactor concepts, if appropriate, by the 2030s. Innovative advanced reactor concepts have the potential to offer significant benefits versus existing technologies, including possible lower costs, enhanced safety and security, greater resource utilization, and easier operation. Such advantages could allow nuclear energy to increase its contributions to United States (U.S.) clean and resilient energy sources and to support the growth of high-paying U.S. jobs. The ART subprogram conducts research and development (R&D) that can help reduce long-term technical barriers for multiple reactor technology concepts with a focus on innovative technologies. This subprogram will address high-value fundamental research for long-term concepts, early stage research and development (R&D) needs of promising mid-range concepts, development of innovative technologies that benefit multiple advanced reactor concepts, including emerging microreactor designs, and stimulation of new ideas for transformational future concepts.

Early stage R&D efforts support innovative reactor concepts, including high temperature gas-cooled reactors (HTGRs), fast reactors, and molten salt reactors (MSRs) using liquid salt coolants and/or fuels. The ART subprogram focuses on early stage, industry-informed R&D priorities that could provide widely-applicable benefits across many different advanced reactor concepts, including: fundamental technologies and design methods for advanced reactors; interactions of advanced reactor coolants with materials and components; advanced instrumentation and controls that can operate in severe environments; research to enhance safety; advanced materials development and codification; cross-cutting areas of support in advanced energy conversion technologies; and, research to support special purpose applications, such as microreactors for remote applications. The ART subprogram continues support for international activities in the Generation IV International Forum and international collaborations on advanced materials, advanced reactor operations and safety that will promote the development of the U.S. advanced reactor pipeline. Industry-led, innovative early stage cost-shared R&D activities are supported through competitive industry awards, including direct laboratory funded R&D that reduces technical risk, which is expected to help industry as firms pursue Nuclear Regulatory Commission (NRC) regulatory approvals. This subprogram will seek to maximize the leverage of its ongoing and planned R&D by avoiding duplication and maximizing effectiveness of the R&D conducted under the Advanced Small Modular Reactor R&D subprogram.

Advanced Reactor Technologies
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Advanced Reactor Technologies $55,000,000	**$71,000,000**	**+$16,000,000**
• Fast Reactor Technologies - Continue in-sodium testing of industry-identified fast reactor component experiments in Mechanisms Engineering Test Laboratory (METL). Address Nuclear Regulatory Commission (NRC) comments on historical metal fuel testing data qualification and complete the collection and qualification of historical data sets targeted by U.S. vendors. Continue to modernize and validate fast reactor safety codes for use in normal operation and transient analyses. Lead International Atomic Energy Agency (IAEA) Coordinated Research Project on Fast Flux Test Facility Historical Safety Test Benchmark; continue American Society of Mechanical Engineers (ASME) material qualification efforts. • Gas Reactor Technologies - Perform experimental validation of normal operation and transient conditions. Continue ASME code qualification of Alloy 617 and resolve issues necessary to achieve endorsement by NRC. • Molten Salt Reactor Technologies - Continue development of chemical monitoring requirements, methods, and instrumentation. Establish modeling framework for salt characterization. Continue to collect and analyze fundamental data to understand fission product behavior in chloride salt-fueled systems. Develop advanced instrumentation for monitoring fissile material inventory. Investigate chemical control	• Fast Reactor Technologies - Maintain METL facility operational readiness to support industry-identified fast reactor component experiments. Continue in-sodium testing of industry-identified fast reactor component experiments that may yield results that can be useful to multiple reactor developers. Qualify historical fast reactor data sets targeted by U.S. vendors using NRC-approved Quality Assurance methodology. Continue ASME material qualification efforts. Additional activities include: - Develop benchmarks to validate U.S. fast reactor code suites. - Qualify Grade 91 sodium in support of NRC licensing by fast reactor developers. - Support development of hydrogen sensors for near-term sodium fast reactor applications. • Gas Reactor Technologies - Perform experimental validation of normal operation and transient conditions and support modeling and simulation. Continue ASME code qualification of Alloy 617 and resolve issues necessary to achieve endorsement by NRC. TRISO fuel and graphite research and development (R&D) is funded under Fuel Cycle R&D as stated in the FY 2020 conference report. • Molten Salt Reactor Technologies - Continue development of chemical monitoring requirements, methods, and instrumentation. Continue modeling framework for salt characterization. Continue to collect and analyze fundamental data to understand fission product	• The increase reflects funding the highest priority advanced reactor early stage and limited later-stage advanced reactor R&D that will answer fundamental questions.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
strategies for controlled plating techniques and filtering methods. • Microreactor Technologies - Complete development of nonnuclear test bed and begin testing and validation on high priority components e.g., research and development (R&D) on heat pipes, compact heat exchangers). Develop qualification plan for high temperature materials that have the broadest potential application for microreactor applications. • Cross-Cutting Technologies - Continue cross-cutting R&D advanced reactor designs, as described in technology roadmap. Continue work on printed circuit heat exchangers, intermediate heat exchanger alloys and Brayton cycle plant analysis codes. • ART Industry Awards - Support innovation and competitiveness of the U.S. nuclear industry through cost-shared early stage R&D.	behavior in chloride salt-fueled systems. Continue to develop advanced instrumentation for monitoring fissile material inventory. Additional activities include: - Validate chemical control strategies for controlled plating techniques and filtering methods. - Fabricate replacement parts for a test loop using advanced manufacturing methods as a demonstration for future molten salt reactor component builds. • Microreactor Technologies - Continue nonnuclear testing and validation of high priority components. Begin nonnuclear integrated testing and validation of microreactor systems and operational regimes, e.g., load following, process heat, semi-autonomous operation. Continue advanced dynamic analysis of microreactor concepts to support potential demonstration designs. Continue qualification and irradiation testing of high temperature materials that have the broadest potential application for microreactor applications. Additional activities include: - Develop and test integration of heat pipes and gas-cooling to heat exchanger for power conversion systems. - Continue code case development for Grade 91 steel as an improved structural material for microreactors. • Cross-Cutting Technologies - Continue cross-cutting R&D for advanced reactor designs, as described in technology roadmap. Continue work on printed circuit heat exchangers, intermediate heat exchanger alloys and Brayton cycle plant analysis codes.	

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
	• Industry Awards - Support innovation and competitiveness of the U.S. nuclear industry through cost-shared early stage research and development.	

Reactor Concepts Research, Development and Demonstration
Versatile Advanced Test Reactor R&D

Description

A fast spectrum test reactor will be an important experimental tool in the development of the next generation of advanced reactors. Sustaining the existing fleet and the development of advanced reactors are key in providing a diverse portfolio of energy supply sources to ensure national security through energy independence and energy dominance. A fast spectrum test reactor can facilitate the testing and development of advanced fuels, materials and instruments and sensors in extreme environments. Due to the very high neutron flux provided by such a fast test reactor, the irradiation time for testing of new materials can be reduced by an order of magnitude compared to that for a standard thermal test reactor such as the Advanced Test Reactor at Idaho National Laboratory.

The Versatile Advanced Test Reactor (VATR) is one of the Department's highest priorities, and the VATR subprogram serves as a cornerstone to the Administration's focus on reviving and expanding the nuclear sector in the United States (U.S.). Specifically, the VATR will support the modernization of U.S. infrastructure for early stage R&D and will help enable private sector demonstration and deployment of energy technologies. The VATR will help the U.S. to regain and strengthen its global technical leadership role in the field of nuclear energy and train the next generation of scientists and engineers needed for the future nuclear sector.

FY 2019 activities included pre-conceptual analyses and design to support the development of highly credible cost estimates to support approval on February 22, 2019, of Critical Decision (CD)-0, Approve Mission Need, under DOE Order 413.38, Program and Project Management for the Acquisition of Capital Assets. FY 2019 activities that will carry over into FY 2020 include preparation of an Environmental Impact Statement to ensure that all environmental factors are considered with the goal of achieving a Record of Decision in FY 2021, and the development of a conceptual design to support approval of CD-1, Approve Alternative Selection and Cost Range, in FY 2020.

To reflect the transition from a R&D effort to an infrastructure investment program, FY 2021 funding is being requested in the newly established Versatile Test Reactor line item construction project.

Versatile Advanced Test Reactor R&D
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Versatile Advanced Test Reactor$65,000,000	**$0**	**-$65,000,000**
• Develop and approve an Acquisition Strategy. • Develop and approve a preliminary Project Execution Plan. • Complete the safety basis compliance strategy. • Complete draft reactor sizing study. • Complete required Department of Energy (DOE) Order 413.3B documents to support approval of Critical Decision-1 including identification of a preferred alternative. • Complete a conceptual design and associated cost and schedule estimates. • Complete cost estimate for fuel source, fuel fabrication and assembly. • Conduct National Environmental Policy Act required activities with the goal of achieving a Record of Decision in FY 2021.	• No funding is requested in the FY 2021 Reactor Concepts Research Development and Demonstration subprogram.	• The decrease in funding reflects the transition to an infrastructure investment that will be managed in accordance with DOE Order 413.3B, Program and Project Management for the Acquisition of Capital Assets and funded under the newly established Versatile Test Reactor line item construction project.

Fuel Cycle Research and Development

Overview

The Fuel Cycle Research and Development (FCR&D) program conducts early-stage applied research and development (R&D) on advanced fuel cycle technologies that have the potential to accelerate progress on managing and disposing of the nation's spent fuel and high-level waste, accelerate progress on managing and disposing of the nation's spent fuel and high-level waste, improve resource utilization and energy generation, reduce waste generation, and limit proliferation risk. Advancements in fuel cycle technologies support the enhanced availability, economics, and security of nuclear-generated electricity in the United States (U.S.), further enhancing U.S. energy independence and economic competitiveness. The program conducts system analyses of advanced fuel cycle options and alternative solutions to help guide decision-making and prioritization of R&D activities. The FCR&D program also provides technical support for the Department's uranium management policies.

The program prioritizes R&D and evaluation of spent fuel and high-level waste disposition pathways, covering storage, transportation, and disposal technologies. The program also supports R&D on multiple advanced fuel technologies that hold promise for reduced risks and improved economics or are an important element in the development of the next generation of reactor designs; exploring the feasibility of reprocessing highly-enriched uranium to produce high-assay, low-enriched uranium (HALEU); and demonstrating a capability to produce HALEU utilizing U.S. centrifuge technology. These activities provide valuable information that will inform industry's decisions on the commercialization and deployment of advanced reactors, including micro reactors.

The FCR&D program participates in world-class R&D and employs internationally renowned technical experts. All FCR&D subprograms leverage their technical expertise by participating in international collaborations through bilateral and multilateral technical agreements. The program also participates in projects sponsored by the International Atomic Energy Agency and the Organization for Economic Co-operation and Development/Nuclear Energy Agency which provides further leverage in key technical areas.

Highlights of the FY 2021 Budget Request

The Nuclear Waste Policy Act (NWPA) of 1982 made the Department of Energy (DOE) responsible for the United States' (U.S.) spent nuclear fuel and high-level nuclear waste and the Department remains committed to fulfilling the Federal Government's legal and moral obligations to properly manage and dispose of that material. DOE will support the development of a durable, predictable yet flexible plan that addresses more efficiently storing waste temporarily in the near term, followed by permanent disposal. Integrated elements of this effort are reflected in an FY 2021 funding request of $60 million for Used Nuclear Fuel Disposition R&D, an increase of $55 million over the FY 2020 request, and the efforts to develop and implement a robust interim storage option funded under the new Interim Storage and Nuclear Waste Fund Oversight program. The Department recognizes that legislative changes are needed to implement elements of the proposed approach, and looks forward to working with Congress to implement a solution.

New Subprograms

The FY 2021 Budget Request carries over a number of subprogram structure changes included in the FY 2020 appropriation. Specifically, the request includes four new subprograms:

The Mining, Conversion, and Transportation subprogram focuses on R&D supporting U.S. mining and conversion capabilities. In FY 2021, the subprogram will investigate advanced water treatment technologies to reduce the quantity of wastewater generated by uranium production that requires disposal.

The Accident Tolerant Fuels subprogram will continue to make progress towards its goal of enabling industry's development of one or more light water reactor fuel concepts with significantly enhanced accident tolerance through early-stage R&D. The subprogram will continue preparations for the installation of high-risk, high-reward lead test assemblies in commercial reactors in FY 2022. The Transient Reactor Test Facility (TREAT) reactor continues to progress to more advanced tests that demonstrate the performance of advanced fuels under postulated accident conditions. The Accident Tolerant Fuels scope was previously included within the Advanced Fuels subprogram, which was eliminated in FY 2020 by Congress.

The TRISO Fuel and Graphite Qualification subprogram reflects transferred scope from the Reactor Concepts Research, Development and Demonstration – Advanced Reactor Technologies subprogram consistent with the FY 2020 appropriation. The Advanced Gas Reactor TRISO program re-established the U.S. capability to fabricate TRISO fuel and focuses on development and testing activities. The graphite program obtains material properties of irradiated and un-irradiated graphite to support licensing for use in high temperature reactors.

The Fuel Cycle R&D subprogram conducts R&D for the use of innovative process control capabilities to support nuclear fuel cycles for advanced reactors. It also continues activities related to advanced reactor fuel development, systems analysis and integration and material protection, accounting, and control technologies.

Fuel Cycle Research and Development
Funding ($K)

	FY 2019 Current[1]	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Fuel Cycle Research and Development				
Material Recovery and Waste Form Development	36,700	30,000	12,000	-18,000
Mining, Conversion, and Transportation	0	2,000	2,000	0
Civil Nuclear Enrichment	30,200	40,000	40,000	0
Advanced Fuels	112,708	0	0	0
Accident Tolerant Fuels	0	95,600	36,000	-59,600
TRISO Fuel and Graphite Qualification	0	30,000	34,000	+4,000
System Analysis and Integration	6,376	0	0	0
Materials Protection, Accounting and Control Technology	4,716	0	0	0
Fuel Cycle R&D	0	20,000	3,000	-17.000
Used Nuclear Fuel Disposition R&D	50,715	62,500	60,000	-2,500
Integrated Waste Management System	22,500	25,000	0	-25,000
Total, Fuel Cycle Research and Development	**263,915**	**305,100**	**187,000**	**-118,100**

SBIR/STTR:

- FY 2019 Enacted: SBIR $7,725; STTR $1,086
- FY 2020 Enacted: SBIR $7,683; STTR $1,080
- FY 2021 Request: SBIR $4,704; STTR $662

[1] FY 2019 Current column reflects alignment of FY 2019 Fuel Cycle Research and Development appropriations to initiate the Civil Nuclear Enrichment subprogram.

Fuel Cycle Research and Development
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Material Recovery and Waste Form Development: Funding decreases from $30,000,000 to $12,000,000 reflects the elimination of hybrid ZIRCEX engineering scale demonstration design activities.	**-18,000**
Accident Tolerant Fuels Funding decrease from $95,600,000 to $36,000,000 reflects a focusing of resources on high-risk, high-reward accident tolerant fuel concepts that require more research and development (R&D) but offer significant benefits over the near-term concepts.	**-59,600**
TRISO Fuel and Graphite Qualification Funding increased from $30,000,000 to $34,000,000 to accelerate TRISO post-irradiation examination (PIE) activities and provide desired examination results to support industry's efforts to license and qualify TRISO fuel, as well as accelerate graphite testing and characterization, including PIE and analysis, providing data at a faster rate.	**+4,000**
Fuel Cycle R&D: Funding is decreased from $20,000,000 to 3,000,000 to focus on innovative technologies, analysis tools, and advanced integration methods for aqueous and molten salt separation process controls and nuclear materials management.	**-17,000**
Used Nuclear Fuel Disposition R&D: Funding decreases from $62,500,000 to $60,000,000 reflects an increased focus on R&D for alternative storage, transportation, and disposal of U.S. nuclear waste in alignment of the program with Administration efforts to more efficiently manage and dispose spent nuclear fuel and high-level nuclear waste material.	**-2,500**
Integrated Waste Management System: Funding decreased from $25,000,000 to $0 reflecting the completion of the program within Fuel Cycle R&D.	**-25,000**
Total, Fuel Cycle R&D	**-118,100**

Fuel Cycle Research and Development
Material Recovery and Waste Form Development

Description

The Material Recovery and Waste Form Development (MRWFD) subprogram conducts early-stage applied research and development on advanced fuel cycle technologies that have the potential to improve resource utilization and energy generation, reduce waste generation, and limit proliferation risk. The subprogram focuses on developing advanced fuel cycle technologies and addressing fundamental materials separation and recovery challenges that present significant degrees of technical risks and uncertainties making them unlikely for private sectors to invest. Key subprogram objectives include:

(1) Conducting R&D to support the development the hybrid ZIRCEX and Experimental Breeder Reactor-II fuel treatment processes, which will produce limited high assay, low enriched uranium (HALEU);
(2) Developing next generation fuel cycle technologies targeting high-value used fuels (e.g., containing HALEU);
(3) Supporting fundamental nuclear fuel cycle process chemistry and molten salt chemistry to maintain critical R&D core competencies in addressing various chemical challenges related to civil nuclear applications.

MRWFD subprogram evaluates the feasibility of different technologies providing a limited supply of HALEU to support fuel-fabrication R&D needs for potential demonstration of advanced reactor concepts. HALEU can be recovered from feedstock that contains highly-enriched uranium (HEU) by using the molten salt and hybrid ZIRCEX processes. A ¼-scale ZIRCEX pilot facility, using unirradiated materials (cold tests), was built at the Idaho National Laboratory to evaluate the feasibility of using recycled HEU fuel for HALEU production.

MRWFD applies the unique expertise and technical capabilities to a broad range of applications such as a fundamental understanding of various chemical challenges related to civil nuclear applications. It funds molten salt chemistry research to support advanced nuclear technologies using molten salts as electrolytes, fuel solvent and coolants. It also funds research on integrated advanced technologies encompassing R&D on off gas capture, waste form development. The subprogram employs a science-based approach to foster innovative and transformational technology solutions to achieve this objective.

Material Recovery and Waste Form Development
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Material Recovery and Waste Form Development		
$30,000,000	**$12,000,000**	**-$18,000,000**
• Complete CoDeContamination (CoDCon) demonstration lab test. • Continue off-gas and advanced waste form technologies development. • Complete initial evaluation of zirconium studies at the ¼-scale pilot plant using the ZIRCEX process. • Accelerate the Experimental Breeder Reactor-II (EBR-II) used fuel treatment to generate 1 metric ton per year of high assay, low enriched uranium (HALEU) using the molten salt process. • Demonstrate input accountancy options for irradiated used fuel under the Joint Fuel Cycle Study (JFCS) with South Korea.	• Continue the acceleration of EBR-II used fuel treatment. • Continue JFCS for its 10th and final year of collaboration with South Korea. • Continue hybrid ZIRCEX process focusing on cold pilot plant studies. • Support fundamental aqueous and molten salt separation chemistries to address chemical challenges related to civil nuclear energy applications. • Explore next generation fuel cycle technologies targeting high-value used fuels.	• Eliminate hybrid ZIRCEX engineering scale demonstration design.

Description

This subprogram supports early stage, cost-shared research and development that enables technological advances in uranium mining, conversion, and transportation capabilities in the United States as well as the conducting evaluations and assessments related to these areas. This subprogram supports activities related to uranium fuel supply issues.

Mining, Conversion, and Transportation
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Mining, Conversion, and Transportation **$2,000,000**	**$2,000,000**	**$0**
• Identify key challenges in reconstituting mining and conversion capabilities in the United States. • Evaluate the nation's nuclear fuel demands, including potential future demand for high assay, low enriched uranium (HALEU). • Evaluate challenges in uranium fuel shipping. • Evaluate concept of public-private partnerships for HALEU modeled after the National Aeronautics and Space Administration Commercial Orbital Transportation System program.	• Establish a research and development program on advanced water treatment technologies to reduce the quantity of wastewater requiring disposal to reduce the cost of uranium production.	• No change.

Fuel Cycle Research and Development
Civil Nuclear Enrichment

Description

This subprogram executes a three-year, limited scope, demonstration of a U.S. origin, enrichment technology for producing high-assay, low enriched uranium (HALEU). FY 2021 is the final year of funding for this initiative and the project will be brought to closure on June 1, 2022.

Natural uranium consists almost exclusively of two types of uranium isotopes, mostly uranium-238 (99.3 percent) and a smaller fraction (0.7 percent) of the fissionable isotope uranium-235 (U-235). Many advanced reactor concepts are anticipated to require HALEU, which contains a uranium concentrated or enriched to levels between 5 and 20% in the U-235 isotope. Currently, there is no enrichment facility in the United States (U.S.) to produce HALEU for industry's advanced reactor demonstration and deployment.

A HALEU production capability utilizing U.S.-origin enrichment technology may enhance U.S. energy security as well as provide fuel to support development and deployment of advanced reactors, including the global use of U.S. designs. Demonstration of the capability of U.S.-origin enrichment technology to produce HALEU helps enable the private sector to adopt and deploy a U.S.-owned and U.S.-origin HALEU production capability. This demonstration is intended to show that a U.S. technology option is available to the private sector should demand materialize and a market for HALEU emerge, thus promoting U.S. technology leadership and advancing vital strategic interests.

In FY 2021, the Civil Nuclear Enrichment subprogram will complete cascade design work, install support equipment such as the inventory withdrawal station, restore the Piketon facility for handling classified material/information, install centrifuge machinery, condition the system for operation, calibrate operations and operate a cost-shared lead cascade of centrifuges with the goal to produce domestic HALEU in FY 2022. The Federal Government's cumulative cost share contribution over this three-year project, will not exceed $115 million. The lead cascade will include only a small number of centrifuges for demonstration purposes only. The private sector is responsible for funding any expansion or commercialization of the technology to produce HALEU after this project concludes in FY 2022. Work under this subprogram will take place during three years: May 31, 2019, to June 1, 2022. Early production of HALEU will permit vendors to ensure that reactor developers will have sufficient time to test new advanced fuels containing HALEU prior to seeking qualification of these fuels from the U.S. Nuclear Regulatory Commission. This effort is complimentary to National Nuclear Security Administration's Domestic Uranium Enrichment program, which is exploring options to meet certain long-term Departmental uranium enrichment needs.

Civil Nuclear Enrichment
Funding

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Civil Nuclear Enrichment $40,000,000	**$40,000,000**	**$0**
• Procure materials, components and services to complete one lead cascade of centrifuges with the goal to produce high-assay low enriched uranium (HALEU) in FY 2022. • Continue regulatory support related to demonstrating the production of HALEU in FY 2022, including maintaining the existing Nuclear Regulatory Commission (NRC) license and amending it to allow demonstration at 19.75%.	• Complete cascade design work, install support equipment such as the inventory withdrawal station, restore the Piketon, OH facility for handling classified material/information, install centrifuge machinery, condition the system for operation, calibrate operations and operate a lead cascade of centrifuges. • Continue regulatory support related to demonstrating the production of HALEU.	• No change

Description

The subprogram mission enabled industry's development of one or more light water reactor fuel concepts with significantly enhanced accident tolerance through early stage cost shared research and development.

Congress ended this program in FY 2020 and no additional funding is requested in FY 2021. The effort to develop fuels with enhanced accident tolerance is continued within the new Accident Tolerant Fuel subprogram.

Advanced Fuels
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2021 Enacted
Advanced Fuels $0	**$0**	**$0**
• Program scope to continue within new subprograms in Fuel Cycle Research and Development, as appropriated in FY 2020.	• No funding requested in FY 2021 Budget.	• No change.

Fuel Cycle Research and Development
Accident Tolerant Fuels

Description

The subprogram mission is enabling industry's development of one or more light water reactor (LWR) fuel concepts with significantly enhanced accident tolerance through early-stage cost shared research and development (R&D).

Following the accident at Fukushima, Advanced Fuels initiated a program to explore advanced LWR fuel with enhanced accident tolerance to benefit existing U.S. commercial nuclear power reactors. After five years of feasibility studies and assessments of potential fuel concepts, the program identified promising concepts that have the potential to significantly enhance accident tolerance. The program is conducting R&D on enabling the accident tolerant fuel concepts to operate with higher burnup and enrichment levels to enable improved economic performance of commercial nuclear power reactors. In FY 2021, the program will focus on the high-risk, high-reward concepts that require more R&D but offer significant benefits over any of the near-term technologies. The accident tolerant fuel program also will continue its investment in supporting fuel development capabilities of the national laboratories.

Accident Tolerant Fuels
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Accident Tolerant Fuels $95,600,000	**$36,000,000**	**-$59,600,000**
• Prepare for the installation of high-risk, high-reward lead test assemblies in commercial reactors in the FY 2022 time frame. • Develop topical reports to support licensing and develop cost-effective manufacturing processes for first batch reloads of accident tolerant fuel concepts in the mid-2020s. • Continue irradiations of fuel rodlets in the central water loop of the Advanced Test Reactor (ATR). • In the Transient Reactor Test Facility (TREAT) Facility, progress to conducting dry capsule tests on irradiated accident tolerant fuel (ATF) samples. • Continue investment in fuel development capabilities at the national laboratories that are critical for ATF development. • Initiate research and development (R&D) on enabling the accident tolerant fuel concepts to operate at higher burnup and uranium enrichment.	• Continue to prepare for the installation of high-risk, high-reward lead test assemblies in commercial reactors in the FY 2022 time frame. • Continue irradiations of fuel rodlets in the central water loop of the ATR. • In the TREAT Facility, perform reactivity insertion accident tests on irradiated fuel in static water capsules. • Continue investment in fuel development capabilities at the national laboratories that are critical for accident tolerant fuel development.	The reduction reflects focusing subprogram to the high-risk, high-reward accident tolerant fuel concepts that require more R&D but offer significant benefits over the near-term concepts.

Description

The subprogram for Tristructural-isotropic (TRISO)-coated particle fuel and graphite qualification was previously authorized under the Advanced Reactor Technologies program. The subprogram activities include fuel and material irradiation, post-irradiation examination (PIE) and safety testing, fuel performance modeling, and fission product transport and source term research.

TRISO particle fuel development and qualification activities support prismatic and pebble-bed high temperature fuel designs. Since the onset of the TRISO Fuel Program in 2002, the program has focused on qualification of the fuel design for high temperature gas reactor concepts. However, TRISO fuel has applications in other reactor concepts as well. Irradiation, safety testing, and PIE of TRISO fuel will provide data for fuel development and qualification in support of industry efforts to eventually establish a domestic commercial TRISO fuel fabrication capability.

The graphite development and qualification effort provides data to support the use of graphite in high temperature reactor environments. Historical grades of graphite used in previous reactors are no longer available. Graphite development includes efforts to characterize new grades of graphite, and irradiate the graphite to provide non-irradiated and irradiated properties so that the thermomechanical design of the structural graphite in advanced high temperature reactors can be validated. The irradiation experiments span the proposed temperature and dose envelope for a prismatic high temperature gas reactor and is also applicable to pebble bed reactors and possibly molten salt reactors.

TRISO Fuel and Graphite Qualification
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
TRISO Fuel and Graphite Qualification $30,000,000	**$34,000,000**	**+$4,000,000**
• The TRISO fuel and Graphite qualification program was previously funded under Advanced Reactor Technologies. • Continue irradiation of the Advanced Gas Reactor (AGR)-5/6/7 TRISO fuel experiments in the Idaho National Laboratory (INL) Advanced Test Reactor (ATR). • Continue post irradiation examination (PIE) efforts of irradiated TRISO fuel and prepare for post-irradiation examination of the AGR-5/6/7 experiments. • Perform heat up testing, fission product transport studies, and data collection. • Provide fuel performance data for validation of models. • Continue graphite irradiation and PIE of the Advanced Graphite Creep experiments. • Prepare high dose graphite (HDG) experiment for irradiation. • Continue development of predictive material behavior models for graphite codification.	• Complete irradiation of the AGR-5/6/7 TRISO fuel experiments in the INL ATR. • Perform safety testing of TRISO fuel in elevated temperatures as well as in air/moisture ingress environments. • Continue PIE efforts of irradiated TRISO fuel. • Begin HDG experiment irradiation in INL ATR. • Continue characterization and PIE of graphite specimens.	• Acceleration of TRISO PIE activities and provide desired examination results to support licensing and qualification of TRISO fuel. • Accelerate graphite testing and characterization, including PIE and analysis.

Fuel Cycle Research and Development
Systems Analysis and Integration

Description

The Systems Analysis and Integration subprogram provided the critical capability needed to analyze complex fuel cycle system options, assess overall performance under various scenarios, and improve understanding of the interdependencies between various subsystems and associated technologies.

In FY 2020, Congress eliminated the Systems Analysis and Integration subprogram and shifted its mission and scope to the new Fuel Cycle Research and Development subprogram.

Systems Analysis and Integration
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Systems Analysis and Integration $0	**$0**	**$0**
• Program scope to continue in new subprograms within the Fuel Cycle Research and Development program, as appropriated in FY 2020.	• No funding is requested in FY 2021.	• No Change.

Description

The Materials Protection, Accounting and Control Technology (MPACT) subprogram developed innovative technologies, analysis tools and advanced integration methods to enable U.S. domestic nuclear materials management and safeguards for emerging nuclear fuel cycles and reactors. It also included assessing vulnerabilities in current nuclear systems while minimizing proliferation risks.

In FY 2020, Congress eliminated the Materials Protection, Accounting and Control Technology and shifted its mission and scope to the new Fuel Cycle R&D subprogram.

Materials Protection, Accounting and Control Technology
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Materials Protection, Accounting and Control Technology $0	**$0**	**$0**
• Program scope to continue in new subprograms within the Fuel Cycle Research and Development program, as appropriated in FY 2020.	• No funding in the FY 2021 Budget.	• No change.

Description

This subprogram supports early-stage innovative research activities that advance the knowledge base for nuclear fuel cycles and provide transformative changes to accelerate development of civil nuclear technologies, including consideration of fuel cycle impacts from the potential deployment of advanced reactor technologies. It also includes activities in Materials Protection, Accounting and Control Technology (MPACT), Systems Analysis and Integration (SAI), innovative fuel cycle process control capabilities and advanced reactor fuels research and development (R&D).

MPACT develops innovative technologies, analysis tools and advanced integration methods to enable U.S. domestic nuclear materials management and safeguards for emerging nuclear fuel cycles. It also includes assessing vulnerabilities in current nuclear systems while minimizing proliferation risks. Addressing the energy security needs of the country requires innovative approaches to material control and accounting to ensure that nuclear material is not misused, diverted, or stolen.

SAI activities include strategic planning and analysis, and integrated evaluation of program activities. It provides the critical capability needed to analyze complex fuel cycle system options, assess overall performance under various scenarios, and improve understanding of the interdependencies between various subsystems and associated technologies.

Innovative fuel cycle process controls include the development of advanced on-line real-time monitoring technologies to enhance processes controllability and modeling capability to enable predictive and control of separation systems.

Advanced reactor fuels activities include R&D on innovative experimental concepts, continuation of ongoing long-term experiments in the Advanced Test Reactor, and supporting on-going international commitments.

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Fuel Cycle R&D $20,000,000	**$3,000,000**	**-$17,000,000**
• Develop process control modeling capability to enable predictive and control of aqueous and molten salt separation systems. • Develop innovative on-line process monitoring capabilities for advanced reactors fuel recycling. • Develop advanced solvent extractants and complexation agents to improve the separation processes controllability. • Complete a lab-scale demonstration of an advanced safeguards and security system relevant to an electrochemical processing facility. • Develop and demonstrate a virtual electrochemical facility using a complete safeguards and security by design approach which was validated through modeling and experimental data. • Conduct advanced reactor fuel irradiation testing in the Advanced Test Reactor. • Conduct strategic planning and analysis to prioritize and integrate research and development (R&D) activities.	•Continue the development of innovative technologies, analysis tools, and advanced integration methods for aqueous and molten salt separation process controls and nuclear materials management, and other limited fuel cycle R&D activities.	• Advanced Reactor Fuels R&D will be funded within the corresponding advanced reactor programs.

Fuel Cycle Research and Development
Used Nuclear Fuel Disposition R&D

Description
The Used Nuclear Fuel Disposition Research and Development (R&D) subprogram conducts scientific research and technology development to enable long term storage, transportation, and disposal of spent nuclear fuel and wastes. The primary focus of this subprogram supports the development of disposition-path-neutral waste management systems and options in the context of the current inventory of spent nuclear fuel and waste.

Research and Development
Full-Scale Storage Cask Demonstration – Although the nuclear power industry has used dry storage for many years, this storage option has been for low-burnup fuel; therefore, there is limited data available on the degradation of more contemporary high-burnup fuels. To address this data gap, the Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), and nuclear industry are cooperating to investigate extended storage of high-burnup fuels (≥ 45 GWd/MTHM). DOE, in cooperation with the NRC and industry, is conducting a full-scale demonstration of storage for high-burnup fuel that will be beneficial by: 1) benchmarking the predictive models and empirical conclusions developed from short-term laboratory testing, and 2) building confidence in the ability to predict the performance of these systems over extended time periods.

Storage and Transportation R&D – In addition to the Full-Scale Storage Cask project, DOE will continue to support other lab testing, field studies, and modeling R&D related to the storage and transport of high-burnup fuel to include: testing of cladding response with hydride reorientation and embrittlement; the effects of atmospheric corrosion on storage welds; measuring the embrittlement of elastomer seals; determining thermomechanical degradation of bolts, welds, seals and poisons; analyzing thermal profiles of stored fuels; determining the stress profiles of fuels and casks; evaluating cask drying processes; laboratory post-irradiation examination and testing of the fuel from the cask demonstration project at North Anna Generating Station; and the development of sensors for internal and external cask monitoring. R&D will focus on contributing to the technical knowledge to support long-term storage and eventual transportation of high-burn-up fuels.

Disposal R&D – Activities continue to further the understanding of long-term performance of disposal systems in three main geologic rock types: clay/shale, salt, and crystalline rock. These activities include collaborations with international partners to leverage and integrate applicable R&D being conducted by other countries into the U.S. disposal R&D portfolio. Also, evaluations will be completed to determine the feasibility of directly disposing existing single (storage only) and dual-purpose (storage and transportation) used-fuel canisters in a mined repository.

Alternative Technologies and Pathways for Storage, Transportation, and Disposal of Nuclear Waste
Conduct evaluation of alternative technologies and pathways for the storage, transportation, and disposal of the nation's nuclear waste, with a focus on deployable solutions. Increased focus will be technical analyses to support program decisions on near-term storage solutions.

Used Nuclear Fuel Disposition Research & Development (R&D)
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Used Nuclear Fuel Disposition Research & Development $62,500,000	**$60,000,000**	**-2,500,000**
• Study of the performance of the high burnup used nuclear fuel demonstration. • Continue destructive testing on the 25 spent nuclear fuel rods that will be used to determine the performance baseline at the time of loading. • Continue work to determine the effects of stress corrosion cracking on some of the stainless steel components of the cask systems. • Continue priority research and development (R&D) activities associated with exploring potential alternative disposal options for various waste and used nuclear fuel forms, including enhanced modeling for water movement through geologic media, performance of backfill materials at higher temperatures, and total system performance systems advancements. • Maintaining collaborations with international partners to leverage R&D being conducted in various geologic media. • Work to continue evaluating the technical feasibility of eliminating repackaging spent nuclear fuel into disposal packages by disposing fuel in the current dual-purpose canisters.	• Complete non-destructive testing and continued destructive testing of fuel rods that were pulled from a commercial power station to establish the performance baseline of the stored used fuel. • Characterize external loadings on fuel rods during normal conditions of transport. • Develop an understanding of material degradation phenomena in safety components associated with long term storage and transportation systems. This work will support licensing applications for extended dry storage and subsequent retrieval and transport of high burnup used nuclear fuel. • Evaluate integration and implementation methodologies of process-level models with performance assessment tools relating to argillite and crystalline media disposal. Integrated developed modeling tools with analysis software for uncertainty quantification and sensitivity analysis. • Continue science and engineering technical basis for the disposal of heat generating waste in salt. • Continue R&D activities associated with exploring potential alternative disposal options for various waste and spent nuclear fuel forms, including collaboration with international partners to leverage R&D being conducted in various geologic media. • Issue evaluation of the technical feasibility of direct	• Aligns program with Administration efforts to more efficiently manage and dispose spent nuclear fuel and high-level nuclear waste material.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
	disposal of dual-purpose canisters to potentially eliminate the need for repackaging these canisters for disposal. • Test and evaluate the storage, transportation and disposal performance characteristics of the new accident tolerant fuels.	

Fuel Cycle Research and Development
Integrated Waste Management System

Description

The Integrated Waste Management System (IWMS) subprogram will be discontinued. No funding is requested in the FY 2021 Budget. Interim storage and transportation planning scope is moving under the new Interim Storage and Nuclear Waste Fund Oversight program.

Integrated Waste Management System
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Integrated Waste Management System $25,000,000	**$0**	**-$25,000,000**
• Pursue possible storage approaches and solutions. • Implement improvements to the Stakeholder Tool for Assessing Radioactive Transportation (START) and complete migration of the tool to the cloud. • Evaluate transportation infrastructure at three nuclear power plant sites. • Maintain inventory of commercial spent nuclear fuel and system analysis modeling tools. • Continue testing and demonstration of the Atlas railcar consist. • Maintain relationships and cooperative agreements with state and tribal working groups. • Continue to develop cloud-based records and data management systems for a waste disposition program.	• No funding is requested in the FY 2021 Budget.	• Activities will be discontinued under the Fuel Cycle Research and Development program.

Nuclear Energy Enabling Technologies

Overview

The Nuclear Energy Enabling Technologies (NEET) program conducts early-stage research and development (R&D) and makes strategic investments in research capabilities to develop innovative and crosscutting nuclear energy technologies to resolve nuclear technology development issues. The Crosscutting Technology Development subprogram focuses on innovative research that directly supports the existing fleet of nuclear reactors and enables the development of new, next generation reactor and fuel cycle technologies, including topical areas such as sensors and instrumentation; cybersecurity, innovative manufacturing, fabrication and construction technologies; advanced cooling concepts; and other stakeholder-identified research areas. Also, NEET invests in modeling and simulation tools for existing and advanced reactor and fuel system technologies. The program also provides United States (U.S.) industry, U.S. universities, and national laboratories access to unique nuclear energy research capabilities through the Nuclear Science User Facilities. Lastly, NEET includes the Transformational Challenge Reactor (TCR) subprogram to provide a revolutionary platform to reduce the deployment costs and timelines of nuclear energy systems. Collectively, NEET-sponsored activities support the goals, objectives, and activities of the Gateway for Accelerated Innovation in Nuclear initiative to make these technology advancements accessible to U.S. industry through private-public partnerships. In so doing, NEET helps promote U.S. energy independence, electricity grid resiliency, national security and clean baseload power.

Highlights of the FY 2021 Budget Request

The TCR subprogram continues to enhance the development of breakthrough technologies that provide the ability to manufacture small/micro advanced reactor components using additive manufacturing techniques to deliver a new approach to nuclear design and qualification for advanced reactor technologies.

The Nuclear Energy Advanced Modeling and Simulation subprogram completes the initial validation of a prioritized set of advanced reactor modeling tools for use by the nuclear industry in support of design, development and regulatory engagement.

The FY 2021 Budget Request includes $5 million for new crosscutting research that supports Departmental crosscuts in Harsh Environment Materials, Advanced Energy Storage, and Critical Minerals initiatives. The Office of Nuclear Energy (NE) plans to conduct a study on non-uranium critical minerals important to the nuclear industry to inform future R&D investments and competitively award projects on Advanced Energy Storage.

Nuclear Energy Enabling Technologies
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Nuclear Energy Enabling Technologies				
Crosscutting Technology Development	50,000	25,000	28,000	+3,000
Nuclear Energy Advanced Modeling and Simulation	31,000	35,000	30,000	-5,000
Energy Innovation Hub for Modeling and Simulation	27,585	0	0	0
Nuclear Science User Facilities	44,000	30,000	28,000	-2,000
Transformational Challenge Reactor	0	23,450	30,000	+6,550
Total, Nuclear Energy Enabling Technologies	**152,585**	**113,450**	**116,000**	**+2,550**

SBIR/STTR:

- FY 2019 Transferred: SBIR $4,883; STTR $687
- FY 2020 Projected: SBIR $3,631; STTR $511
- FY 2021 Request: SBIR $3,712; STTR $522

Nuclear Energy Enabling Technologies
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Crosscutting Technology Development (CTD) :	**+3,000**
The increase from $25,000,000 to $28,000,000 reflects new Office of Nuclear Energy (NE) support of the Advanced Energy Storage Initiative and the new Critical Minerals Initiative via the CTD subprogram.	
Nuclear Energy Advanced Modeling and Simulation (NEAMS):	**-5,000**
The decrease from $35,000,000 to $30,000,000 reflects further focus of efforts on highest priority modeling and simulation needs identified by NE and informed by stakeholders. In FY 2021, the program will not further develop capabilities for high-resolution gas reactor pebble tracking or advanced light-water reactor thermal-hydraulics.	
Energy Innovation Hub for Modeling and Simulation (M&S Hub):	**0**
There are no changes in the FY 2021 Budget Request.	
	-2,000
Nuclear Science User Facilities (NSUF):	
The decrease from $30,000,000 to $28,000,000 reflects a consolidation of the competitive facility access awards and facility capability enhancement investments by the NSUF program.	
	+6,550
Transformational Challenge Reactor (TCR):	
The increase from $23,450,000 to $30,000,000 will support the progression of activities associated with an operational test of a micro-reactor fabricated using additive manufacturing techniques.	
Total, Nuclear Energy Enabling Technologies	**+2,550**

Crosscutting Technology Development

Description

The Crosscutting Technology Development (CTD) subprogram competitively awards pioneering early-stage research and development (R&D) funding to United States (U.S). industry, universities, and national laboratory partners to develop innovative solutions to crosscutting nuclear energy technology challenges. The CTD subprogram focuses on foundational research that addresses technical gaps in order to support and enable new state-of-the-art transformative technologies needed to maintain the current fleet of nuclear reactors and support the development of advanced reactors (including small modular reactors and micro-reactors) and advanced fuels. CTD is closely coordinated with the Office of Nuclear Energy's (NE) other R&D programs to ensure that developed technologies and capabilities are part of an integrated investment strategy aimed at improving reliability and economics of U.S. nuclear technologies.

Characteristics of the activities within this subprogram include:

- Developing new capabilities needed by the domestic nuclear energy R&D enterprise, with focus on U.S. industry gaps;
- Conducting high-risk research that could overcome current technological limitations;
- Developing enabling technologies that have applicability across multiple technical areas; and,
- Conducting leading-edge, early-stage R&D to improve the economics, quality, security, and efficiencies of nuclear technologies.

The principal focus areas for FY 2021 include advanced sensors and instrumentation, nuclear cybersecurity research, and advanced methods for manufacturing. This includes:

- Advanced Sensors and Instrumentation supports R&D of unique sensor and instrumentation technologies needed to monitor and control new advanced reactors and fuel cycle facilities.
- Nuclear Cybersecurity supports innovative cybersecurity capability development to address cyber threats to the U.S nuclear power infrastructure, which will be coordinated with the Department's Cybersecurity, Energy Security, and Emergency Response office, and other relevant offices as appropriate.
- Advanced Methods for Manufacturing supports R&D to improve and demonstrate advanced methods by which nuclear equipment, components, and plants are manufactured, fabricated, and assembled.
- New research areas that will support the Critical Minerals and Advanced Energy Storage Initiatives.

Crosscutting Technology Development
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Crosscutting Technology Development $25,000,000	**$28,000,000**	**+$3,000,000**
• Conduct research on advanced sensors and instrumentation, competitively solicit new fully-funded research and development (R&D) awards in areas applicable to next generation reactor and fuel cycle technologies, and continue research initiated in prior years. • Continue leading edge manufacturing and fabrication R&D, including a focus on economics, quality, and efficiencies, for nuclear component prototypic conditions. • Conduct research on nuclear cybersecurity to address cyber threats to the U.S. nuclear power infrastructure. Areas of emphasis in FY 2020 include developing standards for reducing supply chain risks and integrating nuclear safety risk management with cybersecurity risk management to better inform whole plant risk. • Conduct early-stage research on integrated energy systems to support nuclear and renewables co-generation and nuclear/industrial applications.	• Conduct research on advanced sensors and instrumentation and competitively award new fully-funded R&D projects in areas applicable to next generation reactor and fuel cycle technologies. • Conduct research on nuclear cybersecurity to address cyber threats to the U.S. nuclear power infrastructure to continue the development of standards for reducing supply chain risks and integrating nuclear safety risk management with cybersecurity risk management. • Competitively award research on nuclear component manufacturing, fabrication, and plant construction of advanced reactor technologies. • Competitively award research on additional crosscutting research areas such as critical minerals (non-uranium) and advanced energy storage. • Continue advanced sensors and instrumentation and advanced methods for manufacturing research initiated in prior years.	• The increase reflects new crosscutting research that supports the Department's critical minerals and advanced energy storage crosscutting initiatives.

Nuclear Energy Advanced Modeling and Simulation

Description

The Nuclear Energy Advanced Modeling and Simulation (NEAMS) subprogram develops and deploys a set of predictive modeling and simulation tools to support and, in some cases, enable improved operation of the current fleet and development and deployment of advanced reactors. NEAMS engages scientists and engineers in developing state-of-the-art, multi-scale models of physics and chemistry that drive advanced computational methods for simulations of advanced nuclear energy systems. NEAMS empowers researchers and designers to gain fundamental insights that are unattainable through experiment alone and inform experiment selection and design to minimize cost of research and development. The set of analytic modeling and simulation tools, called the NEAMS ToolKit, focuses on advanced reactor technologies and accommodate different reactor types and designs. Advanced modeling and simulation capabilities also support the Office of Nuclear Energy (NE) program priorities, such as the development of fuels with enhanced accident tolerance.

The Energy Innovation Hub for Modeling and Simulation developed and deployed a reactor simulation tool set called the Virtual Environment for Reactor Applications (VERA), which focuses on light water reactor (LWR) technologies for an improved understanding of important operational and safety issues in existing commercial reactors. The VERA tools are used to model complex real world phenomena and conditions in the United States (U.S.) fleet of pressurized LWRs and have been used to analyze and understand key challenges to the safety and economics of reactor operations. The VERA tools are also used to analyze light-water based small modular reactor designs currently under development in the U.S. The Modeling and Simulation Hub fully met its objectives and will be brought to closure by June 30, 2020.

Through an enhanced NEAMS programmatic framework, NEAMS and VERA tools will support NE's three mission priority areas: Existing Fleet, Advanced Reactor Pipeline, and the Fuel Cycle Infrastructure. For the existing fleet, NEAMS and VERA tools will address core performance optimization issues and accelerate development of fuels with enhanced accident tolerance to help assure the long-term availability and market competitiveness of nuclear energy. For the advanced reactor pipeline, these tools will help industry accelerate advanced reactor development and meet otherwise cost-prohibitive data needs and will support Nuclear Regulatory Commission efforts to address its confirmatory analysis needs. For fuel cycle technologies, continued modeling and simulation tool development will provide capabilities that can support future used nuclear fuel research and development, including development of strategies to burn less fuel, and high-fidelity analysis and prediction of fuel and cladding performance through the storage cycle.

Nuclear Energy Advanced Modeling and Simulation
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Nuclear Energy Advanced Modeling and Simulation		
$35,000,000	**$30,000,000**	**-$5,000,000**
• Continue deployment and validation of the Nuclear Energy Advanced Modeling and Simulation (NEAMS) ToolKit. − Engage industry through the Gateway for Accelerated Innovation in Nuclear (GAIN) infrastructure and competitively award projects focused on industry needs in both the existing nuclear fleet and advanced reactor development. − Apply advanced coupled capabilities to advanced thermal-fluids solutions needed by industry through the Center for Advanced Thermal-Hydraulics Simulations at the Idaho National Laboratory. − Enable acceleration of Accident Tolerant Fuels (ATF) development and qualification and demonstrate capabilities to support analysis of the insertion of ATF lead test assemblies and transition cores. • Engage NEAMS/Virtual Environment for Reactor Applications (VERA) user communities to focus on those capability enhancements that have broad application to each reactor technology area, and offer greater potential impact in accelerating implementation of new concepts. • Collaborate with the Nuclear Regulatory Commission (NRC) to implement necessary confirmatory analysis capabilities for ATF and advanced reactor technologies.	• Enable and accelerate industry's advanced reactor deployment efforts through advanced multiscale and multiphysics modeling and simulation approaches. − Demonstrate fast reactor multiphysics modeling capability for core radial expansion as an important reactivity feedback mechanism taking structural and irradiation impacts into consideration. − Fully incorporate and update existing tristructural-isotropic (TRISO) fuel models into fuels modeling capability and perform validation against historical and Advanced Reactor Technologies Advanced Gas Reactor tests. − Simulate key molten salt properties and validate them with selected measured data. • Perform initial validation of advanced modeling tools consistent with NRC-specified priorities for specific validation experiments and reactor types. • Complete development and validate fuel performance and cladding models for ATF. Update verification and validation plan with completed Advanced Test Reactor and Transient Reactor Test Facility experiments. • Transition VERA Users Group to a self-sustaining model where the user community manages and funds development and maintenance of the VERA software. • Continue and update quality assurance assessments and documentation to meet stakeholder requirements, such as Nuclear Quality Assurance-1 research level.	• The decrease reflects further focus of efforts on highest priority modeling and simulation needs. In FY 2021, the program will not further develop capabilities for high-resolution gas reactor pebble tracking or advanced light-water reactor thermal-hydraulics.

Energy Innovation Hub for Modeling and Simulation

Description

The Energy Innovation Hub for Modeling and Simulation (M&S Hub) was initiated in FY 2010 to develop computational tools for the advanced simulation of Light Water Reactors (LWRs) and to demonstrate their application to industry-identified operational issues in the existing LWR fleet. Through the execution of several industry-defined challenge problems, the M&S Hub has provided the insights and tools needed by industry to address these key issues. Consequently, the M&S Hub has fully met its objectives and is being brought to closure by June 30, 2020. Hub-developed capabilities, such as the Virtual Environment for Reactor Analysis tool suite, are being integrated into the Nuclear Energy Advanced Modeling and Simulation (NEAMS) subprogram and deployed along with NEAMS tools to industry for commercial application to existing and advanced reactors.

Energy Innovation Hub for Modeling and Simulation
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Energy Innovation Hub for Modeling and Simulation $0	**$0**	**$0**
• No funding was provided in the FY 2020 Budget.	• No funding is requested in the FY 2021 Budget.	• No change.

Nuclear Science User Facilities

Description

The Nuclear Science User Facilities (NSUF) subprogram is the Nation's designated nuclear energy user facility. As a partner facility consortium, the NSUF connects a broad range of nuclear research capabilities, expert mentors and experimenters. The NSUF represents a "prototype laboratory for the future," promoting the use of unique nuclear research facilities located at multiple sites across the Nation and encouraging active university, industry, and laboratory collaboration in relevant nuclear science research. The NSUF, through competitive solicitations, provides a mechanism for research organizations to collaborate, conduct experiments and post-experiment analysis, and utilize high performance computing at facilities not normally accessible to these organizations. On an annual basis, researchers propose projects to be conducted at these unique facilities, with timelines ranging from a few months to several years. When projects are awarded, the NSUF subprogram pays for experiment support and laboratory services at the partner user facilities. In this manner, researchers benefit from the introduction to new techniques, equipment, and personnel.

The NSUF provides access at no cost to the user to the Idaho National Laboratory's Advanced Test Reactor, Transient Reactor Test Facility, post-irradiation examination (PIE) facilities at the Materials and Fuels Complex, and high performance computing capabilities, such as the Falcon supercomputing system at the Idaho National Laboratory, complementing the existing Advanced Scientific Computing Research User Facilities. Additional NSUF capability includes PIE assets at the Center for Advanced Energy Studies; research reactors at Oak Ridge National Laboratory, Massachusetts Institute of Technology, North Carolina State University, and the Ohio State University; beam-line capabilities at the Advanced Photon Source at Argonne National Laboratory in coordination with the Illinois Institute of Technology, the National Synchrotron Light Source II at the Brookhaven National Laboratory, and Los Alamos National Laboratory; ion irradiations at the Intermediate Voltage Electron Microscope at Argonne National Laboratory, Lawrence Livermore National Laboratory, and Texas A&M University; gamma irradiations at Sandia National Laboratories' Gamma Irradiation Facility; irradiation experiment design and fabrication capabilities at Pacific Northwest National Laboratory; hot cells and fabrication capabilities at Westinghouse; and examination facilities at the Universities of Wisconsin, Michigan, California-Berkeley, Purdue, Nevada-Las Vegas, and Florida – all partnered with the NSUF to bring additional nuclear science user facilities to the research community.

Nuclear Science User Facilities
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Nuclear Science User Facilities $30,000,000	**$28,000,000**	**-$2,000,000**
• Competitively solicit and award new fully-funded facility access awards. • Continue to enhance the Nuclear Science User Facilities (NSUF) unique nuclear scientific capabilities that are offered at the Idaho National Laboratory (INL) and the NSUF Partner Institutions. This collaborative user facility model will allow more efficient use of the NSUF subprogram funds by leveraging facility and capability investments. • Continue to enhance the Nuclear Fuels and Materials Library (NFML) and the Nuclear Energy Infrastructure Database (NEID). Expand the tools available to NSUF researchers by offering a Combined Materials Experiment Toolkit that offers on-line experiment design tools and subject matter expertise integrated with the NFML and NEID. • Accelerate NSUF's capability to select and evaluate nuclear materials through the Nuclear Materials Discovery and Qualification initiative. This initiative will deliver computationally informed insight and high-throughput physical infrastructure that facilitate efficient and innovative down-selection of new materials needed for advanced reactor technologies. • Provide nuclear energy computation system and support via INL's High Performance Computing capabilities. This includes operation of three supercomputers: Falcon, Lemhi, and Sawtooth; and includes software/hardware license/maintenance agreements, cybersecurity, and user support.	• Competitively solicit and award new fully-funded facility access awards. • Optimize the capabilities available through partnerships with universities, industry and national laboratories. The unique NSUF consortium offers unparalleled research opportunities in a highly cost-effective manner by leveraging capabilities and investments at partner institutions. • Enhance the research tools provided to the NSUF user community. These on-line tools include the NEID, the NFML, and Combined Materials Experiment Toolkit which, in concert, provide access to information on scientific equipment, previously irradiated materials, irradiation dose predictions and subject matter experts. • Invest in select domestic scientific infrastructure capabilities to support the advancement of applied research and development in support of the Office of Nuclear Energy mission.	• The decrease reflects a consolidation of the competitive facility access awards and facility capability enhancement investments by the NSUF program.

Transformational Challenge Reactor

Description

The Transformational Challenge Reactor (TCR) subprogram provides a revolutionary platform to help demonstrate the ability to reduce the deployment costs and timelines for nuclear energy systems.

The TCR subprogram enhances the development of breakthrough technologies that provide the ability to manufacture small/micro advanced reactor components using additive manufacturing techniques. A central goal of the TCR subprogram is to demonstrate the ability to exploit advanced manufacturing techniques and digital predictive analysis capabilities to deliver a new approach to nuclear design and qualification for advanced reactor technologies. TCR will combine advanced manufacturing with materials and computational sciences to predict optimal performance of components to enable faster innovation and certification. Successful execution of the TCR subprogram will result in an operational test of a micro-reactor fabricated using additive manufacturing techniques and the demonstration of a digital platform for coupling data analytics with nuclear core design, manufacturing and testing data to certify component performance.

TCR subprogram goals:

- Dramatically reduce the deployment costs and timelines of nuclear energy systems while maintaining safety and simplifying operations.
- Integrate digital platforms for manufacturing, design, and qualification to enable rapid nuclear innovation.
- Fully leverage capabilities and expertise across the national laboratory complex in support of TCR's objectives.
- As part of the Harsh Environment Materials Initiative, TCR will apply new advanced additive manufacturing and modeling methods to specific materials, parts, and systems required for new advanced reactor designs.

Transformational Challenge Reactor
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Transformational Challenge Reactor $23,450,000	**$30,000,000**	**+$6,550,000**
• Continue the Transformational Challenge Reactor subprogram initiated in FY 2019 under the Reactor Concepts Research, Development and Demonstration program to demonstrate the ability to develop and apply advanced additive manufacturing concepts and data analytics to advanced reactor applications. • Continue non-nuclear system research and development demonstration efforts. • Continue to develop the digital manufacturing platform for the surrogate core.	• Finalize design of the reactor system to host the nuclear-fueled core. • Begin validation of the digital platform through manufacturing of demonstration reactor components. • Complete preparation of preliminary safety documents in support of the Department of Energy safety authorization processes required for the operational test.	• The increase in funding will support the progression of activities associated with a fueled operational test.

Radiological Facilities Management

Overview

Within the Radiological Facilities Management (RFM) program, the Research Reactor Infrastructure (RRI) subprogram supports the continued operation of U.S. university research reactors by providing university research reactor fuel services, as well as maintenance of, and safety upgrades to, supporting fuel fabrication equipment and facilities.

Highlights of the FY 2021 Budget Request

In FY 2021, the RRI subprogram provides project management, technical support, quality engineering and inspection, and nuclear material support to 25 research reactors located at 24 U.S. universities. Major program deliverables include procuring new plate fuel elements and shipping them to select universities; transporting used fuels from U.S. universities to a DOE site; procuring High Assay Low Enriched Uranium (HALEU) feedstock and shipping it to the Training, Research, Isotopes, General Atomics (TRIGA) Fuel Fabrication Facility (TFFF) in Romans, France. Major equipment and safety process upgrades to the TFFF, required by French safety authority, will be completed in FY 2020 and commercial production will start in FY 2021. In order to meet the increased fresh fuel requests from the 12 TRIGA research reactors located at U. S. universities, and to take advantage of the significant fuel cost discount provided to the Department of Energy (DOE), the RRI program applies an additional $2.5 million in FY 2021 to TRIGA fresh fuel orders. The RRI subprogram also ships used plate and TRIGA reactor fuel elements from supported universities to DOE used fuel receipt facilities. DOE will continue its policy, initiated in FY 2017, of reusing lightly-irradiated TRIGA fuel in the DOE inventory and evaluate additional alternative sources.

Radiological Facilities Management
Funding ($K) (Non-Comparable)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Radiological Facilities Management				
Oak Ridge Nuclear Infrastructure	20,000	0	0	0
Research Reactor Infrastructure	9,000	0	11,500	+11,500
Total, Radiological Facilities Management	**29,000**	**0**	**11,500**	**+11,500**

Radiological Facilities Management
Funding ($K) (Comparable)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Radiological Facilities Management				
Oak Ridge Nuclear Infrastructure	20,000	20,000	0	-20,000
Research Reactor Infrastructure	9,000	9,000	11,500	+2,500
Total, Radiological Facilities Management	**29,000**	**29,000**	**11,500**	**-17,500**

Radiological Facilities Management
Proposed Budget Structure Changes

	FY 2021 Budget Structure for Radiological Facilities Management		
	Oak Ridge Nuclear Infrastructure	**Research Reactor Infrastructure**	**Total**
FY 2020 Budget Structure			
Infrastructure			
ORNL Nuclear Facilities O&M	0	0	0
Research Reactor Infrastructure	0	11,500	11,500
Total, Infrastructure	**0**	**11,500**	**11,500**

Radiological Facilities Management
Explanation of Major Changes (Comparable) ($K)

	FY 2021 Request vs FY 2020 Enacted
Oak Ridge Nuclear Infrastructure:	
The decrease from $20,000,000 to $0 represents completion of one-time congressionally directed nuclear infrastructure activities. Infrastructure used for Office of Nuclear Energy research and development is fully funded through associated FY 2021 program budgets.	**-20,000**
Research Reactor Infrastructure:	
The increase from $9,000,000 to $11,500,000 reflects full production capacity of Training, Research, Isotopes, General Atomics (TRIGA) fuel elements in order to meet the increased new TRIGA fuel requests.	**+2,500**
Total, Radiological Facilities Management	**-17,500**

Oak Ridge Nuclear Infrastructure

Description

Consistent with congressional direction, this program provided funds in FY 2019 and FY 2020 to support Oak Ridge National Laboratory (ORNL) hot cells. FY 2020 funds were provided within the Infrastructure program. In FY 2021, Office of Nuclear Energy use of these ORNL facilities is fully funded through associated program budgets.

Oak Ridge Nuclear Infrastructure

Activities and Explanation of Changes (Comparable)

FY 2020 Enacted[1]	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Oak Ridge Nuclear Infrastructure $20,000,000	**$0**	**-$20,000,000**
• Maintain/replace critical hot cell equipment and infrastructure to assure the Oak Ridge National Laboratory (ORNL) facilities continue to meet safety standards. • Manage hot cell infrastructure to applicable regulations, DOE Orders and Directives, including documented safety analyses, nuclear criticality safety analyses, nuclear material inventory management, radiological protection and industrial safety, waste disposal, staff training, and integrated safety management. • Perform preventative and corrective maintenance and repair of infrastructure, equipment, and components.	• No funding is requested.	• No funding is requested in FY 2021.

[1] Funding for these activities were enacted within a revised Infrastructure Program budget structure in FY 2020. The FY 2020 activities and funding are shown here in a comparable format.

Research Reactor Infrastructure

Description

The Research Reactor Infrastructure (RRI) subprogram provides fresh reactor fuel to, and removes used fuel from, 25 operating university research reactors to support their continued operation. This provides continued research and training reactor capability to U.S. universities to ensure their continued ability to support U.S. nuclear energy initiatives in the areas of research, development, and educational opportunities.

The continued operation of U.S. university research reactors directly supports the successful execution of the nuclear energy research mission and also plays an important role in developing future scientists and engineers in the U.S. This subprogram sustains unique capabilities for research and development and educational opportunities supporting U.S. energy initiatives. Used nuclear fuel shipments support U.S. and Department of Energy non-proliferation and national security objectives.

In FY 2021, the RRI subprogram provides project management, technical support, quality engineering and inspection, and nuclear material support to 25 research reactors located at 24 U.S. universities. Major program deliverables include procuring new plate fuel elements and shipping them to select universities; transporting used fuels from U.S. universities to a DOE site; procuring High Assay Low Enriched Uranium (HALEU) and shipping it to the Training, Research, Isotopes, General Atomics (TRIGA) Fuel Fabrication Facility (TFFF) in Romans, France, for fabrication of TRIGA fuel; and procuring new TRIGA fuel elements from the TFFF. Major equipment and safety process upgrades to the TFFF, required by French safety authority, will be completed in FY 2020 and commercial production will start in FY 2021. In order to meet the increased fresh fuel requests from the 12 TRIGA research reactors located at U.S. universities, and to take advantage of the significant fuel cost discount provided to the Department, the RRI program applies an additional $2.5 million in FY 2021 to TRIGA fresh fuel orders. The RRI subprogram also ships used plate and TRIGA reactor fuel elements from supported universities to DOE used fuel receipt facilities. The Department will continue its policy, initiated in FY 2017, of reusing lightly-irradiated TRIGA fuel in the DOE inventory and evaluate additional alternative sources.

Activities and Explanation of Changes (Comparable)

FY 2020 Enacted[1]	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Research Reactor Infrastructure $9,000,000	**$11,500,000**	**+$2,500,000**
• Procure 40 and deliver between 33 and 36 plate fuel elements required annually by University of Missouri (MURR) and Massachusetts Institute of Technology (MIT) as determined by need and fuel availability. • Ship up to two cask loads of lightly-irradiated 8.5 wt% standard Training, Reactor, Isotope, General Atomics (TRIGA) fuel elements from the Irradiated Fuel Storage Facility at Idaho National Laboratory (INL) to select U.S. university research reactor facilities. • Procure additional TRIGA fuel elements from the TRIGA International fuel fabrication facility (TFFF) in Romans, France upon resumption of operations. • Complete up to 5 used fuel shipments to Savannah River Site (SRS) and the INL, pending resolution of moratorium on such shipments to the INL. • Continue Research Reactor Infrastructure (RRI) project management, quality assurance, nuclear material accountability, and transportation cask maintenance.	• Procure 40 and deliver between 33 and 36 plate fuel elements required annually by MURR and MIT as determined by need and fuel availability. • Ship up to two cask loads of lightly-irradiated 8.5 wt% standard TRIGA fuel elements from the Irradiated Fuel Storage Facility at INL to select U.S. university research reactor facilities. • Procure additional TRIGA fuel elements from the TRIGA International fuel fabrication facility in Romans, France upon resumption of operations and ship fuel elements to TRIGA reactor facilities as determined by need and fuel availability. • Procure and ship high assay low enriched uranium (HALEU) metal to the TFFF in Romans, France. This will support production of about 100 TRIGA fuel elements (full annual production). • Complete up to 5 used fuel shipments to SRS and the INL, pending resolution of moratorium on such shipments to the INL. • Continue RRI project management, quality assurance, nuclear material accountability, and transportation cask maintenance.	• Increase in funding supports additional new TRIGA fuel elements in response to requests from U.S. universities, and also in response to the recently-announced “limited production” strategy from TRIGA International in France. • The cost of individual TRIGA fuel is reduced, as much as 75%, if the production is running at a full capacity (~100 fuel elements). The increased number of TRIGA fuel purchases will allow the operation of the facility at the full capacity.

[1] Funding for these activities were enacted within a revised Infrastructure Program budget structure in FY 2020. The FY 2020 activities and funding are shown here in a comparable format.

Advanced Reactor Demonstration Program

Overview

The Advanced Reactor Demonstration Program focuses Departmental and non-federal resources on the construction of demonstration reactors in the near- and mid-term that are safe and affordable to build and operate.

In the FY 2020 Further Consolidated Appropriations Act, Congress established the Advanced Reactor Demonstration Program to demonstrate multiple advanced reactor designs. To support this goal, the program has five major elements:

- National Reactor Innovation Center (NRIC) – Supports testing, demonstration, and performance assessment to accelerate deployment of advanced reactors through development of advanced nuclear energy technologies by utilizing the DOE unique laboratory facilities and capabilities;
- Advanced Reactor Demonstrations – Cost-shared partnerships with industry (up to 50% government, not less than 50% industry) to build two advanced demonstration reactors with significant improvements compared to the current generation of operational reactors;
- Risk Reduction for Future Demonstrations – Cost-shared research and development activities with industry (up to 80% government, not less than 20% industry) to address technical risks in advanced reactor designs to support potential future advanced reactor demonstrations;
- Regulatory Development – Coordinate activities with the Nuclear Regulatory Commission (NRC) to identify and resolve technical challenges with licensing advanced reactors; and,
- Advanced Reactor Safeguards – Evaluate safeguards issues that are unique to advanced reactors.

FY 2020 activities will focus on defining the program to ensure it is well structured and will maximize efficient and effective use of taxpayer dollars. The program will conduct the solicitation, selection, negotiation and award of cost-shared agreements for two advanced reactor demonstrations, and cost-shared agreements under the Risk Reduction for Future Demonstrations subprogram. Given the size and complexity of these procurement actions, NE will aim to complete awards by the end of FY 2020 and the bulk of the funded activities will be executed during FY 2021. The FY 2021 Budget requests $20 million for this program to focus on continuing activities under the NRIC, Regulatory Development, and Advanced Reactor Safeguards subprogram areas.

Solicitation for Advanced Reactor Demonstrations and Risk Reduction for Future Demonstrations

During FY 2020, the Department plans to execute a competitive solicitation for demonstration proposals for advanced reactors. For the purposes of the program, an advanced reactor is defined as any light water or non-light water fission reactor with significant improvements compared to the current generation of operational reactors. These significant improvements may include but are not limited to characteristics such as inherent safety features, lower waste yields, greater fuel utilization, superior reliability, resistance to proliferation, increased thermal efficiency, and the ability to integrate reactor outputs into electric and nonelectric applications.

The evaluation of the proposals will be supported by an expert panel of reviewers established consistent with Congressional direction.

Highlights of the FY 2021 Budget Request

Additional funding is requested to continue ongoing activities under the NRIC, Regulatory Development, and Advanced Reactor Safeguards subprogram areas.

Advanced Reactor Demonstration Program
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Advanced Reactor Demonstration Program				
National Reactor Innovation Center	0	20,000	10,000	-10,000
Demonstration 1	0	80,000	0	-80,000
Demonstration 2	0	80,000	0	-80,000
Risk Reduction for Future Demonstrations	0	30,000	0	-30,000
Regulatory Development	0	15,000	7,500	-7,500
Advanced Reactor Safeguards	0	5,000	2,500	-2,500
Total, Nuclear Energy Enabling Technologies	**0**	**230,000**	**20,000**	**-210,000**

SBIR/STTR:

- FY 2019 Transferred: SBIR $0; STTR $0
- FY 2020 Projected: SBIR $1,600; STTR $225
- FY 2021 Request: SBIR $320; STTR $45

Advanced Reactor Demonstration Program
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
National Reactor Innovation Center:	
The decrease from $20,000,000 to $10,000,000 supports the continuation of National Reactor Innovation Center planning and implementation activities initiated in FY 2020.	**-20,000**
Demonstration 1:	
The decrease from $80,000.000 to $0 reflects the expectation that NE aims to complete solicitation activities for the first advanced reactor demonstration by the end of FY 2020 and the approved scope will be executed during FY 2021.	**-80,000**
Demonstration 2:	
The decrease from $80,000.000 to $0 reflects the expectation that NE aims to complete solicitation activities for the second advanced reactor demonstration by the end of FY 2020 and the approved scope will be executed during FY 2021.	**-80,000**
Risk Reduction for Future Demonstration:	
The decrease from $30,000,000 to $0 reflects the expectation that the scope of the cost shared research and development awards will be executed through the end of FY 2021.	**-30,000**
Regulatory Development:	
The decrease from $15,000,000 to $7,500,000 provides funding to execute planned FY 2021 activities for continuation of Regulatory Development planning and implementation activities initiated in FY 2020.	**-7,500**
Advanced Reactor Safeguards:	
The decrease from $5,000,000 to $2,500,000 provides funding to execute planned FY 2021 activities for continuation of Advanced Reactor Safeguards planning and implementation activities initiated in FY 2020.	**-2,500**
Total, Advanced Reactor Demonstration Program	**-210,000**

National Reactor Innovation Center

Description

The National Reactor Innovation Center (NRIC) mission is to focus resources of the national laboratories to enable the testing and demonstration of advanced reactors. As such NRIC provides private sector technology developers access to the strategic infrastructures and assets of the national laboratories to enable physical validation of advanced nuclear reactor concepts, resolve technical uncertainties and increase practical knowledge relevant to safety, resilience, security, and functionality of advanced nuclear reactor concepts. NRIC will provide access to national laboratory physical infrastructure and facilities, scientific testing capabilities, and the laboratory science, engineering and technical staff.

The NRIC subprogram activities may include early interactions with reactor developers considering options for demonstrating a specific reactor technology, investigation of the national laboratory capabilities relevant to the potential for hosting demonstrations. While NRIC will be based at the Idaho National Laboratory (INL) with significant activities at the INL Site, resources at other national laboratories and potential nuclear reactor sites will play an important role in achieving NRIC's objectives.

NRIC is expected to accelerate technology readiness from proof of concept through proof of operations. Key capabilities that NRIC will provide includes:

- Well-characterized locations to site reactors for demonstrations to prove performance and to provide a pathway to commercialization;
- Access to key resources, such as materials needed for nuclear reactor fuel, facilities for fabrication of fuels for demonstrations, test reactors such as the Advanced Test Reactor and Transient Reactor Test Facility at the INL and High Flux Isotope Reactor at the Oak Ridge National Laboratory, characterization capabilities such as INL's Irradiated Materials Characterization Laboratory, and access to advanced modeling and simulation codes and high performance computers through the INL Collaborative Computing Center; and,
- Collaboration with national laboratory experts in nuclear science and engineering to support technology development.

National Reactor Innovation Center
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
National Reactor Innovation Center $20,000,000	**$10,000,000**	**-$10,000,000**
• Initiate program planning to establish the National Reactor Innovation Center (NRIC) as a resource to support cost-shared or privately funded advanced nuclear technology demonstrations. • Establish necessary processes/approaches to enable efficient demonstration of reactors. • Initiate evaluation of program activities, staffing mechanisms, organizational structures, and related requirements. • Evaluate opportunities to incorporate approaches to nonproliferation, safeguards, and security in the context of advanced reactor demonstrations.	• Execute FY 2021 activities identified during NRIC planning and subprogram execution initiated during FY 2020.	• The decrease from $20,000,000 to $10,000,000 provides funding to execute planned FY 2021 activities in continuation of NRIC planning and implementation activities initiated in FY 2020.

Demonstration 1 and Demonstration 2

Description

These subprograms will conduct the solicitation, selection, negotiation and award of cost-shared agreements for two advanced reactor demonstrations. The demonstrations will be solicited, awarded, and established as multi-year projects, identifying and incorporating appropriate project management information, including milestones, schedules and cost profiles.

Demonstration 1 and Demonstration 2
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Demonstration 1 $80,000,000	**$0**	**-$80,000,000**
Demonstration 2 $80,000,000	**$0**	**-$80,000,000**
• Issue request for information to obtain technical and programmatic input from industry to help inform the subsequent solicitation. • Define program parameters. • Establish evaluation board. • Conduct solicitation process.	• No funding is requested.	• No funding in the FY 2021 Budget Request.

Risk Reduction for Future Demonstrations

Description

The Risk Reduction for Future Demonstrations subprogram supports the potential future demonstration of additional advanced reactor technologies through cost-shared (up to 80% government, not less than 20% industry) competitively awarded (through solicitations) research and development (R&D) activities that will be designed to maximize the utility of the results across industry. The R&D will be aimed at reducing risk associated with technical uncertainty for a broad class of advanced reactor designs. These activities may include R&D to address technical issues associated with development of technologies and methods to improve the timelines for advanced reactor deployments, the cost and schedule for delivery of nuclear products, services, and capabilities supporting these nuclear technologies, design and engineering processes, and resolution of certification issues potentially impeding the introduction of these technologies into the marketplace. This subprogram will coordinate closely with the Reactor Concepts Research, Development & Demonstration program and other relevant programs to avoid duplication, leverage existing expertise, and maximize synergies.

Risk Reduction for Future Demonstrations
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Risk Reduction for Future Demonstrations		
$30,000,000	**$0**	**-$30,000,000**
• The Department will select multiple projects that provide specific risk reduction value to future demonstrations. • Awards may address risks in areas such as: - Advanced nuclear reactor designs, including small modular reactors of various technology types - Engineering, analyses and research and development that would address technical issues associated with reactor design and demonstration issues; Sensors, instrumentation and control systems; - Plant auxiliary and support systems; - Operational inspection and monitoring capabilities; - Modeling and simulation of various elements of plant life cycle; - Other components, systems, processes, or capabilities that could result in performance and economic improvements in advanced nuclear reactor designs	• No funding is requested.	• No funding in the FY 2021 Budget Request.

Regulatory Development

Description

The Regulatory Development subprogram will coordinate with the NRC to identify how the technical expertise and capabilities of the Department can be applied to help address technical challenges associated with licensing of advanced reactors. Examples of technical challenges that could be addressed under this subprogram includes finalizing the establishment of risk-informed and performance based license application guidance, development of guidance for industry and NRC endorsement of novel manufacturing methods for use in non-LWR designs, resolving the technical basis to support NRC endorsement of codes and standards important for the manufacture of advanced reactor components, and expanding access to priority material property data to be used safety codes and models in support of licensing.

Regulatory Development
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Regulatory Development $15,000,000	**$7,500,000**	**-$7,500,000**
• In coordination with industry and the Nuclear Regulatory Commission, identify technology gaps and high impact challenges regarding advanced reactor regulation, including unresolved licensing modernization efforts. • Initiate priority technical and regulatory risk reduction projects.	• Execute FY 2021 limited early-stage research and development aimed at producing broadly applicable results that can be used by an array of private sector companies to inform their regulatory requirements.	• The decrease from $15,000,000 to $7,500,000 provides funding for the continuation of activities initiated in FY 2020.

Advanced Reactor Safeguards

Description

The Advanced Reactor Safeguards subprogram will evaluate safeguards issues that are unique to advanced reactor designs. Project activities under the Advanced Reactor Safeguards subprogram element will address safeguards and securities vulnerabilities to inform and improve advanced reactor designs, addressing issues such as diversion of advanced fuel forms, protection of remotely operated plants, and other proliferation and security concerns. This subprogram will seek input from the Nuclear Regulatory Commission, National Nuclear Security Administration (NNSA), and Industry, to identify and address safeguards and security gaps and to avoid duplication, leverage existing expertise, and maximize synergies.

Advanced Reactor Safeguards
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Change FY 2021 Request vs FY 2020 Enacted
Advanced Reactor Safeguards $5,000,000	**$2,500,000**	**-$2,500,000**
• The Department will evaluate safeguards issues that are unique to advanced reactors and will select multiple research and development projects that will lead to advanced safeguards and security improvements relevant to advanced reactor demonstrations.	• Execute FY 2021 activities identified during Advanced Reactor Safeguards development planning and subprogram execution initiated during FY 2020.	• The decrease from $5,000,000 to $2,500,000 provides funding to execute planned FY 2021 activities in continuation of Advanced Reactor Safeguards planning and implementation activities initiated in FY 2020.

Versatile Test Reactor Project

Overview

For the United States (U.S.) to regain a global leadership role in the development of the next generation of advanced reactors, a fast spectrum test reactor will be a pivotal experimental tool. Sustaining the existing fleet and the development of advanced reactors are key in providing a diverse portfolio of energy supply sources to ensure national security through energy independence and energy dominance. Advancements in the area of testing of advanced fuels, materials and instruments and sensors in extreme environments, can further facilitate their development. Due to the very high neutron flux provided by such a fast test reactor, the irradiation time for testing of new materials can be reduced by an order of magnitude compared to that for a standard thermal test reactor such as the Advanced Test Reactor at Idaho National Laboratory.

The Versatile Test Reactor (VTR) is one of the Department's highest priorities, and the VTR program serves as a cornerstone to the Administration's focus on reviving and expanding the nuclear sector in the U.S. The VTR was established as an Administration priority through a robust National Security Council-led Policy Coordination Committee process. Specifically, the VTR will support the modernization of the U.S. infrastructure for early stage research and development (R&D). It also aligns with the prioritization of test beds in the Department of Energy's FY 2021 Budget Request, to better enable private sector demonstration and deployment of energy technologies. Advancements in nuclear energy, particularly in the area of testing of advanced fuels, materials and instruments and sensors in extreme environments, is necessary for the advanced reactor community in the U.S. to achieve its goals. The VTR would help allow the U.S. to regain and strengthen its global technical leadership role in the field of nuclear energy, and could contribute to the creation of high-paying jobs and economic prosperity, and train the next generation of scientists and engineers needed for the future viability of our nuclear sector.

Given the magnitude of this important infrastructure project, the Department will execute this project in accordance with the rigorous methodology established by Department of Energy Order (DOE O) 413.3B, Program and Project Management for the Acquisition of Capital Assets. In parallel, the Department has begun preparation of an Environmental Impact Statement in accordance with National Environmental Policy Act requirements to ensure that all environmental factors are considered before the Department makes a final decision to move forward with the project.

In February 2019, the VTR Project was formally initiated with Critical Decision (CD) 0, Approve Mission Need, by the Deputy Secretary of Energy in accordance with DOE O 413.3B requirements. This decision formally evaluated the mission responsibilities and infrastructure capabilities and determined that the Department does not possess the capabilities to perform the needed accelerated testing and qualification of advanced nuclear fuels, materials, instrumentation, and sensors. As a part of this determination, a cost estimate was provided that ranged between $3.0 billion and $6.0 billion with an estimated completion date between 2026 and 2030.

Following establishment of the VTR Project, subsequent FY 2019 and FY 2020 activities focused on completing pre-requisites for the next DOE O 413.3B critical decision milestone, including completing the analyses of alternatives, completing a conceptual design and developing refined cost and schedule estimates. CD-1, Approve Alternative Selection and Cost Range, is expected to be accomplished as early as the 3rd quarter of FY 2020. Other FY 2020 activities include the development of safety design basis documentation, formulation of an acquisition strategy, and development of cost estimates for fuel source, fuel fabrication, and examination of critical component supply chain capabilities.

Highlights of the FY 2021 Budget Request

Reflecting the transition from an R&D effort to an infrastructure investment program, future Versatile Test Reactor (VTR) activities previously funded under the Versatile Advanced Test Reactor subprogram in the Reactor Concepts Research, Development & Demonstration program will now be funded under this newly established VTR Project budget.

In FY 2021, activities will focus on the completion of the preliminary design and initiation of the final design for all mechanical, electrical, instrumentation and controls, and civil and structural disciplines. Other FY 2021 activities will include: prototype development activities on the in-vessel transfer machine (for moving fuel and experiments);

commencement of long-lead procurement of critical components contingent upon satisfactory completion of National Environmental Policy Act requirements; design and prototype development of fuel fabrication processes; continued development of the safety basis documentation; and project management activities.

Versatile Test Reactor Project
Funding ($K)

	FY 2019[1] Enacted	FY 2020[1] Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Versatile Test Reactor Project				
Versatile Test Reactor - Other Project Costs	0	0	33,000	+33,000
Versatile Test Reactor - Design and Construction	0	0	262,000	+262,000
Total, Versatile Test Reactor Project	**0**	**0**	**295,000**	**+295,000**

[1] FY 2019 and FY 2020 VTR activities were previously funded in the Reactor Concepts Research, Development & Demonstration program

Versatile Test Reactor Project
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Versatile Test Reactor – Other Project Costs:	
The increase from $0 to $33,000,000 supports completion of the National Environmental Policy Act Environmental Impact Statement and issuance of a Record of Decision; commencement of design and prototype development of the Versatile Test Reactor fuel fabrication processes; and continued development of safety basis documentation.	**+33,000**
Versatile Test Reactor - Design and Construction	
The increase from $0 to $262,000,000 supports completion of the preliminary design; initiation of final design for all engineering disciplines, initiation prototype activities on the in-vessel transfer machine and initiation of long-lead procurement of critical components.	**+262,000**
Total, Versatile Test Reactor Project	**+295,000**

Versatile Test Reactor – Other Project Costs

Description

In February 2019, the Versatile Test Reactor (VTR) Project was formally initiated with Critical Decision 0, Approve Mission Need, by the Deputy Secretary of Energy in accordance with Department of Energy Order 413.3B requirements. This decision formally evaluated the mission responsibilities and infrastructure capabilities and determined that the Department does not possess the capabilities to perform the needed accelerated testing and qualification of advanced nuclear fuels, materials, instrumentation, and sensors.

This budget line, Versatile Test Reactor – Other Project Costs (VTROPC), will be used to fund VTR costs that are not included in the Versatile Test Reactor - Design and Construction (VTRDC), such as supporting research and development, pre-authorization costs prior to start of preliminary design, plant support costs during design, construction, activation, and startup. VTROPC will also include funding of those activities necessary to comply with National Environmental Policy Act requirements. Specific activities to be accomplished in FY 2021 are in the Activities and Explanation of Changes section.

Versatile Test Reactor – Operating

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Versatile Test Reactor – Operating - $0	**$33,000,000**	**+$33,000,000**
• Funding previously associated with the Versatile Test Reactor (VTR) was requested in the Versatile Advanced Test Reactor subprogram under the Reactor Concepts Research, Development and Demonstration Program.	• Manage VTR Project in accordance with Department of Energy Order 413.3B. • Complete National Environmental Policy Act required Environmental Impact Statement and issue Record of Decision. • Complete Critical Decision 3A documentation to support commencement of long lead procurement items. • Commence design and prototype development of VTR nuclear fuel fabrication processes. • Continue development of the safety basis documentation, including Preliminary Safety Design Report, Transient Analysis, and Probabilistic Risk Assessment. • Initiate development of Operations, Maintenance and Safety Organizations, Processes and Procedures.	• The increase reflects the transition from a research and development effort to an infrastructure investment program.

Versatile Test Reactor – Design and Construction

Description

In February 2019, the Versatile Test Reactor (VTR) Project was formally initiated with Critical Decision 0, Approve Mission Need, by the Deputy Secretary of Energy in accordance with Department of Energy Order 413.3B requirements. This decision formally evaluated the mission responsibilities and infrastructure capabilities and determined that the Department does not possess the capabilities to perform the needed accelerated testing and qualification of advanced nuclear fuels, materials, instrumentation, and sensors.

This budget line, Versatile Test Reactor – Design and Construction (VTRDC), will be used to fund VTR costs that are not included in the Versatile Test Reactor – Other Project Costs, such as all engineering design costs (after conceptual design), facility construction costs, and other costs specifically related to those construction and the procurement of VTR components and hardware. As a part of the project's overall risk reduction efforts, digital requirements management and digital design control techniques are being utilized to maximize design process efficiency and to help achieve the goal of finalizing the design prior to the start of construction. VTR will also include funding of project and construction management during preliminary and final design and construction, and funds to provide for contingency and economic escalation. Specific activities to be accomplished in FY 2021 are in the Activities and Explanation of Changes section.

Versatile Test Reactor – Design and Construction

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Versatile Test Reactor – Design and Construction -	**$262,000,000**	**+$262,000,000**
• Funding previously associated with the Versatile Test Reactor (VTR) was requested in the Versatile Advanced Test Reactor subprogram under the Reactor Concepts Research, Development and Demonstration Program.	• Manage VTR Project in accordance with Department of Energy Order 413.3B. • Complete preliminary design. • Initiate final design for all mechanical, electrical, instrumentation and controls, and civil and structural disciplines. • Initiate prototype fabrication of the in-vessel transfer machine needed for moving fuel and experiments within the reactor. • Upon satisfactory completion of National Environmental Policy Act requirements, commence long-lead procurement of critical components, including electromagnetic pumps, reactor and guard vessel, reactor head and control rod drives.	• The increase reflects the transition from a research and development effort to an infrastructure investment program.

21-E-200, Versatile Test Reactor
TBD
Project is for Design and Construction

1. Summary, Significant Changes, and Schedule and Cost History

Summary

In accordance with DOE Order 413.3B (DOE O 413.3B), the Deputy Secretary approved Critical Decision (CD) 0 on February 22, 2019. Approval of CD-0 formally approved the start of the Versatile Test Reactor (VTR) project by confirming the Department's Mission Need for the VTR. Following CD-0 approval, the Office of Nuclear Energy (NE) will develop the pre-requisite documentation for the next critical decisions, including conducting an Analysis of Alternatives, as well as completing a conceptual design and maturing the cost and schedule ranges. Funds requested in FY 2020 are for the development of prerequisite documentation for CD-1, Approve Alternative Selection and Cost Range, and capital funds to provide initial funding required to start design related activities. Approval of CD-1 is anticipated in May 2020.

In parallel, the Department has begun preparation of an Environmental Impact Statement in accordance with National Environmental Policy Act (NEPA) requirements to ensure that all environmental factors are considered before the Department makes a final decision to move forward with the project.

Funds requested in FY 2021 are for the development of the preliminary design, component prototyping and long lead procurement items ($262 million) and operating funds ($33 million) to complete NEPA requirements; design and prototype development of fuel fabrication processes; continued development of the safety basis documentation; and, project management activities. CD-3A, Approve Long Lead Procurements, is anticipated in the 4th quarter of FY 2021 subsequent to a NEPA Record of Decision. CD-2/3 approval is anticipated in the 2nd quarter of 2023.

The fast neutron testing capability provided through the VTR project will help the United States (U.S.) meet its goal for advanced nuclear reactor technology development. The VTR project will provide leading edge capability for accelerated testing of advanced nuclear fuels, materials, instrumentation, and sensors. It will allow DOE to modernize its essential nuclear energy infrastructure, and conduct crucial advanced technology and materials testing within the U.S. in a safe, efficient and timely way. The proposed VTR project could provide accelerated neutron damage rates 20 times greater than current water-cooled test reactors. These higher damage rates are needed within the U.S. to accelerate the testing of nuclear fuels and materials needed by scientist and developers of transformational reactor technologies.

All scope, schedule, and cost information in this data sheet are pre-decisional. The data sheet details were prepared based on a point estimate of $3.8B for the project and a contingency of $700M in FY 2018 Dollars.

CD-0 was approved with an estimated cost range of $3.0B to $6.0B and an estimated schedule completion range of 2026 to 2030.

Significant Changes

This Project Data Sheet for the VTR represents a new start in FY 2020.

- CD-0, Approve Mission Need, was approved by the Deputy Secretary on February 22, 2019.
- The project has initiated development of all documents necessary for CD-1 approval as defined by DOE O 413.3B.
- A Federal Project Director (FPD) was appointed in the 3Q of FY 2019.
- The project will complete the conceptual design for CD-1 in 3Q FY 2020.
- A Record of Decision is anticipated in 4Q FY2021 concluding the NEPA activities.

Critical Milestone History

Fiscal Quarter or Date

Fiscal Year	CD-0	Conceptual Design Complete	CD-1	CD-2	Final Design Complete	CD-3	D&D Complete	CD-4
FY 2021	2Q FY2019	TBD	TBD	TBD	TBD	TBD	N/A	TBD

CD-0 – Approve Mission Need for a construction project with a conceptual scope and cost range
Conceptual Design Complete – Actual date the conceptual design was completed (if applicable)
CD-1 – Approve Alternative Selection and Cost Range
CD-2 – Approve Performance Baseline
Final Design Complete – Estimated/Actual date the project design will be/was complete (d)
CD-3 – Approve Start of Construction
D&D Complete – Completion of D&D work
CD-4 – Approve Start of Operations or Project Completion

Fiscal Quarter or Date

Fiscal Year	Performance Baseline Validation	CD-3A	CD-3B
FY 2021	2Q FY2023	4Q FY2021	N/A

CD-3A – Approve Long-Lead Procurements, Original Scope
CD-3B – Approve Long-Lead Procurements, Revised Scope

Project Cost History

Fiscal Quarter or Date

Fiscal Year	TEC, Design	TEC, Construction	TEC, Total	OPC, Except D&D	OPC, D&D	OPC, Total	TPC
FY2021	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Conceptual Design Complete – Projected 3QFY2020

2. Project Scope and Justification

Scope

The capability gap identified in the Mission Need Statement for the project can be addressed with a new fast neutron spectrum test facility based on sodium-cooled fast reactor (SFR) technology. With this approach, the new facility could be designed and built using mature SFR technology informed by more than a hundred cumulative years of SFR operating experience and associated lessons learned. This proposed approach is representative of the alternatives that could provide a test facility with versatile operational capabilities and maximum mission flexibility.

A number of important considerations will be addressed by this project:

- Availability and accessibility of pre-and post-irradiation preparation and examination facilities is required and those facilities already exist within the national laboratory system. The availability of existing fuel fabrication, experiment manufacturing, fuels and materials characterization, and post-irradiation examination capabilities provides for optimized benefit of the new capability.
- The facility will be authorized and regulated by DOE consistent with other test reactors in the DOE Complex.
- Teaming with industry to identify and develop mitigations for supply chain challenges is essential to minimize the well-recognized issues associated with new nuclear facility builds and support re-energization and revitalization of the U.S. nuclear industry.

Funds appropriated under this data sheet may be used to provide independent assessments related to project planning and execution.

Justification

The project is being conducted in accordance with the project management requirements in DOE O 413.3B, Program and Project Management for the Acquisition of Capital Assets.

The U.S. has been an international leader in the development and testing of advanced nuclear reactor technologies since the advent of nuclear power generation. The Department of Energy (DOE) and its predecessor organizations appropriately provided nuclear fuels and materials development capabilities and large-scale testing facilities in support of all currently deployed nuclear reactor technologies. However, the U.S. has not maintained a domestic fast neutron spectrum testing capability for over two decades. This gap in testing capability is severely crippling the U.S. ability to move forward in the development of next-generation nuclear reactors – many of which require a fast neutron spectrum for operation – and equally impacts the U.S. ability to regain technology leadership in this arena.

Common to advanced nuclear reactor technology development is the need for accelerated testing and qualification of advanced nuclear fuels, materials instrumentation and sensors.

This testing capability is essential for the U.S. to modernize its nuclear energy research and development (R&D) infrastructure for developing transformational nuclear energy technologies. The light water reactor (LWR) and advanced reactor communities, which are supported by several DOE program areas (e.g., small modular reactor technology development and licensing, LWR sustainability, advanced nuclear technology development) are key to providing a flexible portfolio of energy supply sources.

Failure to develop this capability on an accelerated schedule may lead to further degradation of the U.S. ability to develop advanced nuclear energy technologies. If this capability is not available to U.S. innovators as soon as possible, the ongoing shift of nuclear technology primacy to other international states (e.g., China, the Russian Federation, India) may accelerate, and the opportunity may be missed to re-energize the U.S. nuclear industrial sector. Furthermore, independent of domestic deployment strategies, relinquishing U.S. leadership in advanced reactor technologies may have national security consequences as U.S. influence in global nuclear safety and security policies and their implementation may be severely diminished.

The Office of Nuclear Energy's (NE) mission is to advance nuclear power to meet the nation's energy, environmental, and national security needs. To accomplish this mission, NE has established research objectives to resolve barriers in technical, cost, safety, and proliferation resistance through early-stage research, development and demonstration to:

- Enhance the long-term viability and competitiveness of the existing U.S. reactor fleet
- Develop an advanced reactor pipeline
- Implement and maintain national strategic fuel cycle and supply chain infrastructure

In support of these research objectives, the Versatile Test Reactor will provide leading edge capability for accelerated testing and qualification of advanced fuels and materials, enabling the U.S. to regain and sustain technology leadership in the area of current and future advanced reactor systems.

Key Performance Parameters (KPPs)

The Threshold KPPs, represent the minimum acceptable performance that the project must achieve. Achievement of the Threshold KPPs will be a prerequisite for approval of CD-4, Project Completion. The Objective KPPs represent the desired project performance.

The KPPs will be established as part of the performance baseline at CD-2/3.

Performance Measure	Threshold	Objective
TBD	TBD	TBD

3. Project Cost and Schedule

Financial Schedule

(Dollars in Thousands)

	Budget Authority (Appropriations)	Obligations	Costs
Total Estimated Cost (TEC)			
Design			
FY 2019	--	--	--
FY 2020	--	--	--
FY 2021	262,000	262,000	210,000
Outyears	TBD	TBD	TBD
Construction			
FY 2020	--	--	--
FY 2021	0	0	0
Outyears	TBD	TBD	TBD
Total Estimated Costs (TEC)			
FY 2019	--	--	--
FY 2020	--	--	--
FY 2021	262,000	262,000	210,000
Outyears	TBD	TBD	TBD
Total TEC	**TBD**	**TBD**	**TBD**
Other Project Costs (OPC)			
FY 2019	65,000	65,000	55,000
FY 2020	100,000	100,000	95,000
FY 2021	33,000	33,000	26,000
Outyears	TBD	TBD	TBD
Total OPC	**TBD**	**TBD**	**TBD**
Total Project Costs (TPC)			
FY 2019	65,000	65,000	55,000
FY 2020	100,000	100,000	95,000
FY 2021	295,000	295,000	236,000
Outyears	TBD	TBD	TBD
Grand Total	**TBD**	**TBD**	**TBD**

4. Details of Project Cost Estimate

(Budget Authority in Thousands of Dollars)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
Design			
Design	TBD	--	--
Contingency	TBD	--	--
Total, Design	TBD	--	--
Construction			
Site Work	TBD	--	--
Equipment	TBD	--	--
Construction	TBD	--	--
Other, as needed	TBD	--	--
Contingency	TBD	--	--
Total, Construction	TBD	--	--
Other TEC (if any)			
Cold Startup	--	--	--
Contingency	--	--	--
Total, Other TEC	--	--	--
Total Estimated Cost	**TBD**	--	--
Contingency, TEC	*TBD*	--	--
Other Project Cost (OPC)			
OPC except D&D			
R&D	TBD	--	--
Conceptual Planning	TBD	--	--
Conceptual Design	TBD	--	--
Other OPC Costs	TBD	--	--
Contingency	TBD	--	--
Total, OPC	**TBD**	--	--
Contingency, OPC	*430,000*	--	--
Total Project Cost	**4,500,000**	--	--
Total Contingency (TEC+OPC)	***995,000***	--	--

5. Schedule of Appropriations Requests

(Dollars in Thousands)

Request Year	Type	Prior Years	FY 2020	FY 2021	Outyears	Total
FY 2021	TEC	--	--	262,000	TBD	TBD
	OPC	65,000	100,000	33,000	TBD	TBD
	TPC	65,000	100,000	295,0000	TBD	TBD

6. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	TBD
Expected Useful Life (number of years)	TBD
Expected Future Start of D&D of this capital asset (fiscal quarter)	TBD

Related Funding Requirements

(Budget Authority in Millions of Dollars)

	Annual Costs		Life Cycle Costs	
	Previous Total Estimate	Current Total Estimate	Previous Total Estimate	Current Total Estimate
Operations and Maintenance	--	TBD	--	TBD

7. D&D Information

The new area being constructed in this project is not replacing existing facilities.

	Square Feet
New area being constructed by this project at selected DOE laboratory	up to 325,000
Area of D&D in this project at selected DOE laboratory	0
Area at selected DOE laboratory to be transferred, sold, and/or D&D outside the project, including area previously "banked"	0
Area of D&D in this project at other sites	0
Area at other sites to be transferred, sold, and/or D&D outside the project, including area previously "banked"	0
Total area eliminated	0

8. Acquisition Approach

The Versatile Test Reactor (VTR) is a Hazard Category 1 nuclear facility and design and construction must be integrated with ongoing nuclear operation activities at a designated national laboratory. Design and construction must also be coordinated/integrated with nuclear research and development programs to ensure mission objectives are met. The VTR is anticipated to follow a design-build project delivery method utilizing a cost plus incentive fee contract, with the incentives contingent upon successfully meeting project deliverables.

Idaho Facilities Management

Overview

The mission of the Idaho Facilities Management (IFM) program is to manage the planning, acquisition, operation, maintenance, and disposition of the Office of Nuclear Energy (NE)-owned facilities and capabilities at the Idaho National Laboratory (INL). The IFM program maintains Department of Energy (DOE) mission-supporting facilities and capabilities at the INL in a safe, compliant status (with DOE Orders, federal laws and regulations, and state agreements) to enable technological advancement in the existing nuclear fleet, advanced reactor pipeline, and fuel cycle mission areas. The availability of these key facilities and capabilities to support NE research and development (R&D) is critical to the ongoing effort to revitalize nuclear energy in the United States. INL facilities and capabilities also support testing of naval reactor fuels and reactor core components and a diverse range of national security technology programs that support the National Nuclear Security Administration (NNSA) and other federal agencies such as the Department of Homeland Security (DHS) in the areas of critical infrastructure protection, nuclear nonproliferation, and incident response. The IFM program integrates and closely coordinates with research programs to ensure proper alignment and prioritization of infrastructure investments, as well as infrastructure availability for programmatic work.

The IFM program enables long-term nuclear R&D activities by providing the expertise, facilities, equipment, and nuclear materials necessary to conduct a wide array of experimental activities in a safe and compliant manner. The Advanced Test Reactor (ATR) provides unique irradiation capability to further nuclear fuel and reactor component research in support of advanced nuclear reactor design activities. The Materials and Fuels Complex (MFC) contains a comprehensive range of fuel and experiment fabrication, material recovery activities, and pre- and post-irradiation examination capabilities used to assess material and fuel characteristics and performance in varying reactor environments. A limited number of facilities at the Idaho Nuclear Technology and Engineering Center are utilized to support material consolidation and storage, fuel cycle R&D, and National and Homeland Security activities.

Highlights of the FY 2021 Budget Request

The Further Consolidated Appropriations Act, 2020, included a structure change that moved IFM into a new Infrastructure program, which also included Oak Ridge National Laboratory (ORNL) Nuclear Facilities Operations and Maintenance (O&M) and the Research Reactor Infrastructure (RRI). Due to the complexities introduced by this change, the Department is not implementing the structure change in the FY 2021 Budget Request and the IFM request is provided in a comparable format.

The focus of IFM program activities remains on the safe and compliant operation of the INL's nuclear research reactor and non-reactor nuclear and radiological research facilities while continuing to realize improvements in the condition of aging INL infrastructure. In FY 2021, these activities include:

- Operating and maintaining the ATR Complex, the Transient Reactor Test Facility (TREAT), and key nuclear and radiological facilities at the MFC in a safe and compliant manner.
- Improving the reliability and availability of the ATR to meet research customer demands through a risk-based prioritization of plant, equipment, and experimental loop investments.
- Initiating the ATR Core Internals Change-out (CIC) to replace components within the high-flux region of the reactor core, including the Beryllium reflectors. During the extended 6 to 9 month outage, ATR will also complete reactor inspections and maintenance on critical balance of plant equipment.
- Addressing infrastructure gaps identified and required to fulfill the NE mission by continuing construction activities for the Sample Preparation Laboratory (SPL) following Critical Decision (CD)-1R/2/3 approval in FY 2020.

Idaho Facilities Management
Funding ($K) (Non-Comparable)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Idaho Facilities Management				
INL Nuclear Research Reactor Operations and Maintenance	119,000	0	107,491	-107,491
INL Non-Reactor Nuclear Research Facility Operations and Maintenance	152,286	0	84,890	-84,890
INL Engineering and Support Facility Operations and Maintenance	7,321	0	6,500	-6,500
INL Regulatory Compliance	9,393	0	9,119	-9,119
Construction	30,000	0	18,000	-18,000
Total, Idaho Facilities Management[1]	**318,000**	**0**	**226,000**	**-226,000**

Idaho Facilities Management
Funding ($K) (Comparable)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Idaho Facilities Management				
INL Nuclear Research Reactor Operations and Maintenance	119,000	116,900	107,491	-9,409
INL Non-Reactor Nuclear Research Facility Operations and Maintenance	152,286	146,029	84,890	-61,139
INL Engineering and Support Facility Operations and Maintenance	7,321	7,396	6,500	-896
INL Regulatory Compliance	9,393	9,675	9,119	-556
Construction	30,000	25,450	18,000	-7,450
Total, Idaho Facilities Management[1]	**318,000**	**305,450**	**226,000**	**-79,450**

[1] Funding does not reflect the transfer of approximately $85.5M in FY 2019 and $88.5M in FY 2020 from Naval Reactors for maintenance and operation of the Advanced Test Reactor.

Idaho Facilities Management
Proposed Budget Structure Changes

The Further Consolidated Appropriations Act, 2020, funded Idaho Facilities Management (IFM) into a new Infrastructure program, which also included Oak Ridge National Laboratory Nuclear Facilities O&M and Research Reactor Infrastructure. In FY 2021, NE proposes to keep the old IFM budget structure.

	FY 2021 Budget Structure for Idaho Facilities Management		
	Operations and Maintenance	**Construction**	**Total**
FY 2020 Budget Structure			
Infrastructure			
INL Facilities Operations and Maintenance	208,000	0	208,000
Construction	0	18,000	18,000
Total, Infrastructure	**208,000**	**18,000**	**226,000**

Idaho Facilities Management
Explanation of Major Changes (Comparable) ($K)

	FY 2021 Request vs FY 2020 Enacted
INL Nuclear Research Reactor Operations and Maintenance:	
The decrease from $116,900,000 to $107,491,000 reflects the completion of strategic investments to improve the availability and reliability of the Advanced Test Reactor (ATR) such as canal short bulkhead replacement, simulator refurbishment, and reactor data acquisition system (RDAS)/lobe power calculation and indication system (LPCIS) replacement.	**-9,409**
INL Non-Reactor Nuclear Research Facility Operations and Maintenance:	
The decrease from $146,029,000 to $84,890,000 reflects completion of strategic investments to improve the availability and reliability of the Materials and Fuels Complex (MFC), such as hot cell window and manipulator replacement, criticality alarm replacements, and laboratory refurbishments.	**-61,139**
INL Engineering and Support Facility Operations and Maintenance:	
The decrease from $7,396,000 to $6,500,000 reflects the necessary funds to support Federally-funded program activities and community regulatory support activities.	**-896**
INL Regulatory Compliance:	
There is no major change.	**-556**
Construction:	
The decrease from $25,450,000 to $18,000,000 reflects completion of full first year award of the Sample Preparation Laboratory (SPL) construction subcontract and partial second year award to continue construction activities following Critical Decision (CD)-1R/2/3 approval in FY 2020.	**-7,450**
Total, Idaho Facilities Management	**-79,450**

Idaho Facilities Management
INL Nuclear Research Reactor Operations and Maintenance

Description

This subprogram supports nuclear research reactor operations and maintenance at the Advanced Test Reactor (ATR) Complex and the Materials and Fuels Complex (MFC) for the Idaho National Laboratory (INL), including the ATR, the ATR Critical Facility (ATRC), the Transient Reactor Test Facility (TREAT), and the Neutron Radiography Reactor (NRAD).

The ATR is the primary research reactor at the INL. The ATR supports the majority of Office of Nuclear Energy (NE) research and development (R&D) programs, as well as Naval Reactors (NR) Program work in support of the U.S. Navy nuclear fleet and National Nuclear Security Administration (NNSA) programs. The ATR is also used by universities, laboratories, and industry, and is the primary scientific capability of the Nuclear Science User Facilities (NSUF). R&D demand for thermal neutron irradiation at ATRC and neutron radiography and small component test irradiation at NRAD continues to be significant. The TREAT reactor, also supporting NE R&D and the NSUF, continues to address technical challenges for reactor fuel related to nuclear-fuel performance and qualification. All programmatic work is funded by the sponsoring federal programs. The cost to other users is determined in accordance with Department of Energy (DOE) regulations and depends upon the demands on the reactor and the nature of the user.

To satisfy the irradiation needs of ATR users, efforts in FY 2020 that will continue in FY 2021 will refurbish and replace major ATR components and systems in order to improve the availability and reliability of the ATR. This investment strategy, jointly developed with NR, seeks to accomplish increased efficiency and irradiation days by prioritizing plant, equipment, and experimental loop investments using a risk-informed approach. In FY 2019, ATR plant health investment activities included diesel fuel distribution system upgrades, 670-E-28 DC electrical panel replacement, primary coolant system refurbishment, digital radiation monitoring system replacement, plant instrument air upgrades, warm waste treatment system replacement, and experiment loop refurbishment. Through plant health investments, ATR anticipates reducing deferred maintenance by over $5 million in FY 2020.

Following the successful restart of TREAT in FY 2018, TREAT continues to support regular transient testing operations in FY 2021. In addition to NE R&D programs, TREAT is now supporting a range of external customers' fuel development and qualification missions, including the National Aeronautics and Space Administration (NASA) and the U.S. nuclear industry.

INL Nuclear Research Reactor Operations and Maintenance
Funding

Activities and Explanation of Changes (Comparable)

FY 2020 Enacted[1]	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
INL Nuclear Research Reactor Operations and Maintenance $116,900,000	**$107,491,000**	**-$9,409,000**
• Maintain an Advanced Test Reactor (ATR) operating efficiency greater than 80% with a target of 143 irradiation days. • Continue investments to improve ATR availability and reliability through refurbishments and replacements of reactor systems and components such as ATR transformer yard replacement, ATR simulator refurbishment, and reactor data acquisition system (RDAS)/lobe power calculation and indication system (LPCIS) replacement. • Complete preparatory activities for the ATR core internals change-out (CIC), planned for 2021, such as completing all required procedures and work packages. • Continue transient testing base operations at the Transient Reactor Test Facility (TREAT).	• Maintain an ATR operating efficiency greater than 80% with a target of 74 irradiation days prior to beginning the CIC. • Continue investments to improve ATR availability and reliability through refurbishments and replacements of reactor systems and components such experiment loop refurbishment, cold waste control system refurbishment, and console display system annunciator upgrades. • Initiate the ATR CIC to replace major internal components including the Beryllium reflectors. • Complete major ATR reactor inspections including the reactor vessel weld and tank chain. • Continue transient testing base operations at TREAT.	• The decrease reflects the completion of strategic investments to improve the availability and reliability of the ATR such as canal short bulkhead replacement, simulator refurbishment, and reactor data acquisition system (RDAS)/lobe power calculation and indication system (LPCIS) replacement.

[1] Funding for these activities were provided within the Infrastructure program in FY 2020. The FY 2020 activities and funding are shown here in a comparable format.

Idaho Facilities Management
INL Non-Reactor Nuclear Research Facility Operations and Maintenance

Description

This subprogram provides funding for operations, maintenance, and support for non-reactor nuclear and radiological research facilities primarily located at the Materials and Fuels Complex (MFC). Activities within this category support sustainment of unique nuclear and radiological capabilities that are required to support The Office of Nuclear Energy's (NE) essential research and development (R&D) programs. Work scope focuses on maintaining a safe operating envelope while conducting corrective and cost-effective preventative maintenance activities necessary to sustain this core infrastructure. The non-reactor nuclear research facilities support core programmatic research capabilities including:

- Post-Irradiation Examination (PIE) and Fresh Fuel Characterization – Receipt of irradiated fuels/materials, non-destructive examination, destructive examinations and analyses, and mechanical testing of highly radioactive materials.
- Experimental Fuel Fabrication – Glovebox lines, fume hoods, and hot cell capabilities; unique fabrication capabilities; and instrumentation and testing equipment that support R&D on multiple fuel types and hazard levels.
- Advanced Separation and Waste Forms –Separations and pretreatment technologies development and electrochemical separations and waste form development (engineering scale).
- Management of NE-owned special nuclear material (SNM), including the characterization, packaging, storage, and disposition of surplus SNM.

Funding is provided for the management of NE-owned SNM. Access to and responsible management of SNM is fundamental to ensuring nuclear material is readily available to support mission activities.

This subprogram provides funding for Remote-Handled Low-Level Waste (RHLLW) Disposal Facility base operations, as well as Other Project Costs (OPCs) for the Sample Preparation Laboratory (SPL) Project.

In FY 2019, funding was provided for Plant Health investments at MFC, aligned with the 5 year investment plan, to focus on improving availability and throughput in MFC mission facilities. These activities include: Advanced Fuels Facility (AFF) (MFC-784) HVAC modifications, hot cell window and manipulator replacements, Fuel Manufacturing Facility (FMF) and Zero Power Physics Reactor (ZPPR) roof replacements, legacy material disposition, Fuel Conditioning Facility (FCF) control system replacement, Analytical Laboratory (AL) renovations, development of a sodium transient irradiation loop, and activities to refine use of ultra-sensitive instruments in the Irradiated Materials Characterization Laboratory (IMCL). Plant Health investments at MFC continue to improve the availability and reliability of operations at MFC, yielding 91% facility availability in FY 2019.

INL Non-Reactor Nuclear Research Facility Operations and Maintenance
Funding

Activities and Explanation of Changes (Comparable)

FY 2020 Enacted[1]	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
INL Non-Reactor Nuclear Research Facility Operations and Maintenance $146,029,000	**$84,890,000**	**-$61,139,000**
• Operate and maintain Materials and Fuels Complex (MFC) infrastructure, facilities, and equipment to support facility operations and programmatic work activities. • Perform maintenance and refurbishment activities within the MFC nuclear facilities and infrastructure consistent with the approved safety bases. • Perform maintenance and refurbishment on the radiological and balance-of-plant facilities necessary to support the MFC nuclear facilities and core missions. • Continue off-site disposition of surplus Nuclear Energy (NE)-owned special nuclear material (SNM) consistent with programmatic needs and approved nuclear material allotment forecasts. • Operate and maintain the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility to provide legacy and newly-generated waste disposal capability. • Continue MFC infrastructure investments, such as hot cell window and manipulator replacement, criticality alarm replacements, and laboratory refurbishments.	• Operate and maintain MFC infrastructure, facilities, and equipment to support facility operations and programmatic work activities. • Perform maintenance and refurbishment activities within the MFC nuclear facilities and infrastructure consistent with the approved safety bases. • Perform maintenance and refurbishment on the radiological and balance-of-plant facilities necessary to support the MFC nuclear facilities and core missions. • Continue off-site disposition of surplus NE-owned SNM consistent with programmatic needs and approved nuclear material allotment forecasts. • Operate and maintain the RHLLW Disposal Facility to provide legacy and newly-generated waste disposal capability. • Conduct construction oversight activities for the Sample Preparation Laboratory (SPL) Project.	• The decrease from reflects completion of strategic investments to improve the availability and reliability of MFC such as hot cell window and manipulator replacement, criticality alarm replacements, and laboratory refurbishments.

[1] Funding for these activities were provided within the Infrastructure program in FY 2020. The FY 2020 activities and funding are shown here in a comparable format.

Idaho Facilities Management
INL Engineering and Support Facility Operations and Maintenance

Description

This subprogram provides funds to support Federally-funded program activities and community regulatory support activities, such as site environmental monitoring and Payment in Lieu of Taxes (PILT), to meet obligations defined in crosscutting agreements and contracts. Examples of entities this subprogram has agreements or contracts with include the Shoshone-Bannock Tribes, the Defense Contract Audit Agency, and the National Oceanic and Atmospheric Administration.

INL Engineering and Support Facility Operations and Maintenance
Funding

Activities and Explanation of Changes (Comparable)

FY 2020 Enacted[1]	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
INL Engineering and Support Facility Operations and Maintenance $7,396,000	**$6,500,000**	**-$896,000**
• Continue to support Federally-funded activities to maintain operations at Idaho National Laboratory (INL) such as Nuclear Regulatory Commission (NRC) certificates for casks, Payment in Lieu of Taxes (PILT), and environmental monitoring to support State requirements.	• Continue to support Federally-funded activities to maintain operations at the INL such as NRC certificates for casks, PILT, and environmental monitoring to support State requirements.	• The decrease reflects the necessary funds to support Federally-funded program activities and community regulatory support activities.

[1] Funding for these activities were provided within the Infrastructure program in FY 2020. The FY 2020 activities and funding are shown here in a comparable format.

Idaho Facilities Management
INL Regulatory Compliance

Description

This subcategory supports activities for continued compliance with State and Federal environmental laws and other regulations that are under the purview of the Office of Nuclear Energy. Compliance activities focus on air, soil, and water monitoring and waste disposal consistent with Federal and State permit requirements and agreements such as the Idaho National Laboratory (INL) Site Treatment Plan. Regulatory activities also include efforts that support continued compliance with the 1995 Settlement Agreement with the State of Idaho, which governs management and disposition of spent nuclear fuel and transuranic wastes at the INL.

INL Regulatory Compliance
Funding

Activities and Explanation of Changes (Comparable)

FY 2020 Enacted[1]	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
INL Regulatory Compliance $9,675,000	**$9,119,000**	**-$556,000**
• Continue regulatory compliance program management. • Meet Idaho National Laboratory (INL) Site Treatment Plan milestones for treatment of two cubic meters of Mixed Low-Level Waste (MLLW). • Complete a minimum of 10 transfers of used nuclear fuel from wet storage in accordance with the 1995 Idaho Settlement Agreement and consistent with material requirements for the treatment of Experimental Breeder Reactor II (EBR-II) used nuclear fuel.	• Continue regulatory compliance program management. • Meet INL Site Treatment Plan milestones for treatment of two cubic meters of MLLW. • Complete a minimum of 10 transfers of used nuclear fuel from wet storage in accordance with the 1995 Idaho Settlement Agreement and consistent with material requirements for the treatment of EBR-II used nuclear fuel.	• There is no major change.

[1] Funding for these activities were provided within the Infrastructure program in FY 2020. The FY 2020 activities and funding are shown here in a comparable format.

Idaho Facilities Management
Construction

Description

Line-item capital projects are sometimes required at the Idaho National Laboratory (INL) to maintain its ability to support mission goals. These projects help achieve the Department's and the Office of Nuclear Energy's (NE) strategic objectives by maintaining site services and providing critical information for future decisions. This activity is focused on two primary objectives: (1) identification, planning, and prioritization of projects required to meet NE program objectives, and (2) development and execution of these projects within approved cost and schedule baselines as such projects are deemed necessary. While the Department's acquisition management process does not guarantee that a project will be completed once the initial information gathering and preliminary design phase are complete, it does provide an important decision-making framework that, when well executed, allows only the most critically necessary, cost-effective projects to proceed to construction.

The Sample Preparation Laboratory (SPL) project is a line item capital project that will provide the capability for sample preparation to support micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. This capability will augment non-destructive examination, elemental analysis, and radiological capabilities already present or being developed at INL. The SPL will, when coupled with existing facilities and recapitalization efforts, fulfill near-term capabilities for conducting the advanced post-irradiation examination needed to improve understanding of nuclear fuels and material performance at the micro-, nano-, and atomic scales.

The FY 2021 Budget Request for the Sample Preparation Laboratory (SPL) project is $18,000,000. The most recent Department of Energy Order (DOE O) 413.3B Critical Decision (CD), CD-1R/2/3 (Reaffirm Alternative Selection Process, Approve Performance Baseline, and Approve Start of Construction), was approved on January 31, 2020 with a Total Project Cost (TPC) of $166,000,000 and CD-4, Approve Project Completion, in FY 2027.

In August 2017, preliminary and final facility design of the SPL were initiated following an extended FY 2017 continuing resolution. Final facility design of the SPL was completed in October 2018 and the facility's preliminary documented safety analysis (PDSA) was approved in April 2019. Subsequent to completion of final design, a request for proposals for construction of the SPL was issued with an objective of obtaining construction bids to inform the project performance baseline. A single bid for construction of the SPL was received in April 2019. Based on delay in initiation of preliminary and final facility design activities following CD-1, further refinement of facility scope during preliminary and final facility design, and volatile construction market conditions experienced during a competitive bid process, the project exceeded the upper end of the TPC range established at CD-1.

Capital funding requested in FY 2021 continues project activities, such as procurement of key equipment and hardware, hot cell component fabrication, and facility construction.

Activities and Explanation of Changes (Comparable)

FY 2020 Enacted[1]	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Construction $25,450,000	**$18,000,000**	**-$7,450,000**
Sample Preparation Laboratory (16-E-200) *($25,450,000)* • Funding enacted supports award of the Sample Preparation Laboratory (SPL) Project construction subcontract and initiation of construction activities, following Critical Decision (CD)-1R/2/3 approval, such as: site mobilization; excavation work; completion of concrete footings, backfill, and slab on grade; and fabrication of shielded enclosures.	*Sample Preparation Laboratory (16-E-200)* *($18,000,000)* • Funding is requested to continue SPL construction activities, such as: equipment and hardware procurement; hot cell liner fabrication; concrete stair and elevator core construction; concrete shear wall construction; and hot cell window delivery.	*Sample Preparation Laboratory (16-E-200)* *(-$7,450,000)* • The decrease from $25,450,000 to $18,000,000 reflects progression from initiation of SPL Project construction to continuation of construction activities and initiation of research hardware procurements.

[1] Funding for these activities were provided within the Infrastructure program in FY 2020. The FY 2020 activities and funding are shown here in a comparable format.

Idaho Facilities Management
Capital Summary ($K)

	Total	Prior Years	FY 2019 Enacted	FY 2019 Actuals	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Capital Operating Expenses Summary (including Major Items of Equipment)							
Capital Equipment >$500K (including MIE)	n/a	0	750	750	5,396	0	-5,396
Minor Construction Project	10,904	0	10,904	10,904	0	0	0
Total, Capital Operating Expenses	**n/a**	**0**	**11,654**	**11,654**	**5,396**	**0**	**-5,396**
Capital Equipment > $500K (including MIE)							
Total Non-MIE Capital Equipment	n/a	0	750	750	0	0	0
Transmission Electron Microscope (Indirect Funded)	5,396	0	0	0	5,396	0	-5,396
Total, Capital Equipment (including MIE)	**n/a**	**0**	**750**	**750**	**5,396**	**0**	**-5,396**
Minor Construction Projects							
Materials and Fuel Complex Analytical Laboratory HVAC and Controls Upgrade General Plant Project	10,904	0	10,904	10,904	0	0	0
Total, Minor Construction Projects	**10,904**	**0**	**10,904**	**10,904**	**0**	**0**	**0**
Total, Capital Summary	**n/a**	**18,092**	**11,654**	**11,654**	**5,396**	**0**	**-5,396**

Idaho Facilities Management
Construction Projects Summary (Comparable) ($K)

	Total	Prior Years	FY 2019 Enacted	FY 2019 Actuals	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
16-E-200, Sample Preparation Laboratory, INL							
Total Estimated Cost (TEC)	144,600	14,000	30,000	30,000	25,450	18,000	-7,450
Other Project Costs (OPC)	21,400	4,647	0	0	0	2,403	+2,403
Total Project Cost (TPC) Project Number 16-E-200	**166,000**	**18,647**	**30,000**	**30,000**	**25,450**	**20,403**	**-5,047**
Total All Construction Projects							
Total Estimated Cost (TEC)	144,600	14,000	30,000	30,000	25,450	18,000	-7,450
Total Other Project Costs (OPC)	21,400	4,647	0	0	0	2,403	+2,403
Total Project Cost (TPC) All Construction Projects	**166,000**	**18,647**	**30,000**	**30,000**	**25,450**	**20,403**	**-5,047**

16-E-200, Sample Preparation Laboratory
Idaho National Laboratory
Project is for Design and Construction

1. Summary, Significant Changes, and Schedule and Cost History

Summary

The FY 2021 Budget Request for the Sample Preparation Laboratory (SPL) project is $18,000,000. The most recent Department of Energy Order (DOE O) 413.3B Critical Decision (CD), CD-1R/2/3 (Reaffirm Alternative Selection Process, Approve Performance Baseline, and Approve Start of Construction), was approved on January 31, 2020 with a Total Project Cost (TPC) of $166,000,000 and CD-4, Approve Project Completion, in FY 2027.

In August 2017, preliminary and final facility design of the SPL were initiated following an extended FY 2017 continuing resolution. Final facility design of the SPL was completed in October 2018 and the facility's preliminary documented safety analysis (PDSA) was approved in April 2019. Subsequent to completion of final design, a request for proposals for construction of the SPL was issued with an objective of obtaining construction bids to inform the project performance baseline. A single bid for construction of the SPL was received in April 2019. Based on delay in initiation of preliminary and final facility design activities following CD-1, further refinement of facility scope during preliminary and final facility design, and volatile construction market conditions experienced during a competitive bid process, the project exceeded the upper end of the TPC range established at CD-1.

Capital funding requested in FY 2021 continues project activities, such as procurement of key equipment and hardware, hot cell component fabrication, and facility construction.

A Level II Federal Project Director has been assigned to this project, and their Level III certification is in progress.

Significant Changes

This Construction Project Data Sheet (CPDS) is an update of the FY 2020 CPDS and does not include a new start for FY 2021. The TPC estimate for the project is now $166 million and CD-4 is estimated for Q1 FY 2027, for reasons provided above.

Critical Milestone History

(Fiscal Quarter or Date)

Fiscal Year	CD-0	Conceptual Design Complete	CD-1	Final Design Complete	CD-1R/2/3	D&D Complete	CD-4
FY 2016	1/31/2011	4Q FY2014	3Q FY2015	TBD	TBD	TBD	TBD
FY 2017	6/18/2015	1Q FY2016	1Q FY2016	TBD	TBD	N/A	TBD
FY 2018	6/18/2015	8/31/2016	9/30/2016	TBD	TBD	N/A	TBD
FY 2019	6/18/2015	8/31/2016	9/30/2016	TBD	TBD	N/A	TBD
FY 2020	6/18/2015	8/31/2016	9/30/2016	TBD	TBD	N/A	TBD
FY 2021	6/18/2015	8/31/2016	9/30/2016	10/24/2018	1/31/2020	N/A	11/30/2026

CD-0 – Approve Mission Need for a construction project with a conceptual scope and cost range
Conceptual Design Complete – Actual date the conceptual design was completed (if applicable)
CD-1 – Approve Alternative Selection and Cost Range
Final Design Complete – Estimated/Actual date the project design will be/was complete (d)
CD-1R/2/3 – Reaffirm Alternative Selection Process, Approve Performance Baseline, and Approve Start of Construction
D&D Complete – Completion of D&D work
CD-4 – Approve Start of Operations or Project Closeout

Fiscal Year	Performance Baseline Validation	CD-3A	CD-3B
FY 2016	N/A	N/A	N/A
FY 2017	N/A	N/A	N/A
FY 2018	N/A	N/A	N/A
FY 2019	N/A	N/A	N/A
FY 2020	N/A	TBD	TBD
FY 2021	1/31/2020	N/A	N/A

CD-3A – Approve Long-Lead Procurements, Original Scope
CD-3B – Approve Long-Lead Procurements, Revised Scope

Project Cost History

Fiscal Year	TEC, Design	TEC, Construction	TEC, Total	OPC, Except D&D	OPC, D&D	OPC, Total	TPC
FY 2016	10,000	68,000	78,000	17,000	0	17,000	95,000
FY 2017	10,000	73,000	83,000	12,000	0	12,000	95,000
FY 2018	13,385	72,615	86,000	12,200	0	12,200	98,200
FY 2019	13,385	72,615	86,000	12,200	0	12,200	98,200
FY 2020	13,385	72,615	86,000	12,200	0	12,200	98,200
FY 2021[a]	9,998	134,602	144,600	21,400	0	21,400	166,000

a. Project costs updated due to factors summarized in Section 1.

2. Project Scope and Justification

Scope

The Sample Preparation Laboratory (SPL) will be designed and constructed to receive irradiated materials and to prepare samples for micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. The improved sample preparation and analytical capabilities provided by SPL will enhance non-destructive examination, elemental, and radiological capabilities already present at the Materials and Fuels Complex (MFC).

SPL will provide the required capabilities to allow high hazard materials to be routinely prepared and tested in a safe, secure, and environmentally controlled environment. To meet this objective, SPL will be designed and constructed to include the following specific capabilities:

- Next generation radiation-shielded enclosures designed for regular manned access when radioactive samples are not present. The shielded enclosures will be flexible and reconfigurable to accommodate operational requirements for use with modern characterization instruments.
- The facility will be designed to meet stringent vibration, electrical and magnetic field, acoustic, and temperature fluctuation requirements for advanced analytical equipment with the ability to support development and deployment of equipment, instruments, and models to meet future nuclear fuel research and development (R&D) needs over a 40-year period.
- The facility will be designed to provide operational flexibility and streamlined workflow processes, including handling of radioactive fuels and materials.
- The facility will include enhanced material handling capabilities using robotics and vision technologies in radioactive sample, specimen, and equipment handling applications.
- The facility will include state-of-the art sample preparation technologies and equipment.
- The facility will support advanced data collection and management capabilities to enable efficient use by advanced modeling and simulation assets.
- The facility will provide interim storage for radioactive material experiments subject to examination.
- The facility will be designed to include radioactive waste management capabilities.

The initial complement of three scientific instruments, and an additional five advanced scientific instruments will be procured, remotized (as needed), and tested as part of the project prior to installation in the facility.

The Sample Preparation Laboratory (SPL) facility will be an alpha-limited post-irradiation examination (PIE) facility and operate in conjunction with the Hot Fuel Examination Facility, Analytical Laboratory, Irradiated Materials Characterization Laboratory (IMCL), and offsite facilities to provide the overall capability to analyze and characterize irradiated and non-irradiated nuclear material samples. The SPL facility will not replace these facilities; it will function synergistically with them. Having most of these facilities located within a single security-protected site (i.e., MFC) supports efficient nuclear material control, security, and management.

Facility operations will include cask receipt and unloading, experiment decontamination, sample preparation (e.g., machining, grinding, and polishing), sample storage, waste packaging, and various micro-structure and thermal examinations. The majority of these operations will take place within shielded cells and enclosures due to the radioactivity of the materials handled. These include the Sample Preparation Line, the Mechanical Properties Test Cell (MPTC), and the shielded instrument rooms. The facility is anticipated to be a Hazard Category 3 nuclear facility.

A wide variety of samples will be handled in the facility. Non-alpha emitting samples will include solids or contained powders. In some cases, very small quantities of non-dispersible alpha-emitting material (i.e., fuels) may be received in the form of metallurgical mounts for examination using the advanced examination capabilities deployed at SPL. Nuclear materials and samples will be received in containers ranging from the Battelle Energy Alliance, LLC (BEA) research reactor cask to shielded/non-shielded 55 gallon drums, incorporating a truck lock for cask and related container handling. The primary method of sample transfer within the SPL facility will be via a progressive pass-along process through the sample preparation line of hot cells. Once processed in the hot cells, the materials will be distributed to the MPTC, a glove box, IMCL, or to the individual shielded instrument rooms. Transfer of samples within the SPL facility will be via a pneumatic transfer system. Samples will also be transferred within the facility and to other facilities via small shielded pigs or casks that mate to the outside of the hot cells. Samples will be appropriately shielded and confined to protect workers, equipment, and the facility. Preliminary key performance parameters (KPPs) were established for the project at CD-1. KPPs are defined as a vital characteristic, function, requirement, or design basis that, if changed, would have a major impact on the facility or system performance, scope, schedule, cost, risk, or the ability of an interfacing project to meet its mission requirements. The KPPs represent the minimum acceptable scope for successful delivery of SPL. Achievement of KPPs will be a prerequisite for approval of CD-4. The KPPs provided herein are preliminary, pre-baseline objectives. The final KPPs will be established as part of CD-2/3.

Preliminary SPL threshold and objective KPPs.

Performance Measure	Threshold	Objective*
Construct a Hazard Category-3, non-reactor nuclear laboratory facility	Minimum of 40,000 gross square feet of laboratory/support space	N/A
Provide a shielded sample preparation capability designated for beta/gamma emitting irradiated materials	Shielded hot cell with five workstations/windows and associated equipment that support cask receipt, material handling, gross source material sizing, storage, decontamination, and fine sample preparation	N/A
Provide advanced post-irradiation examination capabilities for beta/gamma emitting irradiated materials	Three shielded scientific instrument enclosures Three advanced scientific instruments that support interior (crystal) phase characterization, fracture surface analysis, and surface science	Up to five additional advanced scientific instruments and associated facility infrastructure

* SPL will be baselined to the Threshold Measure. Objective KPPs will be executed if funding is available after Threshold KPPs are achieved.

The facility will be constructed using sustainable building considerations per Department of Energy Guide 413.3-6, “High Performance Sustainable Building”. The SPL facility design includes provisions for meeting the Guiding Principles for Federal Leadership in High Performance and Sustainable Building per Executive Order (EO) 13693. The facility will include provisions for meeting the 2016 Guiding Principles for Sustainable Federal Buildings per EO 13834, “Efficient Federal Operations.”

Funds appropriated under this data sheet may be used to provide independent assessments related to project planning and execution.

Justification

The behavior of fuels and materials in a nuclear reactor irradiation environment is the limiting factor in nuclear plant safety, longevity, efficiency, and economics. During the last 15 years, nano-scale (i.e., 10^{-9} meter) characterization of nonnuclear materials has become routine, with capabilities for sub-angstrom (i.e., 10^{-10}meter) investigation becoming increasingly available to researchers in other fields. An understanding of nuclear fuel and material performance in the nuclear reactor internal environment at this scale is critical to development of the innovative fuels and materials required for tomorrow's nuclear energy systems.

Existing post-irradiation examination (PIE) and thermal and mechanical properties testing capabilities at U.S. Department of Energy (DOE) laboratories, universities, and in the private sector are widely dispersed. Current PIE capabilities serve basic needs for fuel examination, material handling, and waste disposal, but are limited in their ability to function on the micro, nano, and atomic scale. Advanced characterization of radioactive samples at nano-scale to micro-scale length resolutions will support development of modern computer codes that could enable order-of-magnitude improvements in the time and cost of developing new fuels.

The SPL facility will support a variety of programs and users by receiving irradiated nuclear materials and by preparing samples for micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. This improved sample preparation capability will enhance non-destructive examination, elemental, and radiological capabilities already present at the Materials and Fuels Complex (MFC). The SPL may also provide source material and sample storage capability. The laboratory will, when coupled with existing facilities and recapitalization efforts, fulfill near-term advanced post-irradiation capabilities necessary for conducting the advanced post-irradiation examination needed to improve understanding of nuclear fuels and materials performance at the micro-, nano-, and atomic scales. This new understanding will allow for the development of innovative fuels and materials that can be used by the nuclear energy community. Irradiation-driven phenomena can only be understood through conducting a scientific program that includes experimental irradiation testing and post-irradiation examination, materials characterization, and testing coupled with modeling and simulation.

The project is being conducted in accordance with the project management requirements in DOE Order 413.3B, Program and Project Management for the Acquisition of Capital Assets.

3. Financial Schedule

(Dollars in Thousands)

	Budget Authority (Appropriations)	Obligations	Costs
Total Estimated Cost (TEC)			
Design			
Prior Years	13,385	13,385	6,517
FY 2019	0	0	3,471
Construction			
Prior Years	615	615	0
FY 2019	30,000	30,000	0
FY 2020	25,450	25,450	19,277
FY 2021	18,000	18,000	38,396
Outyears	57,150	57,150	76,939
Total Estimated Costs (TEC)			
Prior Years	14,000	14,000	6,517

	Budget Authority (Appropriations)	Obligations	Costs
FY 2019	30,000	30,000	3,471
FY 2020	25,450	25,450	19,277
FY 2021	18,000	18,000	38,396
Outyears	57,150	57,150	76,939
Total TEC		**144,600**	**144,600**
Other Project Costs			
Prior Years	4,647	4,647	2,756
FY 2019	0	0	1,139
FY 2020	0	0	740
FY 2021	2,403	2,403	2,321
Outyears	14,350	14,350	14,444
Total OPC	21,400	21,400	21,400
Total Project Costs (TPC)			
Prior Years	18,647	18,647	9,273
FY 2019	30,000	30,000	4,610
FY 2020	25,450	25,450	20,017
FY 2021	20,403	20,403	40,717
Outyears	71,500	71,500	91,383
Grand Total	**166,000**	**166,000**	**166,000**

4. Details of Project Cost Estimate

(Budget Authority in Thousands of Dollars)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
Design			
Design	9,998	10,785	N/A
Contingency	0	2,600	N/A
Total, Design	9,998	13,385	N/A
Construction			
Site Work	2,505	2,230	N/A
Equipment	17,878	8,545	N/A
Construction	94,237	56,840	N/A
Other, as needed	--	--	--
Contingency	19,982	5,000	N/A
Total, Construction	134,602	72,615	N/A
Other TEC (if any)			

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Cold Startup	--	--	--
Contingency	--	--	--
Total, Other TEC	--	--	--
Total **Estimated Cost**	144,600	86,000	N/A
Contingency, TEC	19,982	7,600	N/A
Other Project Cost (OPC)			
OPC except D&D			
R&D	0	4,220	N/A
Conceptual Planning	1,310	1,310	N/A
Conceptual Design	821	821	N/A
Other OPC Costs	15,743	4,549	N/A
Contingency	3,526	1,300	N/A
Total, OPC	21,400	12,200	N/A
Contingency, OPC	3,526	1,300	N/A
Total Project Cost	166,000	98,200	N/A
Total Contingency (TEC+OPC)	23,508	8,900	N/A

5. Schedule of Appropriation Requests

(Dollars in Thousands)

Request Year	Type	Prior Years	FY 2018	FY 2019	FY 2020	FY 2021	Outyears	Total
FY 2016	TEC	2,000	TBD	TBD	TBD	0	0	78,000
	OPC	1,847	TBD	TBD	TBD	0	0	17,000
	TPC	3,847	TBD	TBD	TBD	0	0	95,000
FY 2017	TEC	8,000	TBD	TBD	TBD	TBD	TBD	83,000
	OPC	4,647	TBD	TBD	TBD	TBD	TBD	12,000
	TPC	12,647	TBD	TBD	TBD	TBD	TBD	95,000
FY 2018	TEC	8,000	6,000	TBD	TBD	TBD	TBD	86,000
	OPC	4,647	0	TBD	TBD	TBD	TBD	12,200
	TPC	12,647	6,000	TBD	TBD	TBD	TBD	98,200
FY 2019	TEC	8,000	6,000	TBD	TBD	TBD	TBD	86,000
	OPC	4,647	0	TBD	TBD	TBD	TBD	12,200
	TPC	12,647	6,000	TBD	TBD	TBD	TBD	98,200
FY 2020	TEC	8,000	6,000	30,000	5,242	TBD	TBD	86,000
	OPC	4,647	0	0	0	TBD	TBD	12,200
	TPC	12,647	6,000	30,000	5,242	TBD	TBD	98,200
FY 2021	TEC	8,000	6,000	30,000	25,450	18,000	57,150	144,600
	OPC	4,647	0	0	0	2,403	14,350	21,400

	TPC	12,647	6,000	30,000	25,450	20,403	71,500	166,000

6. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	1Q FY 2027
Expected Useful Life (number of years)	40
Expected Future Start of D&D of this capital asset (fiscal quarter)	1Q FY 2067

Related Funding Requirements
(Budget Authority in Thousands of Dollars)

	Annual Costs		Life Cycle Costs	
	Previous Total Estimate	Current Total Estimate	Previous Total Estimate	Current Total Estimate
Operations and Maintenance	N/A	9,926	N/A	1,675,000

Life-cycle operations and maintenance costs include annual escalation.

7. D&D Information

The new area being constructed in this project is not replacing existing facilities.

	Square Feet
New area being constructed by this project at [Lab]	49,000
Area of D&D in this project at [Lab]	0
Area at [Lab] to be transferred, sold, and/or D&D outside the project, including area previously "banked"	0
Area of D&D in this project at other sites	0
Area at other sites to be transferred, sold, and/or D&D outside the project, including area previously "banked"	0
Total area eliminated	0

Site location, building name or numbers, and square footages of existing facilities to be replaced: N/A

As a new Laboratory facility, the proposed SPL is not subject to Freeze the Footprint (>50% lab space).

8. Acquisition Approach

As a Hazard Category 3 nuclear facility, design and construction of the Sample Preparation Laboratory (SPL) must be integrated with ongoing nuclear operations activities. Design and construction must also be coordinated/integrated with nuclear research and development programs. Therefore, a design-bid-build project delivery method managed by the Idaho National Laboratory management and operating contractor will be used for the design and construction of the SPL. A firm, fixed price construction subcontract is anticipated for the construction of the SPL.

Idaho Sitewide Safeguards and Security

Overview

The Idaho Sitewide Safeguards and Security (S&S) program supports the Idaho National Laboratory (INL) complex nuclear facility infrastructure and enables the Office of Nuclear Energy (NE) to conduct research and development (R&D) in support of multiple program missions. The S&S program benefits the site infrastructure and users by providing the safeguards and security functions required at Department of Energy (DOE) sites to enable R&D utilizing nuclear materials and protected information. In addition to NE R&D activities, S&S enables a range of national security programs that support the National Nuclear Security Administration (NNSA) and other Federal agencies including the Department of Homeland Security in the areas of critical infrastructure protection, nuclear nonproliferation and incident response. Safeguards and security functions, through the INL S&S program, also enable the Department of the Army, the Department of the Navy, and NNSA Naval Reactors mission activities.

The FY 2021 Budget Request provides direct funding for the INL S&S base program. Strategic Partnership Projects (SPP) will continue to fund an allocable share of the S&S program via full cost recovery. Extraordinary security requirements, such as dedicated security for special projects or exercises, will be a direct charge to DOE and SPP customers.

Highlights of the FY 2021 Budget Request

In FY 2021, the S&S program will continue to sustain program functionality at the level necessary to assure high confidence in the protection of INL assets and a high degree of customer service by maintaining effective staffing levels, proactive preventative and corrective maintenance programs, and a robust cybersecurity program. The FY 2021 Budget Request will focus on continued implementation of infrastructure investments, capital improvements, emerging technology investments, and enhanced cybersecurity program capabilities to adequately secure site assets; including:

- Completing critical physical security infrastructure investments and hiring protective force staff required to maintain an S&S program consistent with Departmental requirements such as initiating designs, related analyses, and modifications to support a continued multi-year effort to enhance physical security infrastructure across several INL complexes.
- Supporting physical security systems life-cycle replacement including preventative and corrective maintenance on critical security systems, subsystems, and components.
- Supporting implementation of the new Design Basis Threat and Departmental Orders and the additional force-on-force exercises and equipment required to analyze and validate changes to security models to provide data for risk-informed decision making and directly test the efficacy of the protection methodology and posture.
- Maintaining an effective cybersecurity program through the addition of lifecycle hardware/software upgrades and replacements including continuous monitoring, maintaining Industrial Control Systems, essential cybersecurity positions and associated training.

Idaho Sitewide Safeguards and Security
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Idaho Sitewide Safeguards and Security				
Protective Forces	76,881	79,450	80,812	+1,362
Security Systems	10,075	10,075	10,075	0
Security Infrastructure	16,839	21,588	4,618	-16,970
Information Security	4,674	4,674	4,674	0
Personnel Security	7,714	7,714	7,714	0
Material Control & Accountability	4,876	4,876	4,876	0
Program Management	8,175	8,175	8,175	0
Cybersecurity	16,856	16,856	16,856	0
Total, Idaho Sitewide Safeguards and Security	**146,090**	**153,408**	**137,800**	**-15,608**

Idaho Sitewide Safeguards and Security
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Protective Forces: The increase from $79,450,000 to $80,812,000 reflects costs for additional protective force staff to support approved security enhancement activities consistent with Departmental protection requirements. Funding also supports additional protective force equipment, training, facilities, and management consistent with approved protection strategy.	**+1,362**
Security Systems: There are no changes to the budget.	**0**
Security Infrastructure: The decrease from $21,588,000 to $4,618,000 reflects receipt of full funding in FY 2020 for the Protective Force Building at the Materials and Fuels Complex that will meet the needs of expanded protective force and security operations required by the Department's Design Basis Threat.	**-16,970**
Information Security: There are no changes to the budget.	**0**
Personnel Security: There are no changes to the budget.	**0**
Material Control & Accountability: There are no changes to the budget.	**0**
Program Management: There are no changes to the budget.	**0**
Cybersecurity: There are no changes to the budget.	**0**
Total, Idaho Sitewide Safeguards and Security	**-15,608**

Idaho Sitewide Safeguards and Security

Description

The Idaho Sitewide Safeguards and Security (S&S) program funds Office of Nuclear Energy (NE) base physical and cybersecurity activities for the Idaho National Laboratory (INL), providing protection of the Department of Energy's (DOE) nuclear materials, classified and unclassified matter, government property, personnel and other vital assets from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts that may cause adverse impacts on our national security; program continuity; or the health and safety of employees, the public, or the environment.

Protective Forces

Protective Forces provides security police officers (SPO's) and other specialized personnel, equipment, training, and management needed during normal and security emergency conditions for the adequate protection of site assets consistent with site security plans. Protective force personnel are deployed 24 hours a day, 7 days a week, across 890 square miles to deter, detect, delay, and respond to adversarial threats.

Security Systems

Physical Security Systems provides preventative and corrective maintenance and performance testing of intrusion detection and assessment systems, entry and search control equipment, barriers, secure storage, lighting, sensors, entry/access control devices, locks, explosives detection, and tamper-safe monitoring. Ensures 24 hours a day, 7 days a week operation of approximately 4,600 security alarms and 6,100 security locks at multiple security areas.

Security Infrastructure

Security Infrastructure provides critical security infrastructure investments and protection enhancements necessary to ensure adequate protection of assets consistent with Departmental requirements. These include, but are not limited to: upgrades, refurbishments or replacement of protective force training and muster facilities; physical security systems or equipment required by Departmental Orders, such as perimeter intrusion detection and assessment systems, closed-circuit televisions, central and/or secondary alarm stations; and other similar activities.

Information Security

Information Security provides for the protection and control of classified and sensitive matter that is generated, received, transmitted, used, stored, reproduced, and/or destroyed. The Classified Matter Protection and Control Program and Operations Security Program ensure that classified and sensitive unclassified matter is appropriately managed and adequately protected and controlled to prevent access by unauthorized individuals and that those individuals that do have access are trained to handle classified matter. Information Security executes the Technical Security Countermeasures (TSCM) program and conducts TSCM surveys.

Personnel Security

Personnel Security provides access to classified and sensitive information and assignment of personnel in sensitive positions through the clearance program, adjudication, security awareness and education, U.S. citizen and foreign visitor control, Human Reliability Program, psychological/medical assessments, and administrative review costs. Personnel security includes both contractor and federally funded activities.

Materials Control and Accountability

Material Control & Accountability (MC&A) provides the personnel, equipment, and services required to account for and control special nuclear materials (SNM) from diversion. MC&A is accomplished through the administration of a robust formal inventory process that allows security personnel to locate and track specific quantities of SNM in real time, state of the art measurement equipment, non-destructive analysis, and a robust tamper indicating device program.

Program Management

Program Management includes policy oversight, development, and update of site security plans; vulnerability assessments and performance testing to ensure adequate protection of SNM; investigations into incidents of security concern; and issuance of security infractions. The activities completed within Program Management allow for risk-informed decision making, support a performance-based S&S program, and directly test the efficacy of the protection methodology/posture.

Cybersecurity

Cybersecurity maintains the staffing, computing infrastructure, and network security configuration necessary to support classified and unclassified information and electronic operations. The Cybersecurity program uses a graduated risk approach based on data sensitivity and impact of loss/compromise to ensure that electronic or computer information systems are protected in a manner consistent with upholding key priorities; including importance to national security, support of DOE missions and programs, vulnerability to threats, and the magnitude of harm that would result from an information system and industrial control systems compromise.

Idaho Sitewide Safeguards and Security
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Protective Forces $79,450,000	**$80,812,000**	**+$1,362,000**
• Provided funding for the protective force staff consistent with the Site Security Plan, approved site labor wage agreement, and Idaho National Laboratory (INL) cost model, including associated training activities and facilities required to maintain protective force qualifications. • Provided funding to purchase protective force equipment such as ammunition, weapons, protective gear and vehicles.	• Provides funds for additional protective force staff to continue security infrastructure Phase IIA Implementation Plan activities consistent with the Site Security Plan, approved site labor wage agreement, and INL cost model, including associated training activities and facilities required to maintain protective force qualifications. • Provides funding to purchase Protective Force equipment such as ammunition, weapons, protective gear and vehicles.	• Increase reflects funds to continue support for Phase IIA Implementation Plan force staffing requirements consistent with the approved protection strategy for integrating Departmental security requirements.
Security Systems $10,075,000	**$10,075,000**	**+$0**
• Provided full funding for staff and equipment to plan and conduct preventative and corrective maintenance on physical security systems across multiple security areas. • Supported the operation of INL central alarm stations, development and modification of security alarm systems and life cycle replacement of systems.	• Provides full funding for staff and equipment to plan and conduct preventative and corrective maintenance on physical security systems across multiple security areas. • Supports the operation of INL central alarm stations, development and modification of security alarm systems and life cycle replacement of systems.	• No change.
Security Infrastructure $21,588,000	**$4,618,000**	**-$16,970,000**
• Provided funds for Implementation Plan Phase IIA activities and initial implementation of Phase IIB by performing design work, related analyses, and modifications in support of the multi-year effort to enhance physical security infrastructure across several INL complexes. • Funding was also provided for construction of the Protective Force Building at the Materials and Fuels Complex (MFC).	• Supports continued work on Implementation Plan Phase IIB activities including the performance of design work, construction, and related analyses required by Departmental Orders. These modifications are in support of the multi-year effort to enhance physical security infrastructure across several INL complexes, as approved by the Department. • Funds implementation of internet pipeline infrastructure upgrades required to maintain security controls on the increased capacity of the	• The decrease reflects receipt of FY 2020 funding for the construction of the Protective Force Building at the MFC that will meet the needs of expanded protective force and security operations required by the Department's Design Basis Threat.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
	modernized system and meet protection requirements.	
Information Security $4,674,000	**$4,674,000**	**+$0**
• Provided funds to implement information security activities to protect classified and sensitive unclassified matter including Classified Matter Protection and Control, Technical Surveillance Countermeasures, Classification/Declassification, and Operations Security programs.	• Provides funds to implement information security activities to protect classified and sensitive unclassified matter including Classified Matter Protection and Control, Technical Surveillance Countermeasures, Classification/Declassification, and Operations Security programs.	• No change.
Personnel Security $7,714,000	**$7,714,000**	**+$0**
• Provided funding for federal and contractor personnel security programs including processing, tracking and adjudication of security investigations, including the reduction in case backlog, Homeland Security Presidential Directive-12 (HSPD-12) badging and smart card administration, foreign visits and assignments, and management of the human reliability program including medical examinations. • Supported personnel security services for the Office of Nuclear Energy (NE) headquarters staff.	• Provides funding for federal and contractor personnel security programs including processing, tracking and adjudication of security investigations, including the reduction in case backlog, HSPD-12 badging and smart card administration, foreign visits and assignments, and management of the human reliability program including medical examinations. • Supports personnel security services for NE headquarters staff.	• No change.
Material Control & Accountability (MC&A) $4,876,000	**$4,876,000**	**+$0**
• Provided funds to maintain the site's special nuclear material (SNM) database and tracking systems, coordinate on-and off-site material movements, and to conduct SNM inventories.	• Provides funds to maintain the site's SNM database and tracking systems, coordinate on- and off-site material movements, and to conduct SNM inventories.	• No change.
Program Management $8,175,000	**$8,175,000**	**+$0**
• Provided funding to assure program effectiveness in the implementation of Departmental Orders. • Provided funds to support force-on-force exercises which directly test the efficacy of the protection methodology and posture and allow for risk-informed decision making.	• Provides funding to monitor and improve program management functions, including the development, and maintenance of security program documentation, vulnerability and risk assessments and to conduct performance testing to assure program effectiveness in the implementation of Departmental Orders. • Provides funds to support force-on-force exercises which directly test the efficacy of the protection	• No change.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
	methodology and posture and allow for risk-informed decision making.	
Cybersecurity $16,856,000	**$16,856,000**	**+$0**
• Provided funding for certification and accreditation activities for classified and unclassified cybersecurity systems, a key activity in FY 2020 to maintain an effective cybersecurity program consistent with the Department's measured risk management and vulnerability and incident management strategies including staffing, training, tools, and hardware/software lifecycle replacement. • Continued development of the Idaho National Laboratory (INL) Industrial Control Systems (ICS) cybersecurity program. • Continued to improve network traffic visibility and further develop advanced forensic capabilities. • Maintained 24/7 intrusion detection and prevention monitoring, ensuring that incidents and breaches were discovered and remediated as soon as possible.	• Provides funding to maintain an effective cybersecurity program, consistent with the Department's measured risk management and vulnerability and incident management strategies. • Maintain 24/7 intrusion detection and prevention monitoring, ensuring that incidents and breaches are discovered and remediated. • Provides funding for staffing, training, tools, hardware and software lifecycle replacement, and certification and accreditation for classified and unclassified systems. • Continue to improve cyber threats detection and response capabilities, develop hunt teams and improve network traffic monitoring capabilities by detecting and isolating advanced threats. • Perform penetration testing on INL ICS cybersecurity program and initiate integrating ICS activities into the Security Operations Center and Vulnerability Management program.	• No Change.

Idaho Sitewide Safeguards and Security
Capital Summary ($K)

	Total	Prior Years	FY 2019 Enacted	FY 2019 Actuals	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Capital Operating Expenses Summary (including Major Items of Equipment)							
Minor Construction	n/a	5,150	15,339	15,339	21,588	4,618	-16,970
Total, Capital Operating Expenses	**n/a**	**5,150**	**15,339**	**15,339**	**21,588**	**4,618**	**-16,970**
Minor Construction Projects							
ATR Complex Security Building	10,000	0	10,000	10,000	0	0	0
Internet Pipeline Monitoring Infrastructure	1,800	0	0	0	0	1,800	+1,800
Security Infrastructure Phase III	20,000	0	0	0	0	0	0
Materials and Fuels Complex Protective Forces Building	15,600	0	0	0	15,600	0	-15,600
Security Infrastructure Phase IIB	18,000	0	0	0	5,477	2,818	-2,659
Security Infrastructure Phase IIA project 1	5,700	3,900	1,800	1,800	0	0	0
Security Infrastructure Phase IIA project 2	5,300	1,250	3,539	3,539	511	0	-511
Total, Minor Construction Projects	**76,400**	**5,150**	**15,339**	**15,339**	**21,588**	**4,618**	**-16,970**
Total, Capital Summary	**n/a**	**5,150**	**15,339**	**15,339**	**21,588**	**4,618**	**-16,970**

International Nuclear Energy Cooperation

Overview

The International Nuclear Energy Cooperation (INEC) program leads the Department's international engagement for civil nuclear energy, including analysis, development, coordination and implementation of international civil nuclear energy policy with the integration of the Office of Nuclear Energy's (NE) international nuclear technical activities, in coordination with the Department's Office of International Affairs (IA). These activities contribute to international bilateral and multilateral civil nuclear research and development (R&D) with countries that have advanced nuclear programs, while providing the expertise to better inform countries on safety and security issues that should be considered before developing a civilian nuclear program. INEC utilizes workshops and other expert-based exchange fora to engage industry, stakeholders and foreign governments on issues of interest including expert training, financing of nuclear builds, safety and multinational options for nuclear spent fuel disposal.

An important element of INEC's mission is support of advocacy for the U.S. commercial nuclear sector, including industry vendors and utilities. This mission supports increased nuclear exports, which in turn could contribute to domestic infrastructure development and job creation while protecting U.S. intellectual property.

In summary, INEC enables the Department to meet the demands of engagement with international partners on civil nuclear policy, research, development and demonstration (RD&D) and related activities. INEC's bilateral and multilateral engagement supports broader U.S. policy and commercial goals related to the safe and secure deployment of nuclear energy worldwide and facilitates more effective integration of NE international R&D and policy objectives, while remaining sensitive to facilitating civil nuclear exports and supporting nonproliferation policies. INEC executes its international missions in coordination with the National Nuclear Security Administration, Office of Environmental Management, and IA; the National Security Council; Department of State; the Department of Commerce; and the Nuclear Regulatory Commission to facilitate U.S. nuclear energy RD&D, nuclear safety, policy, and commercial interests internationally.

Highlights of the FY 2021 Budget Request

Congress has directed that the INEC program be funded within NE's Program Direction (PD) account in FY 2020. The FY 2021 Request carries forward this directive and funds INEC within NE's PD account.

International Nuclear Energy Cooperation
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
International Nuclear Energy Cooperation				
International Nuclear Energy Cooperation	3,000	0	0	0
Total, International Nuclear Energy Cooperation	**3,000**	**0**	**0**	**0**

Program Direction

Overview

Program Direction provides the federal staffing resources and associated costs required to support the overall direction and execution of the Office of Nuclear Energy (NE) programs. NE has staff strategically located in multiple locations: Washington, D.C. Headquarters, Oak Ridge Operations Office, Nevada Field Office, and the Idaho Operations Office. Activities within the site offices support inherently federal functions that facilitate the efficient execution of the Department of Energy (DOE) programs or directly execute DOE mandated safety, security, business functions, and public outreach. In addition to NE federal personnel, Program Direction supports select federal staff and support for the Office of Human Capital Service Center.

The Support Services subprogram allows the Department to cost-effectively hire the best available industry experts to support federal staff in managing the nuclear programs and complex activities. The ability to acquire expertise quickly and on an "as needed basis" provides flexibility in team composition as the needs of NE evolve. Program Direction also includes the Other Related Expenses subprogram, which provides NE's directed funding contribution to the Department's Working Capital Fund (WCF). The WCF supports specific Departmental services and activities that are shared across DOE including: employee health and testing services, and consolidated training and recruitment initiatives; all established in previous fiscal years and supported in FY 2021.

In addition to appropriated funds, NE also manages approximately $200 million annually from other activities including: Strategic Partnerships Program and reimbursable funding from the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD).

The FY 2021 Program Direction Budget Request reflects NE's continued effort to optimize support for its federal programs through continued efficiency and cost-effectiveness; and to ensure a measured and effective oversight of NE mission activities. Federal staff supported by the Program Direction account are responsible for ensuring the appropriate planning, oversight, and execution of all activities within NE.

The International Nuclear Energy Cooperation (INEC) program, now funded within the Program Direction Budget Request leads the Department's international engagement for civil nuclear energy, including analysis, development, coordination and implementation of international civil nuclear energy policy with the integration of the NE international nuclear technical activities. These activities contribute to international bilateral and multilateral civil nuclear research and development (R&D) cooperation with countries that have advanced nuclear programs, while providing the expertise to better inform countries on safety and security issues that should be considered before developing a civilian nuclear program. INEC utilizes workshops and other expert-based exchange fora to engage industry, stakeholders and foreign governments on issues of interest including expert training, financing of nuclear builds, safety and multinational options for nuclear spent fuel disposal. INEC will continue to collaborate and coordinate with DOE's Office of International Affairs to ensure transparency, leverage expertise, and avoid duplication.

Highlights of the FY 2021 Budget Request

The FY 2021 Program Direction Budget Request includes a transfer from NE of staff and associated costs to establish and manage the Interim Storage and Nuclear Waste Fund Oversight program. Federal oversight and procurement efforts will also be funded to support the Uranium Reserve Program. The Request also includes a one percent pay increase in civilian salaries, FERS increase, and supplemental funds for performance award pool increase in FY 2021.

Program Direction
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Program Direction				
Salaries and Benefits	48,990	50,809	47,655	-3,154
Travel	1,629	1,512	1,512	0
Support Services	11,015	10,219	9,701	-518
Other Related Expenses	18,366	14,460	14,263	-197
International Nuclear Energy Cooperation	0	3,000	2,000	-1,000
Total, Program Direction	**80,000**	**80,000**	**75,131**	**-4,869**

Program Direction
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Salaries and Benefits:	
The decrease from $50,809,000 to $47,655,000 reflects the transfer of funding for personnel costs of employees to support the Interim Storage and Nuclear Waste Fund Oversight program in FY 2021. This decrement is offset by an increase for additional FTEs to support federal oversight of the Uranium Reserve Program, and enhanced federal performance awards.	**-3,154**
Travel:	
No change.	**0**
Support Services:	
The decrease from $10,219,000 to $9,701,000 reflects an adjustment of support contracts needed to support the Office of Nuclear Energy's (NE) programs.	**-518**
Other Related Expenses:	
The decrease from $14,460,000 to $14,263,000 reflects the transfer of funding for Other Related Expenses to support the Interim Storage and Nuclear Waste Fund Oversight program in FY 2021.	**-197**
International Nuclear Energy Cooperation	
The decrease from $3,000,000 to $2,000,000 reflects the International Nuclear Energy Cooperation's realignment of priorities for international engagement toward increased support for the U.S. commercial nuclear exports while increasing coordination within NE for international research and development engagement, coupled with the completion of activities initiated in the FY 2019/FY 2020 timeframe.	**-1,000**
Total, Program Direction	**-4,869**

Program Direction
Funding ($K)

	FY 2020 Enacted	FY 2021 Request	FY 2020 Enacted vs FY 2021 Request
Program Direction Summary			
Washington Headquarters			
Salaries and Benefits	26,489	22,945	-3,544
Travel	1,080	1,080	0
Support Services	8,214	7,696	-518
Other Related Expenses	6,574	6,377	-197
International Nuclear Energy Cooperation	3,000	2,000	-1,000
Total, Washington Headquarters	**45,357**	**40,098**	**-5,259**
Oak Ridge Operations Office			
Salaries and Benefits	612	642	+30
Travel	7	7	0
Support Services	1,075	1,075	0
Other Related Expenses	138	138	0
Total, Oak Ridge Operations Office	**1,832**	**1,862**	**+30**
Nevada Field Office			
Salaries and Benefits	1,628	1,708	+80
Travel	0	0	0
Support Services	0	0	0
Other Related Expenses	103	103	0
Total, Nevada Field Office	**1,731**	**1,811**	**+80**
Idaho Operations Office			
Salaries and Benefits	22,080	22,360	+280
Travel	425	425	0
Support Services	930	930	0
Other Related Expenses	7,645	7,645	0
Total, Idaho Operations Office	**31,080**	**31,360**	**+280**

	FY 2020 Enacted	FY 2021 Request	FY 2020 Enacted vs FY 2021 Request
Total Program Direction			
Salaries and Benefits	50,809	47,655	-3,154
Travel	1,512	1,512	0
Support Services	10,219	9,701	-518
Other Related Expenses	14,460	14,263	-197
International Nuclear Energy Cooperation	3,000	2,000	-1,000
Total, Program Direction	**80,000**	**75,131**	**-4,869**
Federal FTEs	**287**	**272**	**-15**
Support Services			
Technical Support			
Mission Related	1,686	1,686	0
Advisory and Assistance	1,381	1,381	0
Total, Technical Support	3,067	3,067	0
Management Support			
Administrative	6,080	5,562	-518
IT	1,072	1,072	0
Total Management Support	7,152	6,634	-518
Total, Support Services	**10,219**	**9,701**	**-518**
Other Related Expenses			
Working Capital Fund	5,540	5,392	-148
Training	240	240	0
Miscellaneous	6,235	6,186	-49
Rents and Utilities	2,445	2,445	0
Total, Other Related Expenses	**14,460**	**14,263**	**-197**

Program Direction
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Program Direction $80,000,000	**$75,131,000**	**-$4,869,000**
Salaries and Benefits $50,808,681	**$47,654,931**	**-$3,153,750**
• Provides salaries and benefits for 287 FTEs.	• Provides salaries and benefits for 272 FTEs.	• The decrease reflects transfer of staff and associated costs to the Interim Storage and Nuclear Waste Fund Oversight program, offset by small increase to support the Uranium Reserve Program, and enhanced federal performance awards.
Travel $1,512,000	**$1,512,000**	**$0**
• Provides for travel of the federal staff including any necessary permanent change of duty status costs.	• Provides for travel of the federal staff including any necessary permanent change of duty status costs.	• No change.
Support Services $10,218,918	**$9,701,060**	**-$517,858**
• Provides for technical and administrative support services for the Office of Nuclear Energy (NE) federal staff.	• Provides for technical and administrative support services for the NE federal staff.	• The decrease reflects planned adjustment of contractual support staffing needs for NE's programs.
Other Related Expenses $14,460,401	**$14,263,009**	**-$197,392**
• Provides for NE's share of goods and services procured through the Department's Working Capital Fund (WCF); rents and utilities associated with the Idaho Operations Office; federal training expenses; and other miscellaneous expenses.	• Provides for NE's share of goods and services procured through the Department's WCF; rents and utilities associated with the Idaho Operations Office; federal training expenses; and other miscellaneous expenses.	• The decrease reflects transfer of staff and associated costs to the Interim Storage and Nuclear Waste Fund Oversight program.
International Nuclear Energy Cooperation (INEC) $3,000,000	**$2,000,000**	**-$1,000,000**
• Provide country-specific policy and logistical support required to effectively implement NE's bilateral research and development (R&D) activities with expert support from national laboratory lead country coordinators. Maintain existing bilateral and multilateral cooperation	• Provide country-specific policy and logistical support required to effectively implement NE's bilateral R&D activities with expert support from national laboratory lead country coordinators. Maintain existing bilateral and multilateral cooperation commitments. Enhance technical	• The decrease reflects INEC's realignment of priorities for international engagement toward increased support for the U.S. commercial nuclear exports while increasing coordination within NE for international R&D engagement, coupled with

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
commitments. Enhance technical cooperation with advanced and developing nuclear energy countries globally to support both NE and U.S. Government strategic priorities and objectives. • Provide expertise and technical assistance to the Department of Commerce and U.S. interagency in support of U.S. civil nuclear exports.	cooperation with advanced and developing nuclear energy countries globally to support both NE and U.S. Government strategic priorities and objectives. • Provide expertise and technical assistance to the Department of Commerce and U.S. interagency in support of U.S. civil nuclear exports.	the completion of activities initiated in the FY2019/FY 2020 timeframe.

Nuclear Energy
Small Business Innovative Research/Small Business Technology Transfer (SBIR/STTR) ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
STEP R&D			
SBIR	160	160	0
STTR	22	22	0
Reactor Concepts RD&D			
SBIR	10,352	6,464	3,568
STTR	1,456	909	502
Fuel Cycle R&D			
SBIR	7,725	7,683	4,704
STTR	1,086	1,080	662
Nuclear Energy Enabling Technologies			
SBIR	4,883	3,631	3,712
STTR	687	511	522
Advanced Reactors Demonstration Program			
SBIR	0	1,600	320
STTR	0	225	45
Total, SBIR	**23,120**	**19,538**	**12,304**
Total, STTR	**3,251**	**2,747**	**1,730**

Nuclear Energy
Research and Development ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Basic	0	0	0
Applied	892,113	735,684	638,811
Development	401,519	359,895	182,919
Subtotal, R&D	**1,293,632**	**1,095,579**	**821,730**
Equipment	0	0	0
Construction	0	65,000	262,000
Total, R&D	**1,293,632**	**1,160,579**	**1,083,730**

Nuclear Energy
Safeguards and Security ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Idaho Sitewide Safeguards and Security			
Protective Forces	76,881	79,450	80,812
Security Systems	10,075	10,075	10,075
Security Infrastructure	16,839	21,588	4,618
Information Security	4,674	4,674	4,674
Personnel Security	7,714	7,714	7,714
Material Control & Accountability	4,876	4,876	4,876
Program Management	8,175	8,175	8,175
Cybersecurity	16,856	16,856	16,856
Total, Idaho Sitewide Safeguards and Security	**146,090**	**153,408**	**137,800**

Nuclear Energy
Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. The Facilities Maintenance and Repair activities funded by this budget and displayed below are intended to halt asset condition degradation. This excludes maintenance of excess facilities (including high-risk excess facilities) necessary to minimize the risk posed by those facilities prior to disposition.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost	FY 2020 Planned Cost	FY 2021 Planned Cost
Idaho National Laboratory	60,462	25,186	22,120	23,743
Total, Direct-Funded Maintenance and Repair	60,462	25,186	22,120	23,743

Costs for Indirect-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost	FY 20120 Planned Cost	FY 2021 Planned Cost
Idaho National Laboratory	39,809	25,362	21,082	21,607
Total, Indirect-Funded Maintenance and Repair	39,809	25,362	21,082	21,607

Report on FY 2019 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2019 to the amount planned for FY 2019, including congressionally directed changes.

Nuclear Energy
Total Costs for Maintenance and Repair ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost
Idaho National Laboratory	100,271	50,548
Total, Maintenance and Repair	**100,271**	**50,548**

Each year, the "Planned Cost" for maintenance and repair is a minimum target amount. The Nuclear Energy (NE) program met its planned minimum target in FY 2019. The NE program exceeded the minimum target amount due to plus ups in congressional direction allowing for strategic investments at the Advanced Test Reactor and Materials and Fuels Complex at the Idaho National Laboratory.

Nuclear Energy
Excess Facilities

Costs for Direct-Funded Excess Facilities ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost	FY 2020 Planned Cost	FY 2021 Planned Cost
Idaho National Laboratory	1,159	1,159	0	0
Total, Direct-Funded Excess Facilities	1,159	1,159	0	0

Costs for Indirect-Funded Excess Facilities ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost	FY 2020 Planned Cost	FY 2021 Planned Cost
Idaho National Laboratory	0	0	500	0
Total, Indirect-Funded Excess Facilities	0	0	500	0

Nuclear Waste Disposal
Proposed Appropriation Language

For Department of Energy expenses necessary for activities to carry out the purposes of the Nuclear Waste Policy Act of 1982, including interim storage activities, $27,500,000, to remain available until expended, and to be derived from the Nuclear Waste Fund.

Interim Storage and Nuclear Waste Fund Oversight
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
0	0	27,500	+27,500

Overview

The Nuclear Waste Policy Act (NWPA) of 1982 made the Department of Energy (DOE) responsible for the United States (U.S.) spent nuclear fuel and high-level nuclear waste and the Department remains committed to fulfilling the Federal Government's legal and moral obligations to properly manage and dispose of that material. The mission of the Interim Storage and Nuclear Waste Fund Oversight program is to develop and implement a robust interim storage program, support the Department's fiduciary responsibilities for Yucca Mountain, and continue oversight of the Nuclear Waste Fund. The actions of this subprogram contribute to the safe and secure management of spent nuclear fuel (SNF) and high-level waste (HLW) currently located at numerous sites across the U.S. DOE will support the Administration's development of a durable, predictable yet flexible plan that addresses more efficiently storing waste temporarily in the near term, followed by permanent disposal. This integrated plan will address key aspects of implementing an effective nuclear waste management system. The U.S.'s commercial SNF and HLW must be managed safely to minimize the risk to human health and the environment. Effective management of these materials will contribute to the maintenance of the U.S. commercial nuclear fleet and support our international non-proliferation goals. The Department recognizes that legislative changes are needed to implement elements of the proposed approach, and looks forward to working with Congress to implement a solution.

Implementation of interim storage can bring the following benefits:

- Earlier acceptance of nuclear waste by the Federal Government;
- Reduction in the number of dispersed storage sites;
- Added system flexibility; and
- Near-term development and demonstration of institutional and technical infrastructures for large-scale nuclear waste management.

Highlights and Major Changes in the FY 2021 Budget Request

The Interim Storage and Nuclear Waste Fund Oversight program's FY 2021 Budget Request prioritizes a robust interim storage program. The subprogram will lay the groundwork necessary to ensure near-term deployment of interim storage so that waste from across the nation can be safely and effectively collected and stored.

Initial key activities of preparing for interim storage within an integrated waste management system include:

- Developing an integrated program plan;
- Working with State, Tribal and local governments and other affected federal agencies;
- Initiating processes to identify potential sites;
- Developing preliminary design concepts;
- Analyzing and updating critical data on Identifying quantities of and collecting detailed information on relevant nuclear waste inventories to inform options analyses and transportation planning;
- Implementing processes and procedures that support implementation and demands of a regulatory environment; and
- Continuing efforts to establish system capabilities and infrastructure need for large scale transportation.

The FY 2021 Budget Request also includes funding for continued oversight for the Nuclear Waste Fund and includes security, maintenance, and environmental requirements for the Yucca Mountain site and to fulfill the program's Yucca Mountain fiduciary responsibility under the Nuclear Waste Policy Act of 1982.

These funds are inclusive of program direction activities necessary to carry out the subprogram's mission.

Interim Storage and Nuclear Waste Fund Oversight

Overview

The Nuclear Waste Policy Act (NWPA) of 1982 assigns the Department of Energy (DOE) the responsibility for disposition of the United States (U.S.) spent nuclear fuel and high-level radioactive waste and the Department remains committed to fulfilling the Federal Government's legal and moral obligations to properly manage and dispose of that material. The mission of the Interim Storage and Nuclear Waste Fund Oversight program is to develop and implement a robust interim storage program as part of a waste management system, support the Department's fiduciary responsibilities for Yucca Mountain, and continue oversight of the Nuclear Waste Fund (NWF). The actions of this subprogram contribute to the safe and secure management of spent nuclear fuel and high-level waste currently located at numerous sites across the U.S. in nearly 40 states across the nation. DOE will support the Administration's development of a durable, predictable yet flexible plan that addresses more efficiently storing waste temporarily in the near term, followed by permanent disposal. This integrated plan will address key aspects of implementing an effective nuclear waste management system. The U.S.'s commercial spent nuclear fuel and high-level waste must be managed safely to minimize the risk to human health and the environment. Effective management of these materials will contribute to the maintenance of the U.S. commercial nuclear fleet and support our international non-proliferation goals. The Department recognizes that legislative changes are needed to implement elements of the proposed approach, and looks forward to working with Congress to implement a solution.

Highlights of the FY 2021 Budget Request

The Interim Storage and Nuclear Waste Fund Oversight program's FY 2021 Budget Request is dedicated to performing the scoping, planning, and development activities needed to implement an interim storage program enabling near-term consolidation and storage of nuclear waste. These activities include:

- Developing a program plan for a waste management system;
- Working with State, Tribal and local governments and other affected federal agencies;
- Initiating processes to identify potential sites;
- Developing preliminary design concepts;
- Analyzing and updating critical data on Identifying quantities of and collecting detailed information on relevant nuclear waste inventories to inform options analyses and transportation planning;
- Implementing processes and procedures that support implementation and demands of a regulatory environment; and
- Continuing efforts to establish system capabilities and infrastructure need for large scale transportation.

The Administration recognized that new legislation is needed to implement elements of the proposed storage and disposal plans, and it will introduce legislation in support of these goals.

The FY 2021 Budget Request includes funding for continued oversight for the NWF to include the security, maintenance, and environmental requirements for the Yucca Mountain site and to fulfill the program's Yucca Mountain fiduciary responsibility under the NWPA.

These funds are inclusive of program direction activities and cloud migration costs necessary to carry out the mission.

Interim Storage and Nuclear Waste Fund Oversight
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Interim Storage and Nuclear Waste Fund Oversight				
Interim Storage and Nuclear Waste Fund Oversight	0	0	27,500	+27,500
Total, Interim Storage and Nuclear Waste Fund Oversight Programs	0	0	27,500	+27,500
FTEs			26	+26

Explanation of Major Changes
Funding ($K)

	FY 2021 Request vs FY 2020 Enacted
Interim Storage and Nuclear Waste Fund Oversight	
Interim Storage:	**+20,000**
The increase from $0 to $20,000,000 is to establish a new program for an interim storage capability for earlier acceptance of nuclear waste to contribute to the safe and secure management of nuclear waste currently located at numerous sites across the United States.	
Nuclear Waste Fund Oversight:	**+$7,500**
The increase from $0 to $7,500,000 supports maintaining safety and security and other fiduciary responsibilities for the Yucca Mountain site and continued oversight of the Nuclear Waste Fund.	
Total, Interim Storage and Nuclear Waste Fund Oversight Program	**+27,500**

Interim Storage and Nuclear Waste Fund Oversight

Description

The primary mission of the Interim Storage and Nuclear Waste Fund Oversight program is to develop and implement a robust interim storage program, as a part of an overarching waste management system, support the Department's fiduciary responsibilities for Yucca Mountain, and continued oversight of the Nuclear Waste Fund (NWF). In FY 2021, the program will prioritize implementation of an interim storage capability for nuclear waste. The program will also provide continued oversight for the NWF and fulfill the Department's Yucca Mountain fiduciary responsibilities, including site security, maintenance, and environmental requirements. The Department of Energy (DOE) will support the Administration's development of a durable, predictable yet flexible plan that addresses more efficiently storing waste temporarily in the near term, followed by permanent disposal. This integrated plan will address key aspects of implementing an effective nuclear waste management system.

The United States (U.S.) utilizes nuclear technology for national defense, research and development, and electric power generation. These activities produced and continue to create large quantities of spent nuclear fuel (SNF) and high level waste (HLW) that require safe storage and eventual disposal. Commercial electricity generation, the largest generator of SNF accounts for approximately 80,000 metric tons of uranium (MTU) of SNF with the potential to produce an additional 60,000 MTU (total of 140,000 MTU) with the current reactor fleet. Nearly all existing commercial SNF stored at the reactor sites where it was generated. Of the 74 commercial reactor sites, 17 sites no longer have an operating reactor. The U.S. inventory of HLW includes commercial HLW stored in one state and defense HLW stored in three states. Under current law, the federal government, and specifically DOE, is responsible for the disposal of SNF and HLW. Providing for the consolidated interim storage of SNF is a near term step towards the ultimate goal of permanent disposal.

Implementation of interim storage can bring the following benefits:

- Earlier acceptance of nuclear waste by the Federal Government;
- Reduction in the number of dispersed storage sites;
- Added system flexibility and opportunity; and
- Near-term development and demonstration of institutional and technical infrastructures for large-scale nuclear waste management.

Key activities of preparing for interim storage within an integrated waste management system include:

- Developing an integrated program plan;
- Working with State, Tribal and local governments and other affected federal agencies;
- Initiating processes to identify potential sites;
- Developing preliminary design concepts;
- Implementing processes and procedures that support implementation and demands of a regulatory environment;
- Analyzing and updating critical data on Identifying quantities of and collecting detailed information on relevant nuclear waste inventories to inform options analysis and transportation planning; and
- Continuing efforts to establish system capabilities and infrastructure need for large scale transportation.

Execution of the key activities will:

- Further develop knowledge and technology gap analysis, activities, milestones, and resources needed to develop, evaluate, and acquire interim storage capabilities and associated transportation;
- Further evaluate technical, economic, and other factors associated with interim storage concepts; and,
- Maintain engagement with regional, state, and tribal transportation authorities to prepare for SNF and HLW shipments.

Implementation of an appropriate investment strategy and the prudent management of the NWF investment portfolio are essential to fulfilling the program's fiduciary responsibility under the Nuclear Waste Policy Act (NWPA).

Requirements for the management and operation of DOE's physical security under the Protection Program Operations Directive (DOE Order 473.3A) at the Yucca Mountain site will continue.

Interim Storage and Nuclear Waste Fund Oversight
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Interim Storage $0	**$27,500,000**	**+$27,500,000**
• No funding in FY 2020.	• Initiating processes to identify potential sites. • Developing an integrated program plan. • Developing preliminary design concepts. • Conduct analyses, leverage expertise from other programs, and work with stakeholders as appropriate to develop, evaluate, and acquire interim storage capabilities and associated transportation. • Maintain engagement with regional, state, and tribal transportation authorities to prepare for future spent nuclear fuel and high-level radioactive waste shipments. • Maintain support for logistical requirements, packaging and transportation hardware and analytical capabilities. • Implementation of an appropriate investment strategy and the prudent management of the Nuclear Waste Fund (NWF) investment portfolio. • Maintain physical security requirements, under Department of Energy Order 473.3A for the Yucca Mountain site, as well as maintenance and environmental requirements. • Support associated federal staff and support.	• The increase from $0 to $27,500,000 is to establish a new program for scoping and planning for an interim storage capability and continued oversight of the NWF.

Uranium Reserve
Proposed Appropriation Language

Uranium Reserve

For Department of Energy expenses necessary for Uranium Reserve activities to carry out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), $150,000,000, to remain available until expended.

Uranium Reserve
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
0	0	150,000	+150,000

Overview

The Uranium Reserve (UR) program provides assurance of availability of uranium in the event of a market disruption and supports strategic United States (U.S.) fuel cycle capabilities. In addition, while no immediate national security need has been identified, the reserve may also provide a source of U.S.-origin uranium. Establishing a reserve is an urgent step needed in response to an overreliance on imported uranium product that has undermined U.S. energy security and impacted U.S. fuel supply capabilities. This action addresses near-term challenges to the production and conversion of domestic uranium, where the risks are most immediate, and is consistent with the priorities of the Administration's Nuclear Fuel Working Group (NFWG). U.S. energy and national security depends upon a viable U.S. nuclear fuel cycle.

On July 12, 2019, the President issued a Memorandum, which states that "the United States uranium industry faces significant challenges in producing uranium domestically and that this is an issue of national security." The NFWG was directed to "examine the current state of domestic nuclear fuel production to reinvigorate the entire nuclear fuel supply chain, consistent with United States national security and nonproliferation goals." The NFWG will continue to evaluate domestic uranium production issues and the challenges facing the front end of the fuel cycle and is preparing its findings and recommendations for presentation to the President.

Highlights of the FY 2021 Budget Request

The FY 2021 Budget Request of $150 million establishes the UR for the U.S. to support domestic uranium production and uranium conversion services capabilities, provides assurances of uranium availability in the event of a market disruption, and supports strategic U.S. fuel cycle capabilities.

In addition, the Office of Nuclear Energy will engage policy entities and collect information from industry to quickly establish an acquisition approach and begin procurement of U.S. uranium for the reserve and conversion services for uranium in FY 2021. It is expected that this would directly support the operation of at least two U.S. uranium mines and the reestablishment of active domestic conversion capabilities. The UR is not designed to replace or disrupt market mechanisms.

Uranium Reserve

Overview

The Uranium Reserve (UR) program provides assurance of availability of uranium in the event of a market disruption and supports strategic United States (U.S.) fuel cycle capabilities. Establishing a reserve is an urgent step needed in response to an overreliance on imported uranium product that has undermined U.S. energy security and impacted U.S. fuel supply capabilities. This action addresses near-term challenges to the production and conversion of domestic uranium, where the risks are most immediate, and is consistent with the priorities of the Administration's Nuclear Fuel Working Group (NFWG). U.S. energy and national security depends upon a viable U.S. nuclear fuel cycle.

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Uranium Reserve
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Uranium Reserve				
Uranium and Conversion Acquisition and Storage	0	0	150,000	+150,000
Total, Uranium Reserve	**0**	**0**	**150,000**	**+150,000**

Uranium Reserve
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Uranium Reserve	
Uranium:	**+150,000**
The increase from $0 to $150,000,000 to support scoping, planning, and acquisition of uranium, conversion, and storage for a U.S. Uranium Reserve.	
Total, Uranium Reserve	**+150,000**

Uranium Reserve

Description

The Uranium Reserve (UR) program provides assurance of availability of uranium in the event of a market disruption and supports strategic U.S. fuel cycle capabilities. Establishing a reserve is an urgent step needed in response to an overreliance on imported uranium product that has undermined U.S. energy security and impacted U.S. fuel supply capabilities.

In FY 2021, the program will focus on development and execution of a procurement strategy that enables the near-term purchase of uranium and conversion services for the reserve. To initiate this program, the Office of Nuclear Energy (NE) will undertake a number of activities that can be supported with a minor increase in staff and management resources (no more than 3-6 FTEs, which will be funded within the NE R&D Program Direction budget).

Initial actions include the scoping and planning of the acquisition strategy for developing the UR. This will include formal Requests for Information and workshops to optimize engagement. The Department plans to execute a competitive procurement process that will result in the acquisition of uranium and conversion services to best meet program goals, while ensuring the best use of taxpayer dollars. Awards for at least two U.S. uranium mines and for conversion services are expected to be awarded by the end of FY 2021.

Uranium Reserve
Funding

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Interim Storage $0	**$150,000,000**	**+$150,000,000**

• No funding in FY 2020.	• Develop the Uranium Reserve (UR) parameters, including stakeholder engagement, and establish the reserve.
	• Develop acquisition strategy for the UR:
	  ○ Undertake competitive procurement of U.S. uranium
	  ○ Initiate procurement of conversion services
		• The increase from $0 to $150,000,000 funds the establishment of the reserve, initial procurement of uranium and conversion services, and storage.

DEPARTMENT OF ENERGY
Funding by Site Detail
TAS_0319 - Nuclear Energy BY2021
(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Argonne National Laboratory			
Crosscutting Technology Development	1,610	330	30
Nuclear Science User Facilities	450	1,050	750
NEAMS Joint Modeling and Simulation Program	5,650	0	0
Transformational Challenge Reactor	0	2,500	2,500
Joint Modeling and Simulation Program	0	5,000	5,000
Nuclear Energy Enabling Technologies	7,710	8,880	8,280
Light Water Reactor Sustainability	150	50	50
Advanced Reactor Technologies	9,600	8,374	11,000
Versatile Advanced Test Reactor	958	7,000	0
Advanced SMR R&D	1,343	0	0
Reactors Concepts RD&D	12,051	15,424	11,050
Advanced Reactors Demonstration Program	0	5,200	2,600
Program Direction - Nuclear Energy	125	290	185
International Nuclear Energy Cooperation	90	0	0
Material recovery and waste form development	0	703	281
Total Advanced Fuels	0	500	600
Fuel Cycle Research and Development	8,819	0	0
Fuel Cycle Laboratory R&D	0	2,711	100
Used Nuclear Fuel Disposition R&D	0	2,000	2,000
Integrated Waste Management System	0	2,000	0
Fuel Cycle Research and Development FCRD	8,819	7,914	2,981
Total Argonne National Laboratory	**28,795**	**37,708**	**25,096**
Brookhaven National Laboratory			
Nuclear Energy Enabling Technologies	500	650	500
Advanced Reactor Technologies	102	110	150
Versatile Advanced Test Reactor	145	0	0
Reactors Concepts RD&D	247	110	150
Total Advanced Fuels	0	712	0
Fuel Cycle Research and Development	1,434	0	0
Fuel Cycle Laboratory R&D	0	472	71
Fuel Cycle Research and Development FCRD	1,434	1,184	71
Total Brookhaven National Laboratory	**2,181**	**1,944**	**721**
Chicago Operations Office			
Nuclear Science User Facilities	2	0	0
NEAMS Joint Modeling and Simulation Program	234	0	0
Joint Modeling and Simulation Program	0	234	234
Nuclear Energy Enabling Technologies	236	234	234
Total Chicago Operations Office	**236**	**234**	**234**
Golden Field Office			
Crosscutting Technology Development	1,495	0	0
Nuclear Energy Enabling Technologies	1,495	0	0
Total Golden Field Office	**1,495**	**0**	**0**
Idaho National Laboratory			
Crosscutting Technology Development	15,360	14,875	10,500
Energy Innovation Hub for Modeling and Simulation	3,118	0	0
Nuclear Science User Facilities	34,483	24,643	23,270
NEAMS Joint Modeling and Simulation Program	10,005	0	0
Transformational Challenge Reactor	0	950	950

Joint Modeling and Simulation Program	0	9,488	9,000
Nuclear Energy Enabling Technologies	62,966	49,956	43,720
Light Water Reactor Sustainability	18,895	18,785	15,000
Advanced Reactor Technologies	38,393	31,253	30,000
Versatile Advanced Test Reactor	57,763	44,120	0
Advanced SMR R&D	11,938	10,265	150
Reactors Concepts RD&D	126,989	104,423	45,150
National Reactor Innovation Center	0	19,500	9,750
Regulatory Development	0	6,625	3,300
Advanced Reactors Demonstration Program	0	26,125	13,050
Research Reactor Infrastructure	8,951	8,929	11,443
Radiological Facilities Management	8,951	8,929	11,443
INL Operations and Infrastructure	280,190	272,604	201,500
16-E-200 Sample Preparation Laboratory	30,000	25,450	18,000
Construction - Idaho Facilities Managment	30,000	25,450	18,000
Idaho Facilities Management	310,190	298,054	219,500
Safeguards and Security - Nuclear Energy - 9000988	142,191	149,111	133,753
Safeguards and Security - Nuclear Energy	142,191	149,111	133,753
Idaho Sitewide Safeguards and Security	142,191	149,111	133,753
Program Direction - Nuclear Energy - 9001019	1,109	2,039	1,294
Program Direction - Nuclear Energy	1,109	2,039	1,294
Integrated University Program	0	6	0
International Nuclear Energy Cooperation	938	0	0
Mining, Conversion, and Transportation	0	900	450
Fuel Cycle Research and Development Mining and Conversion FCRD	0	900	450
Accident Tolerant Fuels	0	15,975	7,542
Triso Fuel and Graphite Qualification	0	20,081	22,850
Total Advanced Fuels	0	36,056	30,392
Fuel Cycle Research and Development	57,707	0	0
Fuel Cycle Laboratory R&D	0	6,489	187
Used Nuclear Fuel Disposition R&D	0	1,000	1,000
Integrated Waste Management System	0	200	0
Fuel Cycle Research and Development FCRD	57,707	44,645	32,029
Total Idaho National Laboratory	**711,041**	**683,288**	**499,939**

Idaho Operations Office

Crosscutting Technology Development	5,170	180	180
Energy Innovation Hub for Modeling and Simulation	90	0	0
Nuclear Science User Facilities	180	180	180
NEAMS Joint Modeling and Simulation Program	1,464	0	0
Joint Modeling and Simulation Program	0	7,000	9,000
Nuclear Energy Enabling Technologies	6,904	7,360	9,360
Light Water Reactor Sustainability	6,601	6,700	5,000
Advanced Reactor Technologies	21,286	2,830	12,000
Versatile Advanced Test Reactor	2,350	0	0
Advanced SMR R&D	50,200	78,430	8,850
Reactors Concepts RD&D	80,437	87,960	25,850
Demonstration 1	0	79,500	0
Demonstration 2	0	79,500	0
Risk Reduction for Future Demonstration	0	29,500	0
Advanced Reactors Demonstration Program	0	188,500	0
Research Reactor Infrastructure	42	42	42
Radiological Facilities Management	42	42	42
INL Operations and Infrastructure	7,215	6,360	6,000
Idaho Facilities Management	7,215	6,360	6,000
Safeguards and Security - Nuclear Energy - 9000988	3,647	3,900	3,697
Safeguards and Security - Nuclear Energy	3,647	3,900	3,697
Idaho Sitewide Safeguards and Security	3,647	3,900	3,697
Program Direction - Nuclear Energy - 9001019	30,864	31,424	30,546
Program Direction - Nuclear Energy	30,864	31,424	30,546
Integrated University Program	5,000	4,978	0
International Nuclear Energy Cooperation	1,444	0	0

Materials Recovery and Waste Form Development (MRWFD)	0	20,072	8,029
Material recovery and waste form development	0	20,072	8,029
Accident Tolerant Fuels	0	50,898	19,000
Total Advanced Fuels	0	50,898	19,000
Fuel Cycle Research and Development	66,868	0	0
Used Nuclear Fuel Disposition R&D	0	6,000	6,000
Integrated Waste Management System	0	4,150	0
Fuel Cycle Research and Development FCRD	66,868	81,120	33,029
Total Idaho Operations Office	**202,421**	**411,644**	**108,524**

Lawrence Berkeley National Laboratory

NEAMS Joint Modeling and Simulation Program	200	0	0
Joint Modeling and Simulation Program	0	200	200
Nuclear Energy Enabling Technologies	200	200	200
Program Direction - Nuclear Energy - 9001019	120	0	0
Program Direction - Nuclear Energy	120	0	0
Fuel Cycle Research and Development	2,808	0	0
Used Nuclear Fuel Disposition R&D	0	3,750	3,750
Fuel Cycle Research and Development FCRD	2,808	3,750	3,750
Total Lawrence Berkeley National Laboratory	**3,128**	**3,950**	**3,950**

Lawrence Livermore National Laboratory

Crosscutting Technology Development	45	0	0
Energy Innovation Hub for Modeling and Simulation	248	0	0
Nuclear Science User Facilities	146	50	50
NEAMS Joint Modeling and Simulation Program	379	0	0
Joint Modeling and Simulation Program	0	100	100
Nuclear Energy Enabling Technologies	818	150	150
Advanced Reactor Technologies	0	0	50
Reactors Concepts RD&D	0	0	50
Regulatory Development	0	75	50
Advanced Reactors Demonstration Program	0	75	50
Fuel Cycle Research and Development	583	0	0
Used Nuclear Fuel Disposition R&D	0	750	750
Fuel Cycle Research and Development FCRD	583	750	750
Total Lawrence Livermore National Laboratory	**1,401**	**975**	**1,000**

Livermore Site Office

Advanced Reactor Technologies	50	50	0
Reactors Concepts RD&D	50	50	0
Total Livermore Site Office	**50**	**50**	**0**

Los Alamos National Laboratory

Crosscutting Technology Development	1,000	0	0
Energy Innovation Hub for Modeling and Simulation	615	0	0
Nuclear Science User Facilities	0	50	50
NEAMS Joint Modeling and Simulation Program	2,853	0	0
Joint Modeling and Simulation Program	0	2,628	2,600
Nuclear Energy Enabling Technologies	4,468	2,678	2,650
Advanced Reactor Technologies	4,862	4,260	4,000
Versatile Advanced Test Reactor	260	2,000	0
Reactors Concepts RD&D	5,122	6,260	4,000
Accident Tolerant Fuels	0	3,582	1,000
Total Advanced Fuels	0	3,582	1,000
Fuel Cycle Research and Development	12,335	0	0
Fuel Cycle Laboratory R&D	0	2,600	1,000
Used Nuclear Fuel Disposition R&D	0	3,500	3,000
Fuel Cycle Research and Development FCRD	12,335	9,682	5,000
Total Los Alamos National Laboratory	**21,925**	**18,620**	**11,650**

National Energy Technology Lab			
Crosscutting Technology Development	55	0	0
Nuclear Energy Enabling Technologies	55	0	0
Program Direction - Nuclear Energy - 9001019	26	0	0
Program Direction - Nuclear Energy	26	0	0
International Nuclear Energy Cooperation	100	0	0
Total National Energy Technology Lab	**181**	**0**	**0**
National Renewable Energy Laboratory			
Program Direction - Nuclear Energy - 9001019	0	100	0
Program Direction - Nuclear Energy	0	100	0
Total National Renewable Energy Laboratory	**0**	**100**	**0**
Naval Reactors Laboratory Field Office			
Fuel Cycle Research and Development	709	0	0
Used Nuclear Fuel Disposition R&D	0	1,400	0
Fuel Cycle Research and Development FCRD	709	1,400	0
Total Naval Reactors Laboratory Field Office	**709**	**1,400**	**0**
Nevada Field Office			
Program Direction - Nuclear Energy - 9001019	2,116	1,731	1,914
Program Direction - Nuclear Energy	2,116	1,731	1,914
Total Nevada Field Office	**2,116**	**1,731**	**1,914**
Oak Ridge National Laboratory			
Crosscutting Technology Development	1,035	60	60
Energy Innovation Hub for Modeling and Simulation	19,381	0	0
Nuclear Science User Facilities	6,524	1,250	1,200
NEAMS Joint Modeling and Simulation Program	1,538	0	0
Transformational Challenge Reactor	0	17,000	22,550
Joint Modeling and Simulation Program	0	1,080	2,000
Nuclear Energy Enabling Technologies	28,478	19,390	25,810
Light Water Reactor Sustainability	6,612	6,635	5,000
Advanced Reactor Technologies	17,382	3,983	5,000
Versatile Advanced Test Reactor	45	1,800	0
Advanced SMR R&D	17,450	0	0
Reactors Concepts RD&D	41,489	12,418	10,000
Regulatory Development	0	2,000	1,000
Advanced Reactors Demonstration Program	0	2,000	1,000
Oak Ridge Nuclear Infrastructure	19,985	19,957	0
Radiological Facilities Management	19,985	19,957	0
Program Direction - Nuclear Energy - 9001019	250	266	120
Program Direction - Nuclear Energy	250	266	120
International Nuclear Energy Cooperation	146	0	0
Materials Recovery and Waste Form Development (MRWFD)	0	1,100	440
Material recovery and waste form development	0	1,100	440
Accident Tolerant Fuels	0	4,628	1,000
Triso Fuel and Graphite Qualification	0	1,769	1,880
Total Advanced Fuels	0	6,397	2,880
Fuel Cycle Research and Development	25,152	0	0
Fuel Cycle Laboratory R&D	0	1,590	225
Used Nuclear Fuel Disposition R&D	0	5,500	5,000
Integrated Waste Management System	0	7,500	0
Fuel Cycle Research and Development FCRD	25,152	22,087	8,545
Total Oak Ridge National Laboratory	**115,500**	**76,118**	**45,475**
Oak Ridge Office			
Program Direction - Nuclear Energy - 9001019	1,819	1,832	1,862
Program Direction - Nuclear Energy	1,819	1,832	1,862

Civil Nuclear Enrichment	0	40,000	40,000
Material recovery and waste form development	0	40,000	40,000
Fuel Cycle Research and Development	30,200	0	0
Fuel Cycle Research and Development FCRD	30,200	40,000	40,000
Total Oak Ridge Office	**32,019**	**41,832**	**41,862**

Pacific Northwest National Laboratory			
Crosscutting Technology Development	1,430	30	30
Nuclear Science User Facilities	0	50	50
Nuclear Energy Enabling Technologies	1,430	80	80
Advanced Reactor Technologies	500	580	600
Versatile Advanced Test Reactor	0	1,000	0
Advanced SMR R&D	277	0	0
Reactors Concepts RD&D	777	1,580	600
Regulatory Development	0	1,100	550
Advanced Reactors Demonstration Program	0	1,100	550
Program Direction - Nuclear Energy - 9001019	0	158	195
Program Direction - Nuclear Energy	0	158	195
International Nuclear Energy Cooperation	158	0	0
Mining, Conversion, and Transportation	0	0	450
Fuel Cycle Research and Development Mining and Conversion FCRD	0	0	450
Materials Recovery and Waste Form Development (MRWFD)	0	1,010	404
Material recovery and waste form development	0	1,010	404
Fuel Cycle Research and Development	14,840	0	0
Fuel Cycle Laboratory R&D	0	1,140	171
Used Nuclear Fuel Disposition R&D	0	9,000	9,000
Integrated Waste Management System	0	3,500	0
Fuel Cycle Research and Development FCRD	14,840	14,650	10,025
Total Pacific Northwest National Laboratory	**17,205**	**17,568**	**11,450**

Sandia National Laboratories			
Crosscutting Technology Development	1,868	1,875	1,875
Energy Innovation Hub for Modeling and Simulation	978	0	0
Nuclear Science User Facilities	0	50	50
NEAMS Joint Modeling and Simulation Program	100	0	0
Joint Modeling and Simulation Program	0	100	100
Nuclear Energy Enabling Technologies	2,946	2,025	2,025
Light Water Reactor Sustainability	1,285	1,285	825
Advanced Reactor Technologies	175	560	2,200
Reactors Concepts RD&D	1,460	1,845	3,025
Advanced Reactors Safeguards	0	4,000	2,000
Advanced Reactors Demonstration Program	0	4,000	2,000
Program Direction - Nuclear Energy - 9001019	0	15	0
Program Direction - Nuclear Energy	0	15	0
International Nuclear Energy Cooperation	15	0	0
STEP R&D	4,760	4,760	0
Fuel Cycle Research and Development	22,490	0	0
Fuel Cycle Laboratory R&D	0	1,024	500
Used Nuclear Fuel Disposition R&D	0	19,000	19,000
Integrated Waste Management System	0	4,750	0
Fuel Cycle Research and Development FCRD	22,490	24,774	19,500
Total Sandia National Laboratories	**31,671**	**37,419**	**26,550**

Savannah River National Laboratory			
Versatile Advanced Test Reactor	0	500	0
Reactors Concepts RD&D	0	500	0
Fuel Cycle Research and Development	220	0	0
Fuel Cycle Research and Development FCRD	220	0	0
Total Savannah River National Laboratory	**220**	**500**	**0**

Savannah River Operations Office			
Fuel Cycle Research and Development	3,996	0	0
Used Nuclear Fuel Disposition R&D	0	1,600	1,500
Integrated Waste Management System	0	2,900	0
Fuel Cycle Research and Development FCRD	3,996	4,500	1,500
Total Savannah River Operations Office	**3,996**	**4,500**	**1,500**
Washington Headquarters			
Crosscutting Technology Development	20,932	7,650	15,325
Energy Innovation Hub for Modeling and Simulation	3,155	0	0
Nuclear Science User Facilities	1,715	2,027	1,900
NEAMS Joint Modeling and Simulation Program	8,577	0	0
Transformational Challenge Reactor	0	3,000	4,000
Joint Modeling and Simulation Program	0	9,170	1,766
Nuclear Energy Enabling Technologies	34,379	21,847	22,991
Light Water Reactor Sustainability	13,457	13,545	4,625
Advanced Reactor Technologies	19,150	3,000	6,000
Versatile Advanced Test Reactor	3,479	8,580	0
Advanced SMR R&D	18,792	11,305	1,000
Reactors Concepts RD&D	54,878	36,430	11,625
Other Project Costs	0	0	33,000
21-E-200, VTR Project	0	0	262,000
Versatile Test Reactor Project	0	0	295,000
National Reactor Innovation Center	0	500	250
Demonstration 1	0	500	0
Demonstration 2	0	500	0
Risk Reduction for Future Demonstration	0	500	0
Advanced Reactors Safeguards	0	1,000	500
Advanced Reactors Demonstration Program	0	3,000	750
Research Reactor Infrastructure	7	29	15
Oak Ridge Nuclear Infrastructure	15	43	0
Radiological Facilities Management	22	72	15
INL Operations and Infrastructure	595	1,036	500
Idaho Facilities Management	595	1,036	500
Safeguards and Security - Nuclear Energy - 9000988	252	397	350
Safeguards and Security - Nuclear Energy	252	397	350
Idaho Sitewide Safeguards and Security	252	397	350
Program Direction - Nuclear Energy - 9001019	43,571	42,145	39,015
Program Direction - Nuclear Energy	43,571	42,145	39,015
Integrated University Program	0	16	0
International Nuclear Energy Cooperation	109	0	0
STEP R&D	240	240	0
Mining, Conversion, and Transportation	0	1,100	1,100
Fuel Cycle Research and Development Mining and Conversion FCRD	0	1,100	1,100
Materials Recovery and Waste Form Development (MRWFD)	0	7,115	2,846
Material recovery and waste form development	0	7,115	2,846
Accident Tolerant Fuels	0	19,805	7,458
Triso Fuel and Graphite Qualification	0	7,650	8,670
Total Advanced Fuels	0	27,455	16,128
Fuel Cycle Research and Development	15,754	0	0
Fuel Cycle Laboratory R&D	0	3,974	746
Used Nuclear Fuel Disposition R&D	0	9,000	9,000
Fuel Cycle Research and Development FCRD	15,754	48,644	29,820
Total Washington Headquarters	**149,800**	**153,827**	**400,066**

Fossil Energy Research and Development

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FOSSIL ENERGY RESEARCH AND DEVELOPMENT
PROPOSED APPROPRIATION LANGUAGE

For Department of Energy expenses necessary in carrying out fossil energy research and development activities, under the authority of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition of interest, including defeasible and equitable interests in any real property or any facility or for plant or facility acquisition or expansion, and for conducting inquiries, technological investigations and research concerning the extraction, processing, use, and disposal of mineral substances without objectionable social and environmental costs (30 U.S.C. 3, 1602, and 1603), [$750,000,000] $730,601,000, to remain available until expended: *Provided*, That of such amount [$61,850,000] $62,451,000 shall be available until September 30, [2021] 2022, for program direction.
(Energy and Water Development and Related Agencies Appropriations Act, 2021.)

Public Law Authorizations

CCS and Power Systems:

- Public Law 95-91.

Natural Gas Technologies:

- Public Law 91-91, "Department of Energy Organization Act", 1977
- Public Law 109-58, "Energy Policy Act of 2005".

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies:

- Public Law 95-91, "Department of Energy Organization Act", 1977
- Public Law 109-58, "Energy Policy Act of 2005".

NETL Infrastructure and Operations/Plant and Capital Equipment (formerly Plant and Capital Equipment):

- Public Law 95-91, "Department of Energy Organization Act", 1977
- Public Law 108-153, "21st Century Nanotechnology Research and Development Act 2003"
- Public Law 109-58, "Energy Policy Act of 2005".
- Public Law 110-69, "America COMPETES Act of 2007"
- Public Law 110-140, "Energy Independence and Security Act 2007"
- Public Law 111-358, "America COMPETES Act of 2010"

NETL Infrastructure and Operations /Environmental Restoration (formerly Environmental Restoration):

- Public Law 95-91, "Department of Energy Organization Act", 1977
- Public Law 108-153, "21st Century Nanotechnology Research and Development Act 2003"
- Public Law 109-58, "Energy Policy Act of 2005".
- Public Law 110-69, "America COMPETES Act of 2007"
- Public Law 111-358, "America COMPETES Act of 2010"

Special Recruitment Programs:

- Public Law 95-91, "Department of Energy Organization Act", 1977
- Public Law 108-153, "21st Century Nanotechnology Research and Development Act 2003"
- Public Law 109-58, "Energy Policy Act of 2005".
- Public Law 110-69, "America COMPETES Act of 2007"

Public Law 111-358, "America COMPETES Act of 2010"

Fossil Energy Research and Development
(FER&D)
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
740,000	750,000	730,601	-19,399

Overview

The Fossil Energy Research and Development (FER&D) program offices advance transformative science and innovative technologies that enable the reliable, efficient, affordable, and environmentally sound use of fossil fuels. Fossil energy sources constitute over 77% of the country's total energy use,[1] and are critical to the nation's security, economic prosperity and growth. FER&D conducts research and development (R&D) on advanced fossil energy systems, crosscutting fossil energy research, and Carbon Capture Utilization and Storage (CCUS) technologies. FER&D also conducts research related to the prudent and sustainable development of domestic oil and gas resources, with a focus on natural gas technologies and unconventional resources. Finally, FER&D includes funding for the research, operations, and infrastructure of the National Energy Technology Laboratory (NETL).

The Office of Fossil Energy invests in research and development as part of the Department of Energy's (DOE) broad portfolio approach to addressing our Nation's energy and environmental challenges. This Budget Request focuses DOE resources toward early-stage R&D and reflects an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies. It emphasizes energy technologies best positioned to support American energy independence and domestic job-growth in the near- to mid-term. Funding for FER&D will enable the discovery, integration, and maturity of technology solutions to enhance the nation's energy foundation and protect the environment for future generations.

FER&D early-stage research focuses on technology challenges that present a significant degree of scientific or technical uncertainty across a relatively long period, making it unlikely that industry will invest significant R&D on their own. Industry typically focuses on near term (2-4 years) investments in marginal improvements to operational performance, while FER&D early-stage R&D focuses on longer-range (5-15 years) transformational technologies, materials, and processes. Thus, this request maintains the most critical core capabilities and infrastructure at DOE National Laboratories related to advanced fossil energy technologies.

The FER&D FY 2021 Budget Request is informed by guiding principles of energy dominance, security, strong domestic energy production, and advancing clean coal technologies through early stage R&D to revitalize the coal industry. Driven by the Administration's support of the coal industry and the competitiveness of the existing coal fleet, the FER&D budget focuses on cutting edge, early-stage R&D that will prepare innovative new technologies for the private sector to further develop, scale-up, and deploy. R&D will advance small-scale modular coal plants of the future, which are highly efficient and flexible, with zero or near-zero emissions, and develop next-generation materials, components, and systems to improve the performance, reliability, and efficiency of the existing coal-fired fleet. Maintaining U.S. global economic competiveness with the best energy technologies and affordable energy prices is essential to strengthen and grow our economy, create new jobs, and enhance our national security. Developing advanced, clean, high-efficiency technologies underpins our national economy and creates new products for export. The FER&D Office priorities follow:

- **Develop the Coal Plants of the Future:** Advancing small-scale modular coal plants of the future, which are highly efficient and flexible, with zero or near-zero emissions
- **Modernize the Existing Coal Fleet:** Improving the performance, reliability, and efficiency of the existing coal-fired fleet
- **Reduce the Cost of CCUS:** Reducing the cost and risk of CCUS to enable wider commercial deployment
- **Expand the Use of Big Data by leveraging Artificial Intelligence:** Optimizing coal plant performance, CO_2 sequestration, and the recovery of oil and gas resources with real-time analysis informed by machine learning

[1] https://www.eia.gov/todayinenergy/detail.php?id=26912

- **Energy Water Nexus:** Improving our efficient use of scarce water resources
- **Advance Rare Earth Elements, Critical Materials, and Coal Products Technologies:** Developing REE separation and recovery technologies and processes to manufacture valuable products from coal, to address current global market and process economics

Highlights and Major Changes in the 2021 Budget Request

The FER&D FY 2021 Budget Request focuses resources on impactful early-stage research and development that enables domestic energy production and enhances energy security and independence. After initial investment by FER&D, these technologies will then be poised for further advancement, development, and/or scale-up by industry. These investments will drive innovation to support economic growth and provide affordable, reliable, and environmentally sustainable energy. The Office of Fossil Energy will also continue the Department's initiative on streamlining the program to become more accountable and efficient, examining organizational efficiencies at both headquarters and NETL.

The proposed restructure of the Advanced Energy Systems (AES) and Carbon, Capture, Utilization & Storage (CCUS) accounts within FER&D is designed to create better alignment between program budget structure and DOE-FE's programmatic and research priorities to more efficiently support early-stage, transformational R&D that has the potential to modernize our fossil generation infrastructure, provide economic benefits to consumers, and provide resiliency to the grid. With better alignment, DOE is able to more effectively manage its programs, projects, and day-to-day R&D activities. It also more clearly links the funding and related authorized work to measurable program outcomes as reflected in the FE Strategic Vision. A funding crosswalk in the "Budget Structure Crosswalks" chapter of this narrative provides details of the proposed changes.

For comparability, all discussions of funding changes that follow assume the FY 2021 proposed budget structure. Funding crosswalks in the Budget Structure Crosswalks chapter of this narrative provide details of the proposed changes.

Advanced Coal Energy Systems & CCUS ($546.15M)
Descriptions of major funding and programmatic changes and highlights within the Advanced Coal Energy Systems & CCUS program for FY 2021 are as follows:

Advanced Energy Systems (AES) ($321.90M):

The FY 2021 Budget provides $321.90 million to enhance the mission of the Advanced Energy Systems (AES) subprogram to increase the availability, efficiency, and reliability of fossil energy power systems while maintaining environmental standards through early-stage R&D. Specific efforts will focus on seven activities:

- Gasification Systems activities will develop modular technologies that could overcome siting, operating, and logistical constraints that inhibit the deployment of large scale plants. The budget also provides funding to continue R&D on innovative design development for a high-performance, low-cost gasifier as well as advance designs and fabrication of form refractories to provide better heat and temperature distribution inside a gasifier and lower capital costs.
- Advanced Turbines activities will focus on competitively funded new awards with industry to develop advanced steam turbines as well as sCO_2 turbines. The budget also provides funding to advance early-stage pressure gain combustion R&D with the DOE National Laboratories. These activities will include research on key turbine system components that, with additional development by industry, could be capable of achieving a 4-5 percentage point efficiency increase relative to existing combined cycle turbines.
- Solid Oxide Fuel Cells (SOFC) activities will focus on advancing R&D with the DOE National Laboratories that addresses the technical challenges to SOFC commercialization, such as cell power enhancement, advanced materials development for low temperature operation, materials characterization, and systems analysis.
- Advanced Sensors and Controls activities will focus on advanced controls, harsh environment sensors, and load following systems. Novel instrumentation that can withstand harsh environments has the ability to replace inferred process conditions with actual measurements which can facilitate faster/safer response times. In addition, the budget provides support for National Laboratory R&D to test lab-scale sensors in a relevant plant environment to enable technology transfer.

- Power Generation Efficiency activities will focus on continuing to fund ongoing projects for Coal FIRST (Flexible, Innovative, Resilient, Small, Transformative) initiative—to support R&D insights and integrated designs of the coal plant of the future needed to provide secure, stable, and reliable power. This initiative is focused on early stage R&D that benefits multiple technologies for use with different coal types and regions throughout the United States across a broader coal and power industry, including publically available reports on the results of the R&D. The R&D efforts will also support concepts that require longer term development through R&D on critical component design, and advanced engineering design methods (e.g., parametric approaches), advanced combustion, and engineering design. This program will also continue to fund long term advanced concepts at the national labs for advanced combustion systems.

- Advanced Energy Materials activities will focus on developing cost effective structural and functional materials for advanced fossil energy power production technologies, and to reduce the cost and time needed to develop and commercialize new materials for FE applications in extreme operating environments. These advancements are used to promote technologies that enhance plant optimization that reduce operations and maintenance costs of both existing coal-fired plants and new fossil energy infrastructure.
- Advanced Coal Processing will focus on converting coal to high value products, including high-performance carbon materials (carbon fibers etc.), and the development of Novel Lab/Bench-Scale Coal Utilization Technologies.

Crosscutting Research ($65.25M):

The FY 2021 Budget provides $65.25 million to support R&D that bridges basic and applied research by targeting concepts with the greatest potential for transformational breakthroughs. As such, the program focuses on advancing early-stage research in areas such as materials, rare earth recovery from coal and coal byproducts, fluid dynamics, and fuel preparation characteristics (i.e., coal particle sizing and drying). The program also aims to obtain new knowledge regarding plant phenomena and operation that can be incorporated into a new generation of plant control technologies. Specific efforts will focus on the following activities:

- Critical Minerals contains the Critical Materials Initiative, allowing DOE to continue developing technologies with the goal of enabling additional domestic supplies of Rare Earth Elements (REE) and critical materials (CM), reducing environmental impact of coal REE production, and delivering technologies that can be manufactured within the United States. DOE has accomplished much in this area, including the evaluation of pilot-scale processing options and the nature and distribution of REE in U.S. coal deposits.
- Water Management R&D Activities will focus on early-stage development of technologies that increase power plant efficiency and decrease water consumption; field testing of promising technologies that reduce the energy requirements and operating costs of waste water treatment for power plants. The budget also funds DOE National Laboratories to conduct techno-economic assessments to guide water management and to field test wastewater treatment technologies for fossil energy power plants that improve our understanding of the complex water issues facing today's coal fleet as it relates to energy production.
- Modeling, Simulation & Analysis comprises of modeling, simulation and techno-economic analysis to optimize—and reduce the cost—of areas such as water use, emissions, solid waste disposal, materials development, and power plant operations. This activity supports program strategic planning by identifying major challenges, technologies, and advanced concepts that have the potential to improve the efficiency, cost, and/or environmental performance of fossil energy systems.
- University Training and Research provides grants to colleges and universities to support research consistent with the goals of the Advanced Coal Energy Systems and CCUS program. This element provides a two-fold benefit: conducting directed energy research for the Department, and at the same time providing support for expanding the research capabilities and education of the next generation of scientists and engineers. The Historically Black Colleges and Universities (HBCU) and Minority Serving Institutions (MSI) education and training program awards research grants to qualifying universities and institutions, with project results being used to further DOE's commitment to fossil energy research.
- Advanced Energy Storage Initiative: A coordinated effort across DOE that will accelerate the development of energy storage and system flexibility technologies. Leveraging the full suite of DOE technologies, the Advanced Energy Storage Initiative will focus the Agency's efforts to take a more holistic and system-wide perspective to address emerging

challenges, improve the reliability and resilience of the electrical grid, and ensure the affordability and security of energy for transportation.

- International activities: In coordination with the Department's Office of International Affairs, support the deployment of U.S. technologies and fossil energy resources to international markets that are seeking advanced high efficiency power plants and carbon capture and utilization technologies. Funding will be used to support international efforts and technical studies with various partners in Europe, North America, Asia, and the Middle East through bi-lateral and multi-lateral agreements. Supports activities in the clean energy ministerial (CEM), IEA Greenhouse Gas R&D program (IEAGHG), IEA Clean Coal Centre (IEACCC), and Global Carbon Capture Storage Institute (GCCSI).

Carbon Capture, Utilization and Storage ($123.00M):

The CCUS subprogram focuses on early-stage research and development on post-combustion and pre-combustion CO_2 capture, CO_2 utilization technologies to convert CO_2 to valuable products and commodities, and carbon storage to ensure safe and secure geologic storage of CO_2. Specific efforts will focus on the following activities:

- Carbon Capture: FY 2021 activities represent a purposeful shift away from later-stage R&D such as development and scale-up of 2nd generation capture technologies through small and large pilot projects, as incentives exist for industry to adapt, develop, and scale these technologies for cost-competitive deployment. Specifically, in FY 2021, the Budget provides $74 million to the Carbon Capture activity for early-stage pre- and post-combustion capture R&D on transformational gas separation technologies (at least 90% of the CO_2 at 95% purity) that can significantly reduce the cost of CO_2 capture. The program will also leverage these efforts to reduce the cost of technologies that remove CO_2 directly from the atmosphere, i.e., direct air capture systems. Transformational capture systems are a set of disruptive technologies that can significantly reduce the cost of capture, targeting a cost of electricity (COE) at least 30% less than state of the art (~$30/tonne). These transformational technologies will be supportive of the Coal FIRST effort and are designed to adapt to the operational demands of advanced power systems and adjust to the increasing need for fossil fuel power plants to at times be load-following/demand responsive electricity generators. The activity will also investigate approaches to optimize the capture process.
- Carbon Utilization: The Budget provides $15 million to focus on early-stage CO_2 utilization technologies that develop additional markets for fossil energy resources. Areas of research include, but are not limited to, projects focused on the catalytic conversion to chemicals and polymers, mineralization to building products, and biological processes optimized for the conversion of coal based carbon (CO_2 and methane) to higher value products such as nutraceuticals, bio plastics, and animal feed.
- Carbon Storage: R&D activities will focus on development of various monitoring tools and utilization of advanced computational platforms such as machine learning that can lead to real-time decision-making capabilities. Technologies developed and validated through the Carbon Storage activity will improve storage efficiency, reduce overall cost, decrease subsurface uncertainties, and identify ways to ensure that operations are safe, economically viable, and environmentally benign.
- Emissions Control: The Budget provides $4 million to initiates new efforts on addressing non-CO_2 emissions (e.g., trace metals, etc.).

NETL Coal Research and Development ($36.00M):

- NETL Coal R&D: The request of $36 million funds the Federal costs for NETL's in-house research efforts. Specifically, the funding supports the NETL staff of scientists and engineers who conduct in-house research activities for FER&D programs, including salaries and benefits, travel, personal protective equipment, and other employee costs.

Natural Gas Technologies ($15.00M):

- The Natural Gas Infrastructure Research subprogram will focus on early-stage research on innovative sensors, materials, and systems that enable industry to detect and mitigate resource loss and improve the reliability and operational efficiency of natural gas supply and delivery infrastructure. The federal government will continue to have a significant role in addressing areas of public interest and concern, to include pipeline safety and reliability, resource stewardship, and infrastructure security. Additionally, the subprogram will develop new technologies to reduce flaring and venting of natural gas through conversion to high-value, transportable products or electricity.

- The Gas Hydrates subprogram, through DOE National Laboratory and university-led efforts, will continue early-stage R&D to evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates and the resulting resource, hazard, and environmental implications. In FY 2021, the subprogram will focus on fundamental laboratory based research while continuing to plan for a long-term reservoir response flow test on the Alaska North Slope in order to assess the viability of gas hydrates production as an energy resource.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies ($17.00M):

- The program will conduct field research to improve understanding of shale geology and fracture dynamics in key and emerging shales, to include the Marcellus, Utica, Eagle Ford, Appalachia, Delaware, Bakken, Alaska, and Tuscaloosa basins. These field projects conduct testing that aids research, modeling, and experimentation related to unconventional oil and natural gas development. This research addresses fluid flow and physio-chemical interactions in unconventional reservoirs, improves the technical understanding of fracturing dynamics that can contribute to increases in resource recovery factors. The program will conduct field and laboratory research to improve Enhanced Oil Recovery (EOR) methodologies, technologies, and processes in unconventional reservoirs.
- The program will also conduct improved subsurface characterization, visualization, and diagnostics, including the development of predictive models and simulations using high-performance computing.

National Energy Technology Laboratory ($117.51M for NETL; and an additional $34.94M for HQ Program Direction and Special Recruitment):

- The Office of Fossil Energy is committed to supporting the National Energy Technology Laboratory's (NETL) capabilities and competitiveness. NETL, whose primary funding source is the Office of Fossil Energy, is the only federally operated laboratory in the DOE National Laboratory system.

- NETL Infrastructure: The request of $43.10 million supports the fixed costs of maintaining NETL's lab footprint three geographic locations: Morgantown, WV; Pittsburgh, PA; and Albany, OR. These sites include approximately 240 acres of land, including 116 buildings with over 1,100,000 square feet of space.

- NETL Research and Operations: The request of $46.00 million supports NETL's science and technology development and commercialization functions, including technical program management and strategic scientific planning and partnerships. Specifically, funding supports the NETL staff of engineers, and technical project managers who conduct extramural research activities for FER&D programs, including salaries and benefits, travel, and other employee costs. This request also supports the variable operating costs of NETL's research sites.

- NETL and HQ Program Direction and Special Recruitment Programs: The request of $63.35 million ($34.04 million for headquarters, $28.41 million for NETL, and $0.9 million for Special Recruitment) provides for the FER&D organization's federal workforce and contractor support in the Washington, D.C. area including salaries and benefits, support service contracts, travel, training, the working capital fund, and other employee costs. These staff are responsible for the oversight and administration of the FER&D Programs and Natural Gas regulatory activities. In addition, funding for NETL federal technical staff and contractor support that provide Acquisition, Finance and Legal functions is supported.

Cybersecurity: DOE is engaged in two categories of cyber-related activities: protecting the DOE enterprise from a range of cyber threats that can adversely impact mission capabilities and improving cybersecurity in the electric power subsector and the oil and natural gas subsector. The Cybersecurity Crosscut supports central coordination of the strategic and operational aspects of cybersecurity and facilitates cooperative efforts such as the Joint Cybersecurity Coordination Center (JC3) for incident response and the implementation of Department-wide Identity, Credentials, and Access Management (ICAM).

FY 2021 Crosscuts ($K)

	Cybersecurity	Advanced Energy Storage Initiative	Total
NETL Infrastructure	4,772	0	4,772
Program Direction	1,170	0	1,170
Crosscutting Research	0	5,000	5,000
Total, Crosscuts	**5,942**	**5,000**	**10,942**

Fossil Energy Research and Development
Funding by Congressional Control ($K)
(Comparable)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Advanced Coal Energy Systems and CCUS				
Advanced Energy Systems	157,683	150,000	321,900	+171,900
Crosscutting Research	46,350	49,000	65,250	+16,250
Carbon Capture, Utilization and Storage	198,767	217,800	123,000	-94,800
Supercritical Transformational Electric Power (STEP)	22,430	16,000	0	-16,000
Transformational Coal Pilots	25,000	20,000	0	-20,000
NETL Coal Research and Development	36,000	38,000	36,000	-2,000
Subtotal, Advanced Coal Energy Systems and CCUS	**486,230**	**490,800**	**546,150**	**+55,350**
Natural Gas Technologies	51,000	51,000	15,000	-36,000
Unconventional Fossil Energy Technologies from Petroleum - Oil Technologies	46,000	46,000	17,000	-29,000
Program Direction	61,070	61,500	62,451	+951
Special Recruitment Programs	700	700	900	+200
NETL Infrastructure	45,000	50,000	43,100	-6,900
NETL Research and Operations	50,000	50,000	46,000	-4,000
Total, Fossil Energy Research & Development	**740,000**	**750,000**	**730,601**	**-19,399**
Federal FTEs	**630**	**657**	**679**	**+22**

Fossil Energy Research and Development
Funding by Congressional Control ($K)
(Non-Comparable)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Coal				
CCS AND POWER SYSTEMS				
Carbon Capture	100,671	117,800	0	-117,800
Carbon Storage	98,096	100,000	0	-100,000
Advanced Energy Systems	129,683	120,000	0	-120,000
Cross-cutting Research	56,350	56,000	0	-56,000
Supercritical Transformational Electric Power (STEP)	22,430	16,000	0	-16,000
Transformational Coal Pilots	25,000	20,000	0	-20,000
NETL Coal Research and Development	54,000	61,000	**0**	-61,000
Total, CCS and Power Systems	**486,230**	**490,800**	**0**	**-490,800**
Advanced Energy Systems	0	0	321,900	+321,900
Crosscutting Research	0	0	65,250	+65,250
Carbon Capture, Utilization and Storage	0	0	123,000	+123,000
Supercritical Transformational Electric Power (STEP)	0	0	0	0
Transformational Coal Pilots	0	0	0	0
NETL Coal Research and Development	0	0	36,000	+36,000
Total, Advanced Coal Energy Systems and CCUS	**0**	**0**	**546,150**	**+546,150**
Natural Gas Technologies	**51,000**	**51,000**	**15,000**	**-36,000**
Unconventional Fossil Energy Technologies from Petroleum - Oil Technologies	**46,000**	**46,000**	**17,000**	**-29,000**
Program Direction	**61,070**	**61,500**	**62,451**	**+951**
Special Recruitment Programs	**700**	**700**	**900**	**+200**
NETL Infrastructure	**45,000**	**50,000**	**43,100**	**-6,900**
NETL Research and Operations	**50,000**	**50,000**	**46,000**	**-4,000**
Total, Fossil Energy Research & Development	**740,000**	**750,000**	**730,601**	**-19,399**
Federal FTEs	**630**	**657**	**679**	**+22**

SBIR/STTR:

- FY 2019 Transferred: SBIR $17,745; STTR: $2,143
- FY 2020 Enacted: SBIR $13,270; STTR: $1,866
- FY 2021 Request: SBIR $13,415; STTR: $1,887

Budget Structure Crosswalk FY 2020 Enacted
Proposed FY 2021 Budget Structure
($'s in thousands)

		Advanced Coal Energy Systems & CCUS							
		Advanced Energy Systems							
		Advanced Systems				Advanced Materials			
	FY 2020 Enacted ($'s in thousands)	Advanced Combustion/ Gasification Systems	Advanced Turbines	Solid Oxide Fuel Cells	Advanced Sensors and Controls	Advanced Coal Processing	Power Generation Efficiency	Advanced Energy Materials	Total, Advanced Energy Systems
Current Budget Structure	***Advanced Energy Systems***								
	Advanced Combustion Systems	-	-	-	-	-	-	-	-
	Gasification Systems	10,000	-	-	-	-	-	-	**10,000**
	Advanced Turbines	-	25,000	-	-	-	-	-	**25,000**
	Solid Oxide Fuel Cells	-	-	21,000	-	-	-	-	**21,000**
	Advanced Coal Processing	-	-	-	-	30,000	-	-	**30,000**
	Transformative Power Generation	-	-	-	-	-	34,000	-	**34,000**
	Cross Cutting Research								
	Sensors and Controls	-	-	-	9,000	-	-	-	**9,000**
	Crosscutting Materials R&D	-	-	-	-	-	-	5,000	**5,000**
	Advanced Ultra Supercritical Materials R&D	-	-	-	-	-	-	16,000	**16,000**
	Total	**10,000**	**25,000**	**21,000**	**9,000**	**30,000**	**34,000**	**21,000**	**150,000**

Budget Structure Crosswalk FY 2020 Enacted
Proposed FY 2021 Budget Structure
($'s in thousands)

		Advanced Coal Energy Systems & CCUS						
		Crosscutting Research						
	FY 2020 Enacted ($'s in thousands)	Water Management R&D	Modeling, Simulation & Analysis	Advanced Energy Storage Initiative	Critical Minerals	University Training & Research	International Activities	Total, Crosscutting Research
Current Budget Structure	**Cross-cutting Research**							
	Plant Optimization Technologies							
	Sensors and Controls	-	-	-	-	-	-	-
	Crosscutting Materials R&D	-	-	-	-	-	-	-
	Advanced Ultra Supercritical Materials R&D	-	-	-	-	-	-	-
	Water Management R&D	9,000	-	-	-	-	-	**9,000**
	Coal Utilization Science							
	Simulation Based Engineering		6,800	-				**6,800**
	Computational System Dynamics	-	-	-	-	-	-	-
	Focus Area for Computational Energy Science	-	-	-	-	-	-	-
	Energy Analyses							
	Environmental Activities	-	-	-	-	-	-	-
	Technical and Economic Analyses	-	500	-	-	-	-	**500**
	International Activities	-	-	-	-	-	150	**150**
	University Training and Research							
	University Coal Research	-	-	-	-	3,000	-	**3,000**
	HBCUs, Education, and Training	-	-	-	-	2,050	-	**2,050**
	NETL Coal Research and Development	-	-	-	-	-	-	-
	Feasibility of Recovering REEs	-	-	-	23,000	-	-	**23,000**
	Advanced Energy Storage Initiative	-	-	4,500	-	-	-	**4,500**
	Total	**9,000**	**7,300**	**4,500**	**23,000**	**5,050**	**150**	**49,000**

Budget Structure Crosswalk FY 2020 Enacted
Proposed FY 2021 Budget Structure
($'s in thousands)

		Advanced Coal Energy Systems & CCUS						
		Carbon Capture, Utilization & Storage						
		Carbon Utilization	Carbon Capture		Carbon Storage		Emissions Control	
	FY 2020 Enacted ($'s in thousands)	Carbon Use and Reuse	Post-Combustion Capture Systems	Pre-Combustion Capture Systems	Storage Infrastructure	Advanced Storage R&D	Emissions Control	Total, Carbon Capture, Utilization & Storage
Current Budget Structure	***Carbon Capture***							
	Post-Combustion Capture Systems	-	108,800	-	-	-	-	**108,800**
	Pre-Combustion Capture Systems	-	-	6,000	-	-	-	**6,000**
	Carbon Storage							
	Storage Infrastructure	-	-	-	57,000	-	-	**57,000**
	Advanced Storage R&D	-	-	-	-	16,100	-	**16,100**
	Monitoring, Verification, Accounting, and Assessment	-	-	-	-	-	-	**-**
	Carbon Use and Reuse	21,000	-	-	-	-	-	**21,000**
	Sub-disciplinary Storage R&D	-	-	-	-	5,900	-	**5,900**
	Emissions Control	-	-	-	-	-	3,000	**3,000**
	Total	**21,000**	**108,800**	**6,000**	**57,000**	**22,000**	**3,000**	**217,800**

Budget Structure Crosswalk FY 2020 Enacted
Proposed FY 2021 Budget Structure
($'s in thousands)

		Advanced Coal Energy Systems & CCUS			
	FY 2020 Enacted ($'s in thousands)	**Supercritical Transformational Electric Power (STEP)**	**Transformational Coal Pilots**	**NETL Coal R&D**	**Total**
Current Budget Structure					
	Supercritical Transformational Electric Power (STEP)	16,000	-	-	**16,000**
	Transformational Coal Pilots	-	20,000	-	**20,000**
	NETL Coal Research and Development				
	NETL Coal R&D (Other)	-	-	38,000	**38,000**
	Total	**16,000**	**20,000**	**38,000**	**74,000**

Advanced Coal Energy Systems and CCUS
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
486,230	490,800	546,150	+55,350

Overview

Fossil fuels (coal, oil, and natural gas) will continue play a critical role in meeting the Nation's and world's energy needs including power generation. Coal is the Nation's most abundant domestic energy resource, and is an important part of the domestic energy mix, providing about 27% of the Nation's electricity and 38.5% globally. Fossil fuel power plants provide reliable, affordable electricity that powers homes, industry, businesses, and commerce and a significant portion of the country's manufacturing and industrial energy needs. When combined with natural gas, fossil fuels provide over 60% of U.S. electricity.

The Advanced Coal Energy Systems & Carbon Capture, Utilization and Storage (CCUS) program invests in early-stage energy technologies that improve the affordability, competitiveness, and environmental performance of domestic coal-fired power generation; improve electric grid reliability and resilience; develop technologies to convert extract critical minerals from coal and coal by-products; convert coal to value-added products. The program develops transformational energy technologies as part of the Administration's all-of–the-above energy portfolio that enables greater private-sector participation in driving market outcomes to enhance America's competitiveness.

The program's research and development (R&D) focus is early-stage technologies that have the potential to improve the competitiveness and performance of both new and existing fossil-fired plants and open new markets for coal products. The U.S. coal fleet is aging, and less efficient coal plants are shutting down and retiring at unprecedented rates, a challenge exacerbated by the current economic pressures on the coal sector. These retirements negatively impact the overall resiliency and reliability of the electric power grid. Government-supported early-stage R&D in areas such as next-generation materials, advanced power cycles and power generation components, environmental controls, and novel plant controls can help to improve the efficiency and performance of these aging systems, which industry can further develop or deploy. Such advancements are critical to maintaining the grid's resiliency and reliability.

The coal fleet of the future will need to meet the demands of an increasingly complex 21st century energy system. As a result, coal-fired electricity generating units will benefit from the following traits:

- Zero or near-zero emissions including carbon dioxide or even negative emissions when combined with biomass co-firing
- High overall plant efficiency (40%+ HHV or higher at full load, with minimal reductions in efficiency over the required generation range)
- Small, high-quality, low-cost units (50 MW to 350 MW) that minimize field construction time
- Ramp rates and minimum loads compatible with 2050 estimates of renewable energy integration
- Integration with thermal or other energy storage (e.g., chemical production) to mitigate inefficiencies and equipment damage
- Minimized water consumption
- Accelerated design, construction, and commissioning schedules
- Enhanced maintenance features, including technology advances with monitoring and diagnostics to reduce downtime
- Integration with coal upgrading, or other plant value streams (e.g., co-production)
- Capable of natural gas co-firing

The FY 2021 Advanced Coal Energy Systems and CCUS Budget Request of $546.15 million will continue to support early-stage, transformational R&D that has the potential to modernize our fossil generation infrastructure, provide economic benefits to consumers, and provide resiliency to the grid. The request emphasizes R&D that will advance the following priorities:

- **Improving the performance, reliability, and efficiency of the existing coal-fired fleet.** R&D is essential to address performance concerns at the unit, plant, and grid level, caused by aging or increased time spent in cycling mode. More cycling leads to less economic units, lower efficiency, and more stress on equipment, leading to a shortened expected plant life which reduces the reliability and resiliency of the electric power generation system. Developing advanced methods and equipment that reduce the costs and waste from existing environmental control processes will also improve their reliability, cost and efficiency of the existing fleet.
- **Developing technologies that will underpin the coal plant of the future.** The coal plant of the future will need to be small (50 to 350 MW), highly efficient, flexible, reliable, and environmentally responsible to compete with other sources of power generation. The program's Coal FIRST (Flexible, Innovative, Resilient, Small, and Transformative) initiative will develop technologies for future plants and provide secure, stable, and reliable power. This early-stage R&D will underpin coal-fired power plants that are capable of flexible operations to meet the needs of the grid; use innovative and cutting-edge components that improve efficiency and reduce emissions; provide resilient power to Americans; are small compared to today's conventional utility-scale coal; and will transform how coal technologies are designed and manufactured. Technologies developed through this program will not only benefit the U.S. coal fleet, but also provide export opportunities to a number of overseas markets.
- **Reducing the cost of carbon capture.** Cost-competitive carbon capture technologies have the potential to support the fossil sector while advancing U.S. leadership in high efficiency, low-emission (HELE) generation technologies. Further, R&D that reduces the cost of carbon capture technologies can be applied to both the existing fleet of fossil fuel-fired plants, new plants, other industrial facilities, and removal from the atmosphere.
- **Creating new market opportunities for coal.** This request also advances efforts to create additional market opportunities for coal, including developing products from coal and carbon dioxide (CO_2). In addition, the request supports the extraction of critical minerals and rare earth elements from coal and its byproducts, creating new economic opportunities for the coal sector.

To ensure that investments across the Department are efficiently leveraged and coordinated, the FY 2021 Budget Request also includes the Advanced Energy Storage Initiative(AESI), an intra-Departmental initiative, which aligns shared R&D across the Offices of Fossil Energy, Electricity, and Energy Efficiency and Renewable Energy in energy storage. Further details can be found in the Crosscutting Research section.

The proposed restructure of the Advanced Energy Systems (AES) and Carbon, Capture, Utilization & Storage (CCUS) accounts within FER&D is designed to create better alignment between program budget structure and DOE-FE's programmatic and research priorities to more efficiently support early-stage, transformational R&D that has the potential to modernize our fossil generation infrastructure, provide economic benefits to consumers, and provide resiliency to the grid. With better alignment, DOE is able to more effectively manage its programs, projects, and day-to-day R&D activities. It also more clearly links the funding and related authorized work to measurable program outcomes as reflected in the FE Strategic Vision. A funding crosswalk in the "Budget Structure Crosswalks" chapter of this narrative provides details of the proposed changes.

Highlights of the FY 2021 Budget Request

The Advanced Coal Energy Systems & CCUS program will pursue the following major activities in FY 2021:

Advanced Energy Systems

The mission of the Advanced Energy Systems (AES) subprogram is to increase the availability, efficiency, and reliability of fossil energy power systems while maintaining environmental standards. Early-stage R&D will focus on developing and

testing power plant components; novel combustion processes; advanced coal processing; and advanced materials for components, turbines, and fuel cells that will improve the competitiveness of new and existing coal-fired power plants. Development of advanced coal power plants of the future will restore U.S. technical leadership in this area while maintaining the required technical advancements to service the existing fleet for grid stability.

Specific efforts will focus on seven R&D activities: 1) Advanced Combustion/Gasification Systems, 2) Advanced Turbines, 3) Solid Oxide Fuel Cells, 4) Advanced Sensors and Controls and Other Novel Concepts, 5) Advanced Coal Processing 6) Advanced Energy Materials, and 7) Power Generation Efficiency. R&D advances in these areas will support performance improvements for the existing coal fleet, which in turn can also apply to the future fleet. Two key goals of the AES subprogram are to improve the average modeled efficiency (heat rate) of a typical plant in the existing fleet by 5% (i.e., to 32.5% from the 2017 baseline of 31%) by the end of FY 2022, and of an advanced or new coal plant by 5+% by the end of FY 2023 (i.e., to 40+% from the 2017 baseline of 38% of the most recently constructed plants). Further, while the primary focus is on coal-based power systems, improvements to these technologies are also accretive to other fossil energy systems.

Crosscutting Research

The Crosscutting Research subprogram advances and accelerates promising fossil energy technology by supporting innovative early-stage R&D that improves the reliability, availability, efficiency, and environmental performance of advanced fossil-based power systems. The program also aims to obtain new knowledge regarding plant performance and operation that can be incorporated into a new generation of plant control technologies. Crosscutting Research is focused on six activities: 1) Critical Minerals (CM), 2) Water Management R&D, 3) Modeling, Simulation and Analysis, 4) Advanced Energy Storage Initiative (AESI), 5) University Training and Research (UTR), which comprises funding for University Coal Research (UCR), Historically Black Colleges and Universities (HBCU) and other Minority-Serving Institutions (MSI), and 6) International Activities.

Carbon Capture, Utilization & Storage

The CCUS subprogram is focused on early-stage R&D that 1) reduces the cost of capturing CO_2 from fossil, industrial sources, as well as directly from the atmosphere, enabling cost-effective low- and negative-carbon emissions from fossil energy use; 2) advances approaches to safely and securely store CO_2 underground long-term; and 3) advances novel approaches to using CO_2, such as developing value-added products and fuels. More specifically, carbon capture R&D is focused on the development of transformational CO_2 separation technologies—membranes, sorbents, solvents, and cryogenic—for both pre- and post-combustion coal-fired power plants systems that ultimately will capture CO_2 at approximately $30 per ton. The program will also leverage its previous and existing CCUS R&D efforts for other applications such as natural gas power, industrial sources, and negative emissions technologies such as direct air capture. Many of the technologies developed for pre- and post-combustion carbon capture can be applied to these sectors. Carbon utilization R&D is focused on using captured CO_2 and/or carbon-containing substances, or directly using CO_2 from flue gas or other gas streams, and converting it into valuable products. Carbon storage R&D supports the development and testing of advanced sensing and data telemetry capabilities, fault/fracture network characterization, stress state, fluid/pressure migration, and wellbore integrity that advanced real-time, decision-making capabilities. A goal of the CCUS subprogram is to support a new coal-fired plant with CO_2 capture at a cost of electricity at least 30% lower than a supercritical pulverized coal (PC) with CO_2 capture, or approximately $30 per ton of CO_2 captured by 2030. For existing plant retrofits, the subprogram's goal is to reduce the cost of capture by 30% (actual cost of capture varies for each unit).

In FY 2021, the CCUS subprogram will develop new and innovative technologies to improve the operations and economics of CCUS for power, industrial and negative emissions technologies; to improve plant and process efficiency, and reduce the costs and environmental impacts of non-CO_2 emissions from coal-fired power plants (e.g., trace metals emissions in solid, liquid and gaseous effluents) to improve their competitiveness.

Advanced Coal Energy Systems & CCUS
Funding by Congressional Control ($K)
(Comparable)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Advanced Coal Energy Systems & CCUS				
Advanced Energy Systems				
Advanced Gasification Systems	18,000	10,000	7,800	-2,200
Advanced Turbines	20,000	25,000	9,200	-15,800
Solid Oxide Fuel Cells	30,000	21,000	1,900	-19,100
Advanced Sensors and Controls and other Novel Concepts	8,000	9,000	14,500	+5,500
Advanced Coal Processing	13,000	30,000	50,000	+20,000
Power Generation Efficiency	48,683	34,000	216,500	+182,500
Advanced Energy Materials	20,000	21,000	22,000	+1,000
Total Advanced Energy Systems	**157,683**	**150,000**	**321,900**	**+171,900**
Crosscutting Research				
Water Management R&D	**8,000**	**9,000**	**6,650**	**-2,350**
Modeling, Simulation & Analysis	**15,000**	**7,300**	**17,100**	**+9,800**
Advanced Energy Storage Initiative	**0**	**4,500**	**5,000**	**+500**
Critical Minerals				
Feasibility of Recovering REEs	18,000	23,000	32,000	+9,000
Critical Materials	0	0	0	0
Subtotal Critical Minerals	**18,000**	**23,000**	**32,000**	**+9,000**
University Training and Research	**5,050**	**5,050**	**3,500**	**-1,550**
International Activities	**300**	**150**	**1,000**	**+850**
Total Crosscutting Research	**46,350**	**49,000**	**65,250**	**+16,250**

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Carbon Capture, Utilization and Storage				
Carbon Capture				
Post-Combustion Capture Systems	94,671	108,800	70,000	-38,800
Pre-Combustion Capture Systems	6,000	6,000	4,000	-2,000
Subtotal Carbon Capture	**100,671**	**114,800**	**74,000**	**-40,800**
Carbon Utilization				
Carbon Use and Reuse	12,000	21,000	15,000	-6,000
Subtotal Carbon Utilization	**12,000**	**21,000**	**15,000**	**-6,000**
Carbon Storage				
Storage Infrastructure	57,500	57,000	5,000	-52,000
Advanced Storage R&D	28,596	22,000	25,000	+3,000
Subtotal Carbon Storage	**86,096**	**79,000**	**30,000**	**-49,000**
Emissions Control	**0**	**3,000**	**4,000**	**+1,000**
Total Carbon Capture, Utilization and Storage	**198,767**	**217,800**	**123,000**	**-94,800**
Supercritical Transformational Electric Power (STEP)	**22,430**	**16,000**	**0**	**-16,000**
Transformational Coal Pilots	**25,000**	**20,000**	**0**	**-20,000**
NETL Coal Research and Development	**36,000**	**38,000**	**36,000**	**-2,000**
Total, Advanced Coal Energy Systems & CCUS	**486,230**	**490,800**	**546,150**	**+55,350**

Advanced Coal Energy Systems & CCUS

Funding by Congressional Control ($K)
(Non-Comparable)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Coal				
CCS and Power Systems				
Carbon Capture				
Post-Combustion Capture Systems	94,671	108,800	0	-108,800
Pre-Combustion Capture Systems	6,000	6,000	0	-6,000
Emissions Control	0	3,000	0	-3,000
Subtotal Carbon Capture	**100,671**	**117,800**	**0**	**-117,800**
Carbon Storage				
Storage Field Management	57,500	57,000	0	-57,000
Advanced Storage R&D	21,696	16,100	0	-16,100
Carbon Use and Reuse	12,000	21,000	0	-21,000
Sub-disciplinary Storage R&D	6,900	5,900	0	-5,900
Subtotal Carbon Storage	**98,096**	**100,000**	**0**	**-100,000**
Advanced Energy Systems				
Gasification Systems	18,000	10,000	0	-10,000
Advanced Turbines	20,000	25,000	0	-25,000
Coal and Coal Biomass to Liquids	0	0	0	0
Solid Oxide Fuel Cells	30,000	21,000	0	-21,000
Coal Beneficiation	13,000	30,000	0	-30,000
Transformative Power Generation	48,683	34,000	0	-34,000
Subtotal Advanced Energy Systems	**129,683**	**120,000**	**0**	**-120,000**
Crosscutting Research				
Plant Optimization Technologies				
Sensors, Controls and Other Novel Concepts	8,000	9,000	0	-9,000
Crosscutting Materials R&D	5,000	5,000	0	-5,000
Advanced Ultrasupercritical Materials R&D	15,000	16,000	0	-16,000
Water Management R&D	8,000	9,000	0	-9,000
Subtotal Plant Optimization Technologies	**36,000**	**39,000**	**0**	**-39,000**

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Coal Utilization Science				
Simulation Based Engineering	14,000	6,800	0	-6,800
Computational System Dynamics	0	0	0	0
Focus Area for Computational Energy Science	0	0	0	0
Subtotal Coal Utilization Science	**14,000**	**6,800**	**0**	**-6,800**
Energy Analyses				
Environmental Activities	0	0	0	0
Technical and Economic Analysis	1,000	500	0	-500
Subtotal Energy Analyses	**1,000**	**500**	**0**	**-500**
University Training and Research				
University Coal Research	3,000	3,000	0	-3,000
HBCUs, Education, and Training	2,050	2,050	0	-2,050
Subtotal University Training and Research	**5,050**	**5,050**	**0**	**-5,050**
International Activities				
International Program Support	300	150	0	-150
Subtotal International Activities	**300**	**150**	**0**	**-150**
Harsh Environmental Materials Initiative	**0**	**0**	**0**	**0**
Advanced Energy Storage Initiative	**0**	**4,500**	**0**	**-4,500**
Total Crosscutting Research	**56,350**	**56,000**	**0**	**-56,000**
NETL Coal Research and Development				
Feasibility of Recovering Rare Earth Elements	18,000	23,000	0	-23,000
NETL Coal R&D	36,000	38,000	0	-38,000
Subtotal NETL Coal Research and Development	**54,000**	**61,000**	**0**	**-61,000**
Supercritical Transformational Electric Power (STEP)	**22,430**	**16,000**	**0**	**-16,000**
Transformational Coal Pilots	**25,000**	**20,000**	**0**	**-20,000**
Total CCS and Power Systems	**486,230**	**490,800**	**0**	**-490,800**

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Advanced Coal Energy Systems & CCUS				
Advanced Energy Systems				
Advanced Systems				
Advanced Combustion/Gasification Systems	0	0	7,800	+7,800
Advanced Turbines	0	0	9,200	+ 9,200
Solid Oxide Fuel Cells	0	0	1,900	+1,900
Advanced Sensors and Controls and other Novel Concepts	0	0	14,500	+14,500
Subtotal Advanced Systems	**0**	**0**	**33,400**	**+33,400**
Advanced Materials				
Advanced Coal Processing	0	0	50,000	+50,000
Power Generation Efficiency	0	0	216,500	+216,500
Advanced Energy Materials	0	0	22,000	+ 22,000
Subtotal Advanced Materials	**0**	**0**	**288,500**	**+288,500**
Total Advanced Energy Systems	**0**	**0**	**321,900**	**+321,900**
Crosscutting Research				
Water Management R&D	**0**	**0**	**6,650**	**+ 6,650**
Modeling, Simulation & Analysis	**0**	**0**	**17,100**	**+17,100**
Advanced Energy Storage Initiative	**0**	**0**	**5,000**	**+5,000**
Critical Minerals				
Feasibility of Recovering REEs	0	0	32,000	+32,000
Critical Materials	0	0	0	0
Subtotal Critical Minerals	**0**	**0**	**32,000**	**+32,000**
University Training and Research	**0**	**0**	**3,500**	**+3,500**
International Activities	**0**	**0**	**1,000**	**+1,000**
Total Crosscutting Research	**0**	**0**	**65,250**	**+65,250**

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Carbon Capture, Utilization and Storage				
Carbon Capture				
Post-Combustion Capture Systems	0	0	70,000	+70,000
Pre-Combustion Capture Systems	0	0	4,000	+4,000
Subtotal Carbon Capture	**0**	**0**	**74,000**	**+74,000**
Carbon Utilization				
Carbon Use and Reuse	0	0	15,000	+15,000
Subtotal Carbon Utilization	**0**	**0**	**15,000**	**+15,000**
Carbon Storage				
Storage Infrastructure	0	0	5,000	+5,000
Advanced Storage R&D	0	0	25,000	+25,000
Subtotal Carbon Storage	**0**	**0**	**30,000**	**+30,000**
Emissions Control	**0**	**0**	**4,000**	**+4,000**
Total Carbon Capture, Utilization and Storage	**0**	**0**	**123,000**	**+123,000**
Supercritical Transformational Electric Power (STEP)	**0**	**0**	**0**	**0**
Transformational Coal Pilots	**0**	**0**	**0**	**0**
NETL Coal Research and Development	**0**	**0**	**36,000**	**+36,000**
Total, Advanced Coal Energy Systems & CCUS	**0**	**0**	**546,150**	**+546,150**

SBIR/STTR:

- FY 2019 Transferred: SBIR $14,558; STTR: $1,762
- FY 2020 Enacted: SBIR $10,636; STTR: $1,495
- FY 2021 Request: SBIR $12,546; STTR: $1,765

Advanced Coal Energy Systems and CCUS
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Advanced Coal Energy Systems & CCUS	
Advanced Energy Systems: The proposed funding increase will support competitive funding announcements with industry to improve the reliability, efficiency, and performance of the existing coal fleet, including the Coal FIRST initiative – which supports R&D insights and integrated designs of the coal plant of the future needed to provide secure, stable, and reliable power . The Coal FIRST initiative will make future coal-fired power plants more adaptive to the modern electrical grid and eliminate emissions. The initiative is focused on early stage R&D that benefits multiple technologies for use with different coal types and regions throughout the United States across a broader coal and power industry, including publically available reports on the results of the R&DIn addition, this funding increase will support opportunities for other markets for coal including technologies to produce advanced materials and products from coal, and research on manufacturing, and production systems to support industry led modular manufacturing plants.	**+171,900**
Crosscutting Research: The proposed funding increase will support major R&D activities including advancing technologies for rare earth elements pilot facilities, water management R&D, and sensors and controls that can be used to monitor and identify transients associated with a cyber-attack, providing increased reliability and grid stability.	**+16,250**
Carbon Capture, Utilization and Storage: R&D will continue to support early-stage R&D in carbon capture and carbon storage to reduce the cost of CO_2 capture by 30% by 2030 and the Coal FIRST initiative. The proposed funding continues carbon utilization efforts to further development of promising technologies, and continues activities to address non-CO_2 emissions from coal-fired power plants (e.g., trace metals emissions in solid, liquid and gaseous effluents). Essential early-stage pre- and post-combustion capture R&D on transformational gas separation technologies (at least 90% of the CO_2 at 95% purity) that can significantly reduce the cost of CO_2 capture for coal and natural gas-fired power plants, industrial sources, and direct air capture will continue.	**-94,800**
Supercritical Transformational Electric Power (STEP): No funding is requested for the STEP 10MW pilot as it is fully funded with prior year funding.	**-16,000**
Transformational Coal Pilots: No funding is requested in FY 2021.	**-20,000**
Total, Advanced Coal Energy Systems & CCUS	**+57,350**

Advanced Coal Energy Systems & CCUS
Advanced Energy Systems

Description

Coal plays a critical role in powering the Nation's and the world's electricity demand, providing resilient baseload power. The U.S. coal fleet however is aging, and less efficient coal plants are shutting down and retiring at unprecedented rates; a challenge exacerbated by the current economic pressures on the coal sector. Government-supported early-stage research and development (R&D) in advanced energy systems can improve the efficiency and performance of these aging systems, increasing their competitiveness and making available additional revenue streams, providing a platform for developing the advanced systems of the future, and eliminating emissions. R&D in areas such as advanced materials that can withstand extreme environments, next-generation plant power cycles, manufacturing techniques, and controls can lead to more efficient components and systems that industry can further develop or deploy. Such improvements to the efficiency and reliability of coal-fired power plants will also reduce their emissions to zero or near-zero and allow these assets to provide continued low-cost baseload power and resilient grid services.

The mission of the Advanced Energy Systems (AES) subprogram is to increase the availability, efficiency, and reliability of fossil energy power systems while maintaining environmental standards through early-stage R&D. The subprogram comprises seven activities: 1) Advanced Combustion/Gasification Systems, 2) Advanced Turbines, 3) Solid Oxide Fuel Cells, 4) Advanced Sensors and Controls and Other Novel Concepts, 5) Advanced Coal Processing 6) Advanced Energy Materials, and 7) Power Generation Efficiency. While the primary focus is on coal-based power systems, improvements to these technologies are also applicable to other fossil energy systems. Two key goals of the AES subprograms are to improve the average modeled efficiency (heat rate) of a typical plant in the existing fleet by 5% by the end of FY 2022 (i.e., to 32.5% from the 2017 baseline of 31%), and of an advanced or new coal plant by 5% by the end of FY 2023 (i.e., to 40% from the 2017 baseline of 38%).

To achieve these goals, the Office of Fossil Energy has launched an effort—the Coal FIRST (Flexible, Innovative, Resilient, Small, and Transformative) initiative—to support R&D insights and integrated designs of the coal plant of the future needed to provide secure, stable, and reliable power. The Coal FIRST initiative will make future coal-fired power plants more adaptive to the modern electrical grid and eliminate emissions. The initiative is focused on early stage R&D that benefits multiple technologies for use with different coal types and regions throughout the United States across a broader coal and power industry, including publically available reports on the results of the R&D. Through innovative technologies and advanced approaches to design and manufacturing, the initiative will look beyond today's utility-scale power plant concepts (e.g. base-load units) in ways that facilitate electrical grid integration both domestically and internationally. Modular Coal FIRST technologies could increase U.S. energy exports, create domestic jobs, and support our partners abroad—reducing energy poverty in African and Asian nations, while providing affordable electricity and opportunities for economic prosperity to people worldwide.

DOE envisions that the future coal fleet may be based on electricity generating units possessing many of the following traits:

- Zero or near-zero emissions including carbon dioxide or even negative emissions when combined with biomass co-firing
- High overall plant efficiency (40%+ HHV or higher at full load, with minimal reductions in efficiency over the required generation range)
- Small, high-quality, low-cost units (50 MW to 350 MW) that minimize field construction time
- Ramp rates and minimum loads compatible with 2050 estimates of renewable energy integration
- Integration with thermal or other energy storage (e.g., chemical production) to mitigate inefficiencies and equipment damage
- Minimized water consumption
- Accelerated design, construction, and commissioning schedules

- Enhanced maintenance features, including technology advances with monitoring and diagnostics to reduce downtime
- Integration with coal upgrading, or other plant value streams (e.g., co-production)
- Capable of natural gas co-firing

The proposed restructure of AES intends to streamline and improve the alignment of the budget structure to the R&D focus areas. A crosswalk of the proposed restructure is included in the Fossil Energy R&D Overview section.

Advanced Energy Systems – Explanation of Budget Structure Changes

- Sensors and Controls and other Novel Concepts will move from Crosscutting Research and be renamed Advanced Sensors and Controls and Other Novel Concepts.
- Coal Beneficiation will be renamed Advanced Coal Processing.
- Transformative Power Generation will be renamed Power Generation Efficiency.
- Crosscutting Materials R&D and Advanced Ultra Supercritical Materials R&D will move from Crosscutting Research and be combined into a single subprogram, Advanced Energy Materials.

Advanced Combustion/Gasification Systems

Coal gasification is a process that combines oxygen, steam, and coal in a gasifier to produce syngas, a mixture of hydrogen and carbon monoxide through a series of chemical reactions under high temperature and pressure. Gasification also has the potential to gasify both coal and biomass to reduce the carbon footprint of the products produced and when coupled with CCUS can result in negative CO_2 emissions. The syngas can be further converted to hydrogen and CO_2 over a catalyst in a water-gas shift reactor for efficient electricity generation. Syngas can also be used to produce ammonia, fertilizer, liquid fuels, or other high-value chemicals. Currently, all commercially established coal gasification-based power plants use Integrated Gasification Combined Cycle (IGCC) technology. Although IGCC is one of the cleanest and most efficient technologies to convert coal to electricity, the technology involves a complex set of systems tailored for utility-scale electricity generation from a large, centralized power plant. A consequence of tailoring the IGCC technology in this fashion is that technology adopters are required to invest many years of design and construction activity as well as billions of dollars of capital costs. In response, gasification R&D is focused on modularization, which would result in technology solutions that can be implemented quickly and with lower total capital investment.

Advanced Combustion focuses on the development of advanced combustion technologies, such as pressurized oxy-combustion and chemical looping processes, by continuing ongoing activities. These technologies allow power plants to produce flue gas that is rich in CO_2 as the power generation involves combustion in a high-O2 and/or near zero-N_2 concentration environment. An added co-benefit is the dramatic reduction in the emission of conventional pollutants. These advanced technologies are applicable to new and existing power plants. Combustion systems can be improved by lowering the cost of oxygen supplied to the system and by increasing the overall system efficiency. The program targets both of these possible improvements by sponsoring cost-shared research for three key technologies: (1) Oxy-Combustion, (2) Chemical Looping Combustion, and (3) Advanced Concepts.

In FY 2021, the Budget provides $7.8 million for early-stage R&D with DOE National Laboratories to develop modular technologies that could overcome siting, operating, and logistical constraints that inhibit the deployment of large-scale plants. In addition, modular gasification technologies could provide power to remote or rural areas. The Request will enable development of an innovative, fuel flexible, small modular gasifier that uses waste streams (coal refuse, waste coal, coal fines, and bio-waste). The Request continues R&D on innovative design development of a high-performance, low-cost gasifier for small, modular gasification applications as well research to advance design and fabrication of form refractories to provide better heat and temperature distribution inside a gasifier and lower capital costs.

The Request will support development of a high temperature high pressure (HTHP) combustion test process supporting three test cells. Test cells will be reconfigurable to address emergent needs, with an initial focus on oxy-fuel combustion with CO_2 dilution supporting the Allam cycle. Funds will also support R&D on Hydrogen combustion supporting low carbon deployment of fossil energy systems (IGCC and Hydrogen Combined Cycle), pressure gain combustion and fundamental

assessments related to advanced coal combustion, development of combustion chemical kinetics and computational fluid dynamics (CFD) methods, and development and validation of heat transfer and pressure drop correlations for sCO_2 will be conducted. In addition, the Request will support development of small-scale, modular microwave reactor technology that improves coal gasification product flexibility and increases operational flexibility

Advanced Turbines

Coal based boilers provide heat for steam turbine based Rankine cycles. These power plants represent one of the largest sources of power in the U.S., about 27% of the U.S. generation mix in 2018[1]. Historically, these plants have provided stable base load generation with the lowest cost of electricity to the Nation. Today, the future of coal-fired electricity generation is challenged by aging, lower efficiency coal plants and the integration of renewables to the grid. To maintain the base load benefits and coal-fueled capital assets, in FY 2021, the Budget provides $9.2 million to competitively fund new awards with industry to develop advanced steam turbines, sCO_2 turbines, and R&D on hydrogen turbines. This R&D will support the application of advanced manufacturing practices to steam turbine parts to realize lower cost and high performance steam turbines, with the potential for up to 0.5 - 1% power cycle efficiency improvement. In addition to addressing technology advancements that improve turbine performance, research efforts will continue to advance technology for sCO_2 power cycles. Funding will also support advanced turbine cooling technologies to meet the program goals by evaluating the performance of new cooling designs and advanced aerodynamics to develop more efficient, higher temperature with better cooling machines. R&D for turbines fueled with hydrogen produced from coal gasification with CCUS to generate carbon free electric power will be evaluated. If this hydrogen is mixed through the natural gas pipeline infrastructure, existing turbine assets can be used to mitigate carbon emissions while using coal. If desired, this coal-based hydrogen fuel stream could be transitioned to 100 % hydrogen.

The Request also supports early-stage pressure gain combustion R&D with the DOE National Laboratories. R&D will focus on existing advanced manufacturing processes to produce lower cost and higher performance parts to repair/retrofit steam turbines, with the goal of developing a modular scale high efficiency steam turbine for supercritical steam conditions applicable to modular coal boilers. This early stage R&D will lead to lower cost and higher performance options for steam cycles in coal boilers and thereby lower the cost of electricity and CO_2 emissions per MWh. A portion of the Request will also be coordinated with the Offices of Nuclear Energy, and Energy Efficiency and Renewable Energy as part of the Harsh Environment Materials Initiative to leverage common investments and expertise in materials and component manufacturing R&D for advanced thermoelectric plants.

University Turbine Systems Research (UTSR): This sub-activity provides the continued support to the turbines program to university to improve the efficiencies of gas, steam and sCO_2 turbines and components. Key research areas include improving the efficiency of steam turbines for both existing coal plants and conducting R&D and analysis in support of turbines for use in future plants; and reducing the risk of scale-up for use in commercial scale machines, including combustor components, rotating parts, and cooling systems.

Solid Oxide Fuel Cells

This activity focuses on early-stage R&D to enable efficient, cost-effective solid oxide fuel cell (SOFC) electricity generation from coal or natural gas with zero or near-zero atmospheric emissions of CO_2 and air pollutants. Benefits of SOFCs also include minimal water use in both distributed generation and central power generation applications. In FY 2021, the Budget provides $1.9 million to advance R&D with the DOE National Laboratories that addresses the technical challenges to SOFC commercialization, such as cell power enhancement, advanced materials development for low temperature operation, materials characterization, and systems analysis. The Request will also advance R&D on Solid Oxide Electrolyzer Cell (SOEC), which uses excess electricity, water and carbon dioxide (CO_2) to produce hydrogen (H_2) and carbon monoxide (CO). Reversing the mode of operation of a Solid Oxide Fuel Cell (SOFC), it essentially converts it to a SOEC operating at higher temperatures and hence higher efficiency. The H_2 and CO can then either be stored or converted into liquid fuel for use to generate electricity in a turbine or fired in a steam boiler when needed. SOEC is an ideal technology to couple with fossil

[1] https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

power plants, as well as nuclear power plants, that are currently cycling to follow renewables and are generating excess electricity when renewable energy is available. The program will also continue to support the Hybrid Carbon Conversion activities within FE and focus on accelerating the development of highly efficient flexible and cost-effective fossil based power systems by identifying advanced SOFC Hybrid Carbon Conversion (HHC) configuration concepts that enable the generation of ultra-efficient, low-cost electricity for the near-term deployment of distributed generation/modular power systems.

Advanced Sensors and Controls and Other Novel Concepts

This activity, formerly funded under Crosscutting Research, provides $14.5 million to focus early-stage R&D on low-cost and reliable multi-sensing wired and wireless technologies to measure temperature, pressure and gas species that, with additional investment by industry, could be capable of providing real-time information critical to the operation, optimization, reliability and efficiency of the next-generation of power systems. Advances in R&D will enable industry to shift from the current time-based preventive maintenance schedules to ones focused on condition-based maintenance with improved reliability and overall plant economics. Advanced sensors can also be used to monitor and identify transients associated with a cyber-attack, providing increased asset security and grid stability. Novel instrumentation that can withstand harsh environments has the ability to replace inferred process conditions with actual measurements which can facilitate faster/safer response times. National Lab R&D will focus on advanced data analytics and controls development for condition-based maintenance (CBM), building off lessons learned from testing at existing fleet power plants emphasizing integration of materials lifetime modeling and control algorithms. In collaboration with industry, boiler temperature sensors will be one specific area to push into market with remaining development work to include packaging, ruggedizing, and readying for plant integration.

Advanced Coal Processing

Domestic coal production in the U.S. has been on the decline, mainly due to coal being displaced by natural gas for energy generation. R&D in the advanced coal processing subprogram will further efforts to identify and quantify the existing and projected markets for everyday and high value stream carbon products; the potential markets for carbon products if production costs are reduced to make it more competitive with other competing materials; estimate the volume of coal required if coal were the feedstock to produce the carbon product based on several penetration scenarios; and, identify the reasons that have prevented carbon products from further penetrating large markets.

This activity's Request of $50 million combines basic chemistry and combustion science along with basic and fundamental research on thermo-physical properties, materials interactions, and heat transfer to improve how coal is processed and utilized in order to expand the market opportunities for coal. In FY 2021, FE will develop new technologies to create useable coal pitch for creating new products such as carbon fiber and nanomaterials, foams, composites, building materials, and 3D printing materials by integrating coal into the value-chain of industries that typically do not use coal in their manufacturing processes and can supplement traditional markets for U.S. coals. Funds will support NETL techno-economic characterization of markets for coal-derived carbons, composites, and 3D printing fluids in addition to continuing fundamental research in developing new advanced materials. The Request will continue the development of a user friendly coal database with detailed technical information on selected American coals so that the information is machine readable, supports CFD and Institute for the Design of Advanced Energy Systems (IDAES) models, and parametric design methods.

Advanced Energy Materials

Depending on the application, many different types of materials can be used in harsh environments, including metal alloys, polymers, ceramics, glasses, and composites. For some applications, materials that meet performance requirements are unavailable and new materials must be developed and qualified. In other cases, materials that meet stringent operation requirements are available, but costs are too high to justify use of the material. In those cases, research is needed to improve the efficiency of processing techniques and equipment to bring the manufacturing costs of these materials down. Some examples include:

- Gas and steam turbine power plants could achieve higher efficiencies if they operate at higher inlet temperatures, but operating temperatures are constrained by the thermal stability of existing turbine alloys and coatings at high temperatures and pressures.

- Corrosion of iron and steel pipelines can cause leakage of natural gas, leading to wasted energy, explosion hazards, and methane emissions.

The Advanced Energy Materials subprogram focuses on developing cost effective structural and functional materials for advanced fossil energy power production technologies, and to reduce the cost and time needed to develop and commercialize new materials for fossil energy applications in extreme operating environments. High-Performance Material (HPC4Mat) development R&D concentrates on advanced manufacturing methods and computational materials modeling as an enabling technology. These advancements are used to promote technologies that enhance plant optimization that reduce operations and maintenance costs of both existing coal-fired plants and new fossil energy infrastructure. Advanced manufacturing techniques explore processes that can effectively manufacture, develop, and distribute prototype technology.

Extreme environment materials (EEM) development focuses on creating cost effective structural and functional materials for advanced fossil energy power production technologies, and reducing the cost and time needed to develop and commercialize new materials for FE applications in extreme operating environments. EEM development also focuses on advanced manufacturing methods for high-performance materials and computational materials modeling as enabling technologies. A major barrier to the use of new EEMs is the high cost of the constitutive elements in the material. Moreover, EEM manufacturing costs increase as the complexity and performance capabilities of such materials increase. For example, the cost of structural alloys for fossil energy power plants increases exponentially as the temperature limit of the alloys increases.

The Harsh Environment Materials Initiative (HEMI) activity has moved to AES from the Crosscutting Program and is integrated into the Materials subprogram. R&D will focus on advanced data analytics and controls development for condition-based maintenance (CBM), building off lessons learned from testing at existing fleet power plants emphasizing integration of materials lifetime modeling and control algorithms. The physical limitations of materials in demanding environments have long constrained engineers in the design of innovative products and technologies. Aggressive service environments can involve, for example, high temperatures and thermal cycling, high pressures, corrosive chemicals, dust and particulates, mechanical wear, high temperature oxidation, and hydrogen attack. These aggressive environments, and the associated materials durability challenges are common across multiple applications and sectors. New materials development and new materials processing solutions are needed to meet stringent application demands for future products that will provide energy savings, emissions reductions, and other benefits. Funding will also support development of harsh environment sensors for fossil power generation applications and sensor technologies developed with prior DOE funding to ready for commercialization.

The FY 2021 Request of $22 million will provide funding for computational based methods for design and prediction of long term (300,000 hours) mechanical and corrosion behavior of structural and functional components in FE power plants; the production and testing of nickel (Ni) superalloy components for Advanced Ultra Supercritical (AUSC) steam Rankine cycles; and advanced manufacturing methods to reduce fabrication costs. The Request supports supply chain R&D to reduce costs of Ni-based superalloys and enhance cyclic capabilities of materials. Currently, the U.S. supply chain is capable of providing AUSC materials but not at costs needed by utilities. Funding will also support a NETL led National Lab Consortium to Accelerate Design of New EEMs. Funding will also be utilized for computational materials modeling, experimental, and manufacturing expertise resident within the National Laboratory complex to develop a framework to rapidly design new EEM structural alloys with lower cost/mechanical strength ratio than existing iron and nickel based alloys. R&D will also focus on advanced Maintenance & Repair for Coal Plant Boilers through the development of technologies that provide for rapid, low-cost repair of coal plant boilers, leveraging insight afforded by robotic inspection.

Power Generation Efficiency

Changes to the U.S. electricity industry are forcing a paradigm shift in how the nation's power generating assets are operated. Coal-fired power plants optimized as baseload resources are being increasingly relied on as load-following resources to support electricity generated from intermittent renewable sources and variations in natural gas supply and pricing, as well as to provide critical ancillary services to the grid. In addition, wide-scale retirements of the nation's existing fleet of coal-fired power plants—without replacement—may lead to a significant undermining of the resiliency and

reliability of America's electricity supply. Nevertheless, the need for considerable dispatchable generation, critical ancillary services, and grid reliability—combined with potentially higher future natural gas prices, and energy security concerns, such as the importance of onsite fuel availability during extreme events such as weather, etc. —create the opportunity for advanced coal-fired generation, for both domestic and international deployment. These fundamental changes to the operating and economic environment in which coal plants function are expected to persist into the next decade and beyond. Deployment of new coal plants will require a different way of thinking.

Coal FIRST is an FE flagship program that will develop a coal-fired power plant, with zero or near-zero emissions that meets the demands of the 21st century U.S. electricity grid. The International Energy Agency (IEA) projects that coal will be the largest source of electricity production in the world by 2040. The IEA has also concluded that any solution for CO_2 emissions must include carbon capture, one of the key traits for a Coal FIRST power plant. Coal FIRST plants will meet the growing need for dispatchable generation, critical ancillary services, and grid reliability on an evolving grid with increasing amounts of intermittent renewables. The majority of this need is currently being met by natural gas plants that purchase interruptible natural gas pipeline capacity and are subject to shut-down during extreme weather or switching to limited stored-oil capacity. Extreme weather is precisely the time when renewables (wind & solar) are most vulnerable, a situation seen in the Midwest, Northeast and Texas. In addition, these Coal FIRST technologies will provide power producers with a fuel-resilient alternative to natural gas as the aging coal and nuclear fleet continues to retire. Finally, the U.S. is the only country developing the next-generation of coal plants. There is an opportunity for the U.S. to reclaim global leadership from China and sell these technologies to developing economies that will continue to use coal for decades to come.

The Power Generation Efficiency Request of $216.5 million will enable early-stage R&D to: 1) increase the performance and competitiveness and reduce emissions of existing coal-fired power plants, and 2) advance the coal-fired power plants of the future, which industry can further develop and deploy. Specifically, this activity will continue to advance next-generation R&D that improves the operational flexibility, efficiency, and reliability of our existing coal fleet. In parallel, this activity prioritizes R&D to enable the coal plant of the future with the Coal FIRST initiative. This will allow industry to develop the coal plant of the future needed to provide secure, stable, and reliable power. This R&D will underpin coal-fired power plants that are capable of *flexible* operations to meet the needs of the grid; use *innovative* and cutting-edge components that improve efficiency and reduce emissions; provide *resilient* power to Americans; are *small* compared to today's conventional utility-scale coal plants; and will *transform* how coal technologies are designed and manufactured.

In FY 2021, funding opportunities will focus on Phase II efforts of the coal plant of the future: R&D on critical component design, advanced design methods (e.g., parametric approaches), and advanced combustion and continued support of integrated Front End Engineering and Design (FEED) studies for the Coal FIRST initiative that will be applicable to different coal types and regions in the United States. This early-stage component and integrated design research is broadly applicable to a number of potential advanced coal generation technologies and facilities. To appropriately balance the public and private costs and benefits of such FEED studies, DOE will require a non-Federal cost-share; will make all technical information generated under the scope of the FEED study public no more than five years after completion of the study;, and will prioritize the use of federal funding for R&D that will produce widely available results. This research will more effectively enable industry to design, commercialize, and deploy these coal plants of the future. Further, the activity continues existing projects with industry and DOE National Laboratories that support both existing and future coal fleet R&D initiatives in areas including technology and systems integration, advanced coal combustion, and chemical looping research; as well as a new competitive solicitation targeting academic institutions and DOE National Laboratories to focus on the application of artificial intelligence and machine learning to improve plant operations; technology testing; systems analysis; and technology transfer to industry.

Advanced Coal Energy Systems & CCUS
Advanced Energy Systems

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Advanced Energy Systems: $150,000,000	**$321,900,000**	**+$171,900,000**
Advanced Combustion/Gasification $10,000,000	**$7,800,000**	**-$2,200,000**
• Radically Engineered Modular Systems: Continue R&D on the innovative design development of high performance, low cost gasifier/reactor. • Advance modular technologies to help generate electricity in remote or rural areas. • Refractory design and fabrication of form refractories to provide better heat/temperature distribution inside a gasifier and lower capital cost.	• Develop small-scale, modular microwave reactor technology that improves coal gasification product flexibility and increases operational flexibility. • Develop modular gasification system that produces a hydrogen-rich syngas stream not diluted with nitrogen at high rates using a catalyst, coal, and steam which can be operated in a continuous manner with continuous coal addition. • Microwave-based concept for coal gasification to syngas resulting in co-production of energy and value-added chemicals at low temperatures.	• The decrease in funding reflects the change in priorities to Power Generation Efficiency.
Advanced Turbines $25,000,000	**$9,200,000**	**-$15,800,000**
• FOA for development of advanced steam turbine. • FOA for sCO_2 turbine R&D. • Pressure Gain Combustion R&D. • Development of turbine for partial or full hydrogen combustion.	• Support development of advanced steam turbines, sCO_2 turbines, and hydrogen turbines. • R&D on key turbine system components that, with additional development by industry, could be capable of achieving a 4-5 percentage point efficiency increase relative to existing combined cycle turbines.	• The decrease in funding reflects the change in priorities to Power Generation Efficiency. • No funding for FOAs.
Solid Oxide Fuel Cells $21,000,000	**$1,900,000**	**-$19,100,000**
• $30M Funding Opportunity Announcement as directed by FY 2020 appropriations.	• R&D to develop solutions to alleviate component level issues and/or scale-up of solutions to specific stack, mechanical Balance-of-Plant or operational issues including thermal management.	• The decrease in funding reflects a focus on materials development with academia and/or National Laboratories. • No funding for FOAs.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Advanced Sensors & Controls $9,000,000	**$14,500,000**	**+$5,500,000**
• Development of harsh environment sensors for condition based monitoring within fossil power generation applications. • Advanced controls R&D for increased flexibility of FE-based systems in response to load-following; leverages machine learning approaches.	• Development of sensors to enable economic and efficient operation of next generation highly flexible FE power plant designs. • Systems analysis and controls R&D for SCO2 systems, including STEP facility & direct-fired cycle. • Adaptation of laser diagnostics and other non-contact measurement techniques for use in power plants.	• The increase in funding will support early-stage testing of advanced sensor technologies developed within relevant plant environments to improve reliability, availability and efficiency and to enable technology transfer.
Advanced Coal Processing $30,000,000	**$50,000,000**	**+$20,000,000**
• Coal to High Value Products. • Development of Novel Lab/Bench-Scale Coal Utilization Technologies. • Support for carbon fiber test facility to reduce cost of carbon fiber production for multiple products from various coal pitch.	• Database of coal properties to expand markets for coal. • Develop new technologies to create useable coal pitch for creating new products such as carbon fiber and nanomaterials, foams, composites, building materials, and 3D printing materials. • Improve the handling, transportation, and storage characteristics of low rank coal, and notably reducing the moisture content in a fashion that does not detract from these characteristics.	• Accelerate work to develop new technologies for coal to value added products. • Increased funding will support early stage development of carbon product to commercialization.
Advanced Energy Materials $21,000,000	**$22,000,000**	**+1,000,000**
• ComTEST AUSC and supply chain development. • Improve casting and heat treatment processes for nickel superalloys. • Advanced Joining Methods for High-Temperature Fossil Energy Power Cycle Components. • R&D focuses on low TRL innovative advanced manufacturing methods for lowering the cost of HX.	• Funding will support: A collaborative effort with EERE's advanced manufacturing office to conduct supply chain R&D to reduce costs of Ni-based superalloys and enhance cyclic capabilities of materials. • Utilize computational materials modeling, experimental, and manufacturing expertize within the NL complex to develop a framework to rapidly design new EEM structural alloys with	• The increase in funding will accelerate national laboratory R&D.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
• Next Generation Ultra-High Temperature Structural Materials. • Next Generation Fe-9Cr Alloys.	lower cost/mechanical strength ratio than existing iron and nickel based alloys.	
Power Generation Efficiency $34,000,000	**$216,500,000**	**+$182,500,000**
• Competitive funding opportunities on Critical Components R&D, in support of the Coal FIRST initiative • Competitive funding opportunity announcement for FEED studies. • Continue existing projects with industry and DOE National Laboratories that support both the existing and future coal fleet. • Lab and University call focused on the application of artificial intelligence and machine learning to improve plant operations; technology testing; systems analysis; and technology transfer to industry.	• Issue new competitive Funding Opportunities Announcements (FOAs) that focus on Phase II efforts of the coal plant of the future. This funding is specifically focused on R&D on critical component design, advanced design methods (e.g., parametric approaches), and advanced combustion, and broadly applicable integrated design studies. These FOA's will address the needs of both the U.S. and export markets to develop new burner designs; ramping & co-firing with natural gas; coal quality optimization; Validation of Sensors & Controls; Algorithms that improve preventive maintenance and can lead to condition-based maintenance; non-linear model based control & dynamic optimization. In addition the FOA's will also address Advanced Power Cycles integration: AUSC (Advanced Ultra Super Critical) Topping Cycles; New Power Cycles that use supercritical carbon dioxide and other fluids instead of steam for efficient power generation, and Energy Storage that will be integrated for fast start of power plants.	• The increased Request would continue to fund ongoing projects for Coal FIRST. Funding specifically focuses on broadly applicable integrated design studies and concepts that require longer term development through R&D on critical component design.

Advanced Coal Energy Systems & CCUS
Crosscutting Research

Description

Coal plays a critical role in powering the Nation's and the world's electricity generation, and is forecasted to do so for the foreseeable future.[1] However, aging coal generation assets face decreased performance due to the state of the equipment and transient operating conditions— a challenge exacerbated by the current economic pressures on the coal sector. To address the challenges of an aging coal fleet, opportunities exist to support early-stage technologies for further advancement by industry to ultimately repower or retrofit existing facilities with new components that significantly improve plant performance and lower emissions.

Fossil fuels (coal, natural gas) play a critical role in meeting the Nation's energy needs including power generation for the foreseeable future. Coal is the Nation's most abundant domestic energy resource, and is an important part of the domestic energy mix, providing about 27% of the Nation's electricity and 38.5% globally. Fossil fuel power plants provide reliable, affordable electricity that powers homes, industry, businesses, and commerce and a significant portion of the country's manufacturing and industrial energy needs. Fossil fuels provide over 60% of the electric power generating needs alone.

The Crosscutting Research subprogram supports innovative early-stage R&D for improving reliability, availability, efficiency, and environmental performance of advanced fossil-based power systems. The subprogram bridges basic and applied research by targeting concepts with the greatest potential for transformational breakthroughs. Research is focused on six activities: 1) Critical Minerals (CM); 2) Water Management R&D; 3) Modeling, Simulation and Analysis; 4) Advanced Energy Storage Initiative (AESI); 5) University Training and Research (UTR), which comprises funding for University Coal Research (UCR), Historically Black Colleges and Universities (HBCU) and other Minority Serving Institutions (MSI); and 6) International Activities.

Critical Minerals

This Program focuses on the recovery of critical minerals from coal, coal byproducts and other valuable sources, and to improve the economics by evaluation of coproduction product of other valuable products both critical and noncritical. The development of a domestic, economical competitive supply of rare earth elements (REE) and other CM can help fuel our nation's economic growth; secure our energy independence by reducing our reliance on foreign REE sources; and increase our national security. R&D under this activity has so far generated over a thousand rock assays from samples in 14 states. Achieving an economic pathway requires (1) finding the highest REE/CM contents available in these materials, (2) characterizing these materials from the standpoint of economic REE/CM extraction, and (3) development of plant designs to achieve extraction, separation and processing. To achieve this, the program has five key focus areas which support the recently release Presidential Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals":

1. Resource Sampling and Characterization – Characterize physical and chemical properties to identify the optimal coal and coal by-product resources for REEs/CMs.
2. Separation Technology Development – Develop REE separation and extraction capabilities from coal-based resources that are economically feasible and environmentally friendly.
3. REE Sensor Development – Create portable sensors to identify promising REE coal-based resources at field sites and determine the concentrations of REEs within flow streams during the separation process.
4. Process and Systems Modeling – Develop models to use as virtual test platforms to optimize process separation designs.
5. Techno-Economic Analysis – To evaluate the international REE market and assess the economics of commercial production of REEs.

This activity has been underway since 2014, and thousands of samples from fourteen coal-producing states have been analyzed. Since the program's inception, four to five thousand coal-based samples from around the country have been analyzed. In addition to sampling and analysis activities, search activities to date have been assisted by new techniques for

[1] U.S. Energy Information Administration, *Annual Energy Outlook 2018 with projections to 2050*, p. 69, www.eia.gov/aeo

processing well log data developed by FE from the oil and gas industry. Results from this search have included finding materials (in Appalachia and other regions) associated with U.S. coal beds that exceed the ore grades of some REE mining projects under development worldwide. Laboratory characterization work of the samples has thus far indicated REE presence in the materials in the form of conventional minerals, such as monazite and xenotime. However, the work has also found the presence of materials from which REEs can be recovered using an ion-exchange solution, a technique that accounts for about 30% of Chinese REE production. Minerals of this type has been previously unknown to exist in the U.S., and thus offers an opportunity for REE production with less intensive processing steps required to produce REEs from conventional ores. As part of this program, these new technologies, developed by industry and academia, are being tested at small-scale facilities to determine their economic usefulness in recovering REEs from coal-based resources.

The FY 2021 Budget of $32 million will be used to advance technologies to purify individual REEs produced as oxides from coal-based materials. Funding would be applied for optimization and efficiency improvements of process components for improved process economics and to finish ongoing design studies for continuous production REE R&D technologies that produce approximately one ton per day of commercial grade quality elements. Funding is limited to early-stage component and design research that is broadly applicable to a number of potential advanced REE recovery technologies and facilities. This will include publically available reports on the results of the R&D.

Water Management R&D

Water is a fixed resource with numerous competing demands and increased uncertainty in reliably meeting energy needs. The mission of the Water Management R&D activity is to advance sustainable and efficient water use in power generation; develop cost-competitive technology solutions; and enhance understanding of the life cycle relationship between energy and water resources. Thermoelectric power generation accounts for over 40% of freshwater withdrawals and over 4% of freshwater consumption in the United States, while 3% of electricity is used for water infrastructure (e.g., treatment, pumping). Effective water use is important for a stable and secure energy supply.

Proposed activities in FY 2021 include $6.65 million for development, validation testing, and techno-economic analysis. R&D activities include membranes for effluent separation and reuse to minimize compliance volume and sorbents to selectively remove heavy metals. This activity would be focused on early-stage development of technologies that increase power plant efficiency and decrease water consumption; field testing of promising technologies that reduce the energy requirements; and operating costs of water treatment for power plants. The Budget also provides for development of techno-economic assessments of promising technologies to guide technology development pathways. These activities will produce analytical data that speaks to state, regional, and national issues around water as it relates to fossil energy. In addition, FE activities will support the Water Security Grand Challenge a multi-office award to conduct a prize competition associated with Thermoelectric Cooling to be imitated 1 QTR FY 2021.

Modeling, Simulation and Analysis

This activity comprises modeling, simulation and techno-economic analysis to resolve challenges and optimize power plants as they integrate with a dynamic, evolving electricity grid. Key objectives include improving the reliability, flexibility, and economics of the existing coal fleet and accelerating the development of modular fossil plants of the future. This activity also supports strategic program planning by identifying advanced technology solutions that have the potential to improve the efficiency, reliability, cost, and/or environmental performance of fossil energy systems.

In FY 2021, the Budget provides $17.1 million to continue funding DOE National Laboratory R&D, including existing modeling and analysis projects funded under the Grid Modernization Initiative (GMI); and the NETL-led Institute for the Design of Advanced Energy Systems (IDAES) in collaboration with Sandia National Laboratory and Lawrence Berkeley National Laboratory, which develops process systems engineering tools and optimized approaches in the conceptual design and process intensification of innovative systems. The Multiphase Flow with Interphase exchanges (MFIX) element, led by NETL, will also support computational efforts, including machine learning, in collaboration with industry, to gain deep insight into plant operation to improve performance outcomes and reduce unexpected forced outages. Private industry will also use the latest computational tools to mitigate degradation mechanisms imposed by an aging coal fleet and load following to enhance flexibility and extend plant life.

University Training and Research

The University Training and Research activity focuses on developing the next generation of scientists and engineers to strengthen the fossil industry workforce. The FY 2021 Budget will provide $3.5 million for a new competitive funding announcement for U.S. academic institutions of higher learning to support fundamental research that cuts across FE's research focus areas. Such funding aims to sustain a national university program of research in energy and environmental science and engineering related to coal that focuses on innovative and fundamental investigations pertinent to advancing the goals of the Advanced Coal Energy Systems & CCUS program. This activity comprises two areas, which are competitively funded on an annual basis to encourage broad participation:

University Coal Research: This sub-activity provides funding to colleges and universities to support early-stage research consistent with the goals of the program to improve the performance of the existing fleet, develop technologies that will underpin the coal plant of the future, reduce the cost of carbon capture, and create new market opportunities for coal. This sub-activity provides a twofold benefit: conducting directed energy research in an innovative environment, and expanding the research capabilities and education of the next generation of scientists and engineers.

Historically Black Colleges and Universities (HBCU) and other Minority Serving Institutions (MSI): This sub-activity also supports early-stage mission-focused research. Grants awarded under this program are intended to maintain and upgrade the educational, training and research capabilities of HBCUs/MSIs in the fields of science and technology with project results being used to further DOE's commitment to fossil energy research.

Advanced Energy Storage Initiative (AESI)

AESI is a coordinated effort across DOE that will accelerate the development of energy storage R&D as a key to increasing energy security, reliability, resilience and system flexibility technologies. Leveraging the full suite of DOE technologies, the AESI will focus DOE’s efforts to take a broad, more holistic view of energy storage as a set of capabilities that enable temporal flexibility in the conversion of energy resources to useful energy services. Building on OE, EERE, FER&D, and NE activities, the initiative would develop a coordinated strategy for aligning DOE R&D and establish aggressive, yet achievable goals for cost competitive energy storage services. Crosscutting research and analysis in this area will include thermal, mechanical, and/or chemical storage that can be feasibly and economically integrated with existing and future fossil energy power systems. In FY 2021, the Budget provides $5 million to continue funding of this critical area of crosscutting research that spans various divisions in DOE.

International Activities

In coordination with the Department’s Office of International Affairs, international activities support the deployment of U.S. technologies and fossil energy resources to international markets that are seeking advanced high efficiency power plants and carbon capture and utilization technologies. Funding will be used to support international efforts and technical studies with various partners in Europe, North America, Asia, and the Middle East through bi-lateral and multi-lateral agreements. The Request also supports activities in the Clean Energy Ministerial (CEM), International Energy Agency Greenhouse Gas R&D Programme (IEAGHG), International Energy Agency Clean Coal Centre (IEACCC), and Global Carbon Capture Institute (GCCSI).

Sensors and Controls and other Novel Concepts

This activity has moved to the Advanced Energy Systems Program.

Crosscutting Materials R&D

This activity has moved to the Advanced Energy Systems Program.

Advanced Ultra Supercritical Materials R&D

This activity has moved to the Advanced Energy Systems Program.

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Crosscutting Research $49,000,000	**$65,250,000**	**+$16,250,000**
Critical Minerals $23,000,000	**$32,000,000**	**+$9,000,000**
• R&D will advance current bench-scale projects to engineering scale, as well as validate the technical and economic feasibility of producing high purity (90-99% (900,000-990,000 ppm), salable rare earth oxides from 300 parts per million REE-containing coal-based feedstock materials, using conventional extraction, separation and recovery.	• Funding will support optimization and efficiency improvements of pilot-scale facilities for improved process economics; development of innovative transformational REE separation processes using coal-based materials including: sorbents to remove REEs from aqueous sources; sequential leaching concepts; optical fiber & Laser Induced Breakdown Spectroscopy (LIBS) sensor development; interaction with industrial suppliers to provide coal-based feedstock materials for laboratory testing; systems engineering and techno-economic analysis of separation processes; as required, assessment of extramural project economics; and development of geospatial models for the prediction of best available coal-based feedstock resources within the U.S.	• Additional Funds will support accelerated critical minerals extraction and separation from feedstock resources including coal prep/refuse materials and clay-based resources for the generation of critical mineral oxides.
Water Management R&D $9,000,000	**$6,650,000**	**-$2,350,000**
• Field testing, in power plants, of promising technologies developed to reduce energy requirements and operating costs of power plant wastewater treatment. • Development techno-economic assessments of promising technologies to guide technology development pathways. • Increase efficiency of power plants to decrease water consumption. • National Lab. Techno-Economic Assessments to	• Funding will enhance of flexibility, efficiency, and maintainability of existing recirculating cooling towers and advanced dry cooling technology with superior cost and performance, including technologies that operate efficiently under high ambient temperatures.	• The decrease in funding will not impact the ongoing R&D efforts. However, the decrease will limit the number of technologies that can be moved to field testing.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Guide Water Management R&D; Field Testing of Wastewater Treatment Technologies for Fossil Energy Power Plants.		
Modeling, Simulation and Analysis $7,300,000	**$17,100,000**	**+$9,800,000**
• IDAES Consortium in Process Simulation. • NETL-Led National Lab Consortium to accelerate design of new extreme environment materials. • Multiphase Flow Science Modeling - MFIX Toolset Maintenance. • NETL Techno-economic and System Analysis.	• Accelerates code development for the identification of extreme environment materials. • Increase efforts to analyze plant operational data to identify common patterns preceding unexpected plant outages. • Provide for techno-economic and systems studies for efficiency improvements of new and existing plants.	• The Request level will restore funding levels comparable to previous years which was reduced in FY 2020 appropriations.
Advanced Energy Storage Initiative $4,500,000	**$5,000,000**	**+$500,000**
• Crosscutting research and analysis in this area will include thermal, mechanical, and/or chemical storage that can be feasibly and economically integrated with existing and future fossil energy power systems.	• AESI will focus DOE's efforts to take a broad, more holistic view of energy storage as a set of capabilities that enable temporal flexibility in the conversion of energy resources to useful energy services.	• The nominal increase in funding will continue existing R&D for this initiative.
University Training and Research $5,050,000	**$3,500,000**	**-$1,550,000**
• Select and award grants for university based research projects focused on developing concepts related to advanced power systems, open to all university-based applicants.	• New competitive funding announcement for U.S. academic institutions of higher learning to support fundamental research that cuts across FE's research focus areas.	• The decrease in funding will result in fewer projects selected that can advance the university based applicants to innovate in the advanced energy systems.
International Activities $150,000	**$1,000,000**	**+$850,000**
• Funding will cover a portion of membership fees. Remainder of funds will come from program.	• Support for international efforts with various international partners in Europe, North America, Asia, and the Middle East through bilateral and multi-lateral agreements.	• The increase in funding will be utilized for membership fees and supports activities in the clean energy ministerial (CEM), IEAGHG, IEACCC, and GCCSI.

Advanced Coal Energy Systems & CCUS
Carbon Capture, Utilization & Storage

Description

Fossil fuels (coal, natural gas) will play a critical role in meeting the Nation's energy needs including power generation for the foreseeable future. Coal is the Nation's most abundant domestic energy resource, and is an important part of the domestic energy mix, providing about 27% of the Nation's electricity and 38.5% globally. Fossil fuel power plants provide reliable, affordable electricity that powers homes, businesses, and commerce and a significant portion of the country's manufacturing and industrial energy needs. Fossil fuels provide over 60% of the electric power generating needs alone. Over the years, with federal research and development (R&D) investment, coal-fired and natural gas-fired power plants and other industrial sources have made significant progress in reducing emissions of sulfur dioxide, nitrogen oxide, particulate matter, and mercury.

The Carbon Capture, Utilization and Storage (CCUS) subprogram pursues R&D for a new generation of clean, fossil fuel energy conversion systems capable of producing competitively priced electric power with a focus on improving efficiency, increasing plant availability, reducing cooling water requirements, and achieving ultra-low emissions. A key aspect of this research is to enable affordable capture, including conversion techniques, for the utilization of carbon dioxide (CO_2), as well as safe and secure storage of captured CO_2. As such, the program's investments will develop innovative and cost-effective CCUS and emissions control technologies that make progress towards the program goals of reducing the cost of capture by 30% by 2030, for both 1) an existing coal-fired or natural gas-fired power plant retrofitted with CO_2 capture, and 2) a new coal-fired or natural gas-fired power plant with CO_2 capture.

Carbon Capture

Advancements in carbon capture technologies can put the United States (U.S.) within reach of cost-competitive, low CO_2 emission power generation. Carbon capture from fossil fuel-fired generation is a technology solution for mitigating CO_2 emissions, and for concentrating CO_2 for high-value applications such as enhanced oil recovery (EOR). Transformational carbon capture technologies have the potential to support the coal and natural gas sector while advancing U.S. leadership in low-emission generation technology innovation. Many of the same CO_2 capture technologies can be adapted by industry and applied to other industrial sources, natural gas-fired power plants, and for direct air capture (DAC) to remove CO_2 from the atmosphere. R&D is needed on both the materials and systems configurations to address unique challenges such as differences in pollution control systems, oxygen content, and CO_2 concentrations.

The Carbon Capture subprogram is focused on early-stage R&D on post-combustion and pre-combustion CO_2 capture and CO_2 utilization technologies to convert CO_2 to valuable products and commodities. Significant improvements are required to reduce parasitic energy load, and lower capital costs that can support the market potential for large quantities of CO_2 for economic utilization in EOR operations and conversion to high-value products. Low cost CO_2 can strengthen U.S. energy security by enabling the production of up to 60 billion barrels of stranded oil that would otherwise be uneconomic with current recovery practices.[1] Next generation EOR technology could increase recoverable domestic oil to over 130 billion barrels if "next generation" EOR techniques and transformational low cost CO_2 are available.[2] There is not enough low cost CO_2 available from natural sources or natural gas processing facilities to facilitate this recovery to occur. R&D conducted in this subprogram could establish an adoption pathway for industry in transformational low cost CO_2 capture; enabling economic recovery of CO_2 from power plants and other industrial sources.

The Carbon Capture activity has completed its efforts in 1st generation technology through successful demonstration projects. FY 2021 activities represent a focus on new capture technologies to enable novel Coal FIRST concepts and allow for the integration of advanced carbon capture technologies with these systems as well as other CO_2-containing gas streams. Specifically, in FY 2021, the Budget provides $74 million to the Carbon Capture activity for early-stage pre- and

[1] ARI. (2011). Improving Domestic Energy Security and Lowering CO_2 Emissions with "Next Generation" CO_2-Enhanced Oil Recovery (CO_2-EOR).
[2] Ibid

post-combustion capture R&D on transformational gas separation technologies (at least 90% of the CO_2 at 95% purity) that can significantly reduce the cost of CO_2 capture for coal and natural gas-fired power plants, industrial sources, and DAC. Transformational capture systems are a set of disruptive technologies that can significantly reduce the cost of capture, targeting a cost of electricity (COE) at least 30% less than state of the art technologies (~$30/tonne). These transformational technologies will be designed to adapt to the operational demands of current and future advanced power systems including the increasing need for fossil fuel power plants to, at times, be load-following/demand responsive electricity generators. The activity will also investigate approaches to optimize the capture process.

Additionally, the Carbon Capture subprogram will leverage its prior and current R&D experience on carbon capture technology development for application to a suite of negative emissions technologies. These include DAC, and also the application of CCS to bioenergy (i.e., BECCS) and co-firing of mixed feedstocks such as coal and biomass coupled with CCS. R&D will focus on optimization of technologies for these applications to reduce cost and improve performance.

Key R&D challenges for carbon capture include:

- Improving Thermodynamics – reducing energetic requirements through better regeneration energy, lower pressure drops, lower required temperatures and process optimization.
- Improving Kinetics – improving equipment through faster, more selective chemical/physical separation pathways.
- Reducing Capital Cost – reducing total required equipment and costs through advanced manufacturing, process intensification, integration and optimization.
- Improving Scalability – providing economic viability at all relevant process scales.
- Improving Durability – providing rugged long-term performance with slow degradation rates.
- Improving Flexibility – improving process dynamics by improving turn down and operation at variable capture rates.

Post-Combustion Capture Systems

Post-combustion capture refers to removal of the CO_2 after the fuel is combusted. The Carbon Capture program budget includes $70 million for R&D in Post-Combustion Capture Systems, for early-stage R&D on transformational CO_2 separation at both new and existing fossil fuel-fired power plants, and can achieve a 30% reduction in COE compared to a facility operating with current state of the art amine systems. Critical R&D milestones have been achieved since 2008 in laboratory through pilot-scale testing of 2nd generation CO_2 capture approaches through multiple small-scale (0.5-1 MWe) slipstream tests; it is expected that industry will continue the development, adoption, and commercialization of these technologies.

Activities in FY 2021 will continue to focus on the early-stage R&D on novel CO_2 separation technologies such as non-aqueous solvents, membranes, advanced sorbents, and cryogenic processes. This will be achieved through the use of advanced computational tools for rational material discovery, design of advanced capture systems components, and synthesis of these materials with characterization of their physical properties. Funding will support the National Carbon Capture Center (NCCC) to test on actual flue gas. The Budget will also support early stage testing of negative emissions technologies including BECCS and DAC technologies.

Pre-Combustion Capture Systems

Pre-combustion capture refers to removal of the CO_2 from the syngas prior to its combustion for power production.[3] DOE's pre-combustion carbon capture program is focused on pursuing transformational capture goals which require capture of at least 90% of the CO_2, at 95% purity at a cost of approximately $30 tonne/$CO_2$ captured. The Carbon Capture program Budget includes $4 million for Pre-Combustion Capture Systems R&D, to develop transformational technologies for pre-combustion capture that achieve a 30% reduction in the COE relative to state of the art capture technologies. Technologies for pre-combustion capture complement research that is ongoing in creating new fundamental knowledge of advanced gasification systems, including the Coal FIRST initiative, and could be applied to other industrial processes in the chemical industry. Lowering the cost of CO_2 separation from pre-combustion systems is a critical step toward enabling industry to develop and commercialize technologies that open markets for the use of this captured CO_2 for EOR and conversion to

[3] Syngas is primarily hydrogen (H_2) and carbon monoxide (CO) but can include other gaseous constituents. After the syngas is produced, it is further processed in a Water Gas Shift (WGS) reactor to prepare it for pre-combustion capture. WGS converts CO and water to additional H_2 and CO_2.

higher value products or enabling long term storage. FY 2021 funds will continue to support discovery of capture component systems that can enable and be integrated with new Coal FIRST power systems.

Carbon Utilization

The Carbon Utilization subprogram focuses on novel approaches to recycle CO_2 emissions by transforming carbon-containing feedstocks into value-added products. Potential feedstocks include flue gas from fossil fuel generation, industrial point sources, captured/concentrated CO_2, or mixed gas streams. These carbon sources are then converted through a bio-mediated, catalytic, mineralization, or hybrid pathway. Some methods are already commercially available while others are in the very early stages of R&D.

Each conversion technology comes with a suite of particular challenges and opportunities. A critical challenge across utilization technology platforms is the cost-effective, energy-efficient, and selective upgrading of CO_2. The program also works to address the need for enabling technologies including using H_2 as a reactant in the synthesis of fuels and chemicals and maintaining an alkalinity source for mineralization. The efficiency of reaction conversion, amount of CO_2 stored in a product and energy use of these utilization processes also represent a critical challenge that FE can address as it is uniquely positioned to assess the carbon lifecycle of these developing technologies.

In FY 2021, the Budget provides $15 million to this activity for early-stage CO_2 utilization technologies that have the potential to develop additional markets for fossil energy resources. Areas of research include, but are not limited to, new projects focused on the catalytic conversion to higher value products such as nutraceuticals, chemicals and polymers; mineralization to building products; generation of solid carbon products; and biological conversion platforms designed to integrate into fossil fuel plants. Specific focus on catalysts made from low-cost materials, using nano-manufacturing and rational design, will be pursued to lower the energy penalty and capital cost of the conversion process. Funding will support laboratory and bench scale component technologies, as well as the development of at least one early-stage, fully integrated field-test system.

Carbon Storage

The Carbon Storage subprogram is focused on the development of technologies for the safe and secure geologic storage of captured CO_2. Federal government sponsored R&D in this area is critical to validating and increasing confidence in the safety, affordability, and permanence of CO_2 injection and storage. This area of research is in the national interest as it has long-term economic and environmental benefits for the U.S. and industry. In particular these benefits may be realized by financial incentives to store CO_2 such as the California Low Carbon Fuel Standard and the increase to the 45Q tax credit as amended in the 2018 Bipartisan Budget Act. Further advancements in CO_2 storage technology will help ensure that industry has verifiable information to economically and safely assess and monitor long-term storage of CO_2, and ensure the viability of geologic carbon storage as an effective technology solution that can be widely implemented.

Captured CO_2 can be stored in deep saline formations and/or injected for Enhanced Oil Recovery (CO_2-EOR) operations. The Regional Carbon Sequestration Partnership (RCSP) Initiative has demonstrated the technical viability of secure storage through their successful injection and monitoring of over 10 million metric tons of CO_2 into a variety of reservoir types. This initiative, and other projects that have advanced CO_2 storage technologies, have laid a strong technical foundation on which the carbon storage subprogram will build for ensuring safe and secure storage of CO_2. Having achieved this critical step, activities going forward will focus on R&D that accelerates CO_2 storage in on- and off-shore saline reservoirs and the potential added value of CO_2-enhanced hydrocarbon recovery from conventional and unconventional plays. Over 60 billion barrels of known U.S. oil reserves exist that could be produced with CO_2-EOR if large quantities of low cost CO_2 were available. The production of additional tens of billions of barrels could be enabled by further advancements in CO_2 storage technologies that optimize pore space utilization and retention of the CO_2 in the subsurface and displace oil from the oil fields.[4]

[4] ARI. (2011). Improving Domestic Energy Security and Lowering CO2 Emissions with "Next Generation" CO2-Enhanced Oil Recovery (CO2-EOR).

The Budget provides $30 million for R&D activities that address the technical challenges of operating and monitoring CO_2 storage sites. The R&D supported by the Carbon Storage activity in FY2021 will aim to improve storage and operational efficiency, improve understanding of overall cost and strategies to reduce it, and decrease subsurface uncertainties and risk. Achieving each of these elements is critical for enabling storage operations that are safe, economically viable, and environmentally benign.

Storage Infrastructure

The Storage Infrastructure sub-activity is focused on early-stage R&D to identify on- and off-shore geologic storage resources and source matching, to facilitate testing and validation of emerging monitoring technologies, and to evaluate regional CCUS deployment strategies.

The Carbon Storage budget includes $5 million for Storage Infrastructure R&D that will leverage active field projects supported by prior year funding. Historically, FE has funded field projects to conduct regional and site-specific characterization and validation; simulation and risk assessment; and applied monitoring, verification, accounting, and assessment technologies (MVAA) to various onshore and offshore storage reservoirs, including both EOR and saline. These projects have been successful in improving our understanding of CO_2 injection, fluid and pressure migration, and geochemical and geomechanical impacts from CO_2 injection. The projects have also aided development of cost-effective monitoring technologies in all storage types. In an effort to leverage the experience and findings of field efforts such as the Regional Carbon Sequestration Partnerships and the Carbon Storage Assurance Facility Enterprise (CarbonSAFE), FY 2021 funding will support onshore and offshore analyses for geologic/associated storage of CO_2, economic and market analysis and optimization of value added opportunities, and assessments of storage technology readiness, costs, and feasibility.

Advanced Storage R&D

The Advanced Storage R&D sub-activity is focused on developing and validating CO_2 storage technologies that improve capabilities in plume detection, storage efficiency, secure storage verification, subsurface stress assessments, and wellbore integrity monitoring and mitigation. Current CO_2 storage technologies have largely been developed and tested at the laboratory, pilot, and large field test scale. But the integration of these technologies as an optimized monitoring system has yet to be fully vetted. Moreover, multiple complex data streams generated from monitoring activities at various time intervals and spatial scales currently cannot be quickly translated to knowledge about the state of the system. This presents a challenge in making informed decisions that minimize cost and risk and ensure safe and secure operations. Therefore, the rapid conversion of data to knowledge has the potential to transform subsurface operations by enabling rapid decision making and performance assessment based on real-time information.

The Carbon Storage budget includes $25 million for the Advanced Storage R&D sub activity. In FY 2021, activities will focus on efforts to advance machine learning/artificial intelligence (ML/AI) tools and storage technologies with the potential to enable real-time decision-making capabilities for the subsurface. FY 2021 activities will support ML/AI technology pathways for: 1) visualization at relevant scales and machine learning method(s) for real-time visualization; 2) development of real-time history matching capabilities that utilize data from autonomous monitoring platforms; and 3) assessment of enabling smart sensor systems and data processing platforms. Additional activities include R&D to advance sensing and data telemetry capabilities, and high priority studies on fault/fracture networks characterization, stress state, fluid/pressure migration, and wellbore integrity monitoring that advance adaptive reservoir management capabilities and risk reduction.

FY 2021 funded activities also include upgrades to the beta versions of the National Risk Assessment Partnership (NRAP) Phase II tools based on stakeholder and user feedback generated from the integration and utilization of the tools in multiple active projects. Funding for NRAP will also include the further development/demonstration of a set of quantitative, risk-based workflows designed to address risk management and mitigation throughout the lifecycle of a CCUS project. FY 2021 funding will also support on-going curation of program data from existing projects, updates to Atlas and the National Carbon Sequestration Database and Geographic Information System (NATCARB), and the development of new living database systems that can be easily mined by researchers.

Emissions Control

This subprogram, created in FY 2020, focuses on reducing the costs and emissions of non-CO_2 pollutants associated with the use, and combustion of fossil fuels, as well as conversion of coal into combustion residues. This effort would conduct systems analyses and technical assessments to identify and address issues associated with non-CO_2 emissions emitted from fossil-fired power plants as well as industrial applications utilizing coal as a feedstock (i.e., trace and heavy metal emissions in solid, liquid and gaseous effluents that are potential areas of concern). Additional broad research objectives would be to create technologies which would reduce environmental issues arising from (legacy) ash storage facilities. Where applicable, the impacts of and the correlation between coal seams, their content of basic and trace elements, and geochemical interactions in coal seams and their geology on ash composition will be considered.

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Carbon Capture, Utilization & Storage: $217,800,000	***$123,000,000***	***-$94,800,000***
Carbon Capture: $ 114,800,000	**$74,000,000**	**-$40,800,000**
Post-Combustion Capture Systems: $108,800,000	$70,000,000	-$38,800,000
• Discovery of Carbon Capture Substances and Systems (DOCCSS) supports three efforts and scale-up of one DOCCSS technology to test on actual flue gas. • Supports several small scale and/or bench scale carbon capture tests on actual flue gases. • NCCC: Fund and operate the NCCC post combustion carbon capture test facility. • Support R&D to optimize operational parameters such as regeneration energy, solvent degradation, emissions, and materials compatibility. • Support for negative emissions technologies such as DAC. • Support industrial carbon capture pre-feasibility studies.	• Continue support for three DOCCSS technologies and scale-up of one technology to test on actual flue gas. • Continued support for several small scale and/or bench scale carbon capture tests on actual flue gases. • NCCC: Fund and operate the NCCC post combustion carbon capture test facility. • Support R&D to optimize operational parameters such as regeneration energy, solvent degradation, emissions, and materials compatibility. • Laboratory and bench-scale technologies on DAC. • Coal FIRST designs and component testing.	• The decrease in funding reflects the Department's emphasis on early-stage R&D activities and Coal FIRST.
Pre-Combustion Capture Systems: $6,000,000	$4,000,000	-$2,000,000
• Support lab/bench-scale Transformational Carbon Capture technologies.	• Early stage R&D and Coal FIRST design and component testing.	• The decrease in funding reflects the program shift towards emphasizing post-combustion R&D technologies and emphasis on early stage R&D and Coal FIRST.
Carbon Utilization: $21,000,000	**$15,000,000**	**-$6,000,000**
• Laboratory and bench-scale technologies to convert fossil-derived carbon (CO_2, CH_4, and other product and waste streams) in valuable products such as chemicals, fuels, and building products. • Support development of at least one early-stage integrated system	• Laboratory and bench-scale technologies to convert fossil-derived carbon (CO_2, CH_4, and other product and waste streams) in valuable products such as chemicals, fuels, and building products. • Continue to support development of at least one early-stage integrated system.	• The decrease in funding reflects prioritization on early-stage R&D and emphasis on other R&D activities throughout the coal program.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Carbon Storage: $79,000,000	**$30,000,000**	**-$49,000,000**
Storage Infrastructure: $57,000,000	$5,000,000	-$52,000,000
• Support Phase III of the CarbonSAFE initiative and the newly awarded Regional CCUS Deployment Initiative projects. • Perform infrastructure network studies and analyses for CO_2 source and EOR/storage matching, and early stage R&D for high priority activities.	• Perform infrastructure network studies and cost and performance analyses for assessment of onshore and offshore storage technology readiness, costs, and feasibility.	• The decrease in funding reflects R&D activities limited to only those existing projects determined to be high priority.
Advanced Storage R&D: $22,000,000	$25,000,000	+$3,000,000
• Continue support for existing R&D activities on reservoir performance, advanced MVA, geomechanics, wellbore integrity, and risk assessment identified as high priority. • Continue support for NRAP. • Initiates machine learning R&D to advance forecasting capabilities and improve real-time operational performance. • Supports development and deployment of the Energy Data Exchange (EDX).	• Supports R&D to advance sensing and data telemetry capabilities, and high priority studies on fault/fracture networks characterization, stress state, fluid/pressure migration, and wellbore integrity monitoring that advance adaptive reservoir management capabilities. • Continue support for NRAP. • Continue machine learning R&D to advance forecasting capabilities and improve real-time operational performance. • Supports development and deployment of the Energy Data Exchange (EDX).	• The increase in funding continues to prioritize early stage R&D opportunities such as machine learning.
Emissions Control: $3,000,000	**$4,000,000**	**+$1,000,000**
• Conduct systems analyses and technical assessments to identify and address non-CO_2 emissions from coal-fired power plants (i.e., trace metals emissions in solid, liquid and gaseous effluents that are potential areas of concern).	• Conduct early stage R&D, systems analyses and technical assessments to identify and address non-CO_2 emissions from fossil-fired power plants (i.e., trace metals emissions in solid, liquid and gaseous effluents that are potential areas of concern).	• The increase reflects expanded R&D scope that builds upon prior year efforts.

Advanced Coal Energy Systems & CCUS
Supercritical Transformational Electric Power (STEP)

Description

The STEP activity line was created within the Advanced Energy Systems & CCUS program by FY 2015 Enacted appropriations.

The STEP program is focused on R&D to advance higher efficiency and lower cost technologies that advance use of Supercritical CO_2 (sCO_2) power cycles, enabling greater operational efficiency. In FY 2021, the program will continue to work toward design, construction, start-up, and operation of the 10 MWe test facility in San Antonio (TX) and testing to establish operability and performance of selected sCO_2 cycles. This effort includes the design, development, and fabrication of all components in the cycle (i.e., turbomachinery, recuperators, heat source integration, etc.). During operation, the test facility will demonstrate operability of a sCO_2 simple cycle to move the program toward the recompression Brayton Cycle demonstration by 2022.

No funding is requested for the STEP $10MW_e$ pilot as prior year(s) appropriations have fully funded this project.

Supercritical Transformational Electric Power (STEP)

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Supercritical Transformational Electric Power (STEP) **$16,000,000**	**$0**	**-$16,000,000**
• Per congressional direction, $9.8 million consistent with the original scope of work, to complete the necessary design and construction on the 10MW pilot. The remaining $6.2 million will be utilized for additional R&D activities on SCO_2 power cycles.	• No funding is requested in FY 2021.	• Per the original scope of work, FY 2020 funding will fully fund design and construction of the facility.

Advanced Coal Energy Systems & CCUS
Transformational Coal Pilots

Overview

The Consolidated Appropriations Act of 2017 provided $50 million "*to remain available until expended, shall be for the transformational coal technologies pilot program described in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act)"* (H.R. 244). The funding is to support a new solicitation for two large-scale pilots that focus on transformational coal technologies that represent a new way to convert energy to enable a step change in performance, efficiency, and the cost of electricity compared to today's technologies. Such technologies include thermodynamic improvements in energy conversion and heat transfer, such as pressurized oxygen combustion and chemical looping, and improvements in carbon capture systems technology. In making the awards for large-scale pilots, the Department should prioritize entities that have previously received funding for these technologies at the lab and bench scale.

In accordance with this legislation, the solicitation was announced by the Department in August of 2017, with successful Phase I applications announced in FY 2018. Six applicants were selected for Phase II Front End Engineering and Design studies in FY 2019. FY 2019 funds will be carried over into FY 2020 and FY 2021. The balance will be obligated in FY 2020 and FY 2021 for at least one Phase III (construction/operation) award(s).

Description

No funding is requested in FY 2021. Prior year funding will be used to down-select to at least one and possibly two large pilots.

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Transformational Coal Pilots $20,000,000	**$0**	**-$20,000,000**
• Funds will be obligated in FY 2020 and FY 2021 for at least one Phase III (construction/operation) award(s).	• No funding requested.	• No funding is requested. Prior year funding will be used to down-select to at least one and possibly two large pilots.

Advanced Coal Energy Systems & CCUS
NETL Coal Research and Development

Overview

The National Energy Technology Laboratory (NETL) is an integral part of the U.S. Department of Energy (DOE) national laboratory system. There are 17 laboratories in the DOE laboratory system; NETL is unique in that it is the only government operated laboratory. NETL supports the DOE mission to advance the energy security of the United States, as well as Administration interests in domestic energy production, clean coal technologies, and reviving America's coal industry.

NETL Coal Research and Development funds all NETL in-house research efforts. Specifically, NETL Coal Research and Development funding supports Federal researcher salaries and benefits, travel, personal protective equipment and other employee costs for the NETL staff of scientists and engineers who conduct in-house research activities for Fossil Energy Research and Development (FER&D) programs. Funding also supports NETL's Research & Innovation Center strategic efforts such as the Fossil Energy Roadmap and NETL Science & Technology competency assessments. This program supports research capabilities in the areas of computational engineering, material engineering and manufacturing, and geological and environmental systems. NETL in-house research supports program-specific activities in the areas of carbon capture, carbon storage, advanced energy systems, and crosscutting research. This program also funds costs related to collaboration with universities, other national labs, state and local governments, and industry, as well as strategic energy analysis and research data management.

Highlights of the FY 2021 Budget Request

The NETL Coal Research & Development Budget Request of $36.0 million is a $2.0 million reduction from the FY 2020 Enacted level. Within the FY 2021 Budget Request is a decrease in the refresh of specialized research equipment. These purchases will be deferred.

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
$38,000,000	**$36,000,000**	**-$2,000,000**
• Research and Development funding supports salaries and benefits, travel, personal protective equipment and other employee costs for the NETL staff of scientists and engineers who conduct in-house research activities for Fossil Energy Research and Development (FER&D) programs. Funding also supports NETL's Research & Innovation Center strategic efforts such as the Fossil Energy Roadmap and NETL Science & Technology competency assessments. • Funding also provides for costs targeted toward collaboration, strategic energy analysis and research data management areas.	• Research and Development funding supports salaries and benefits, travel, personal protective equipment and other employee costs for the NETL staff of scientists and engineers who conduct in-house research activities for Fossil Energy Research and Development (FER&D) programs. Funding also supports NETL's Research & Innovation Center strategic efforts such as the Fossil Energy Roadmap and NETL Science & Technology competency assessments. • Funding also provides for costs targeted toward collaboration, strategic energy analysis and research data management areas.	• $2 million reduction in total funding. Within the FY 2021 Budget Request is a decrease in the refresh of specialized research equipment. These purchases will be deferred

Natural Gas Technologies
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
51,000	51,000	15,000	-36,000

Overview

Natural Gas sourced from shales has significantly increased America's security of energy supply and lowered prices for consumers. Along with oil and natural gas liquids, natural gas from shales is the foundation of America's newly emergent global energy dominance. Although shale gas has been produced in the United States for many decades, domestic reserves were relatively modest. As recently as 2006, the Energy Information Administration was projecting significant imports of natural gas to meet domestic demand. It has only been over the last decade that new horizontal drilling and hydraulic fracturing technologies have facilitated increased economic production. It is important to note that the "shale revolution" had its early start in technology R&D and field tests conducted by the DOE, leading to subsequent adoption and advancement by industry.

The Natural Gas Technologies Program addresses critical and emergent issues pertaining to the safe and sustainable production and transmission of domestic natural gas. Specifically, the Program's mission is to conduct early stage R&D that supports the prudent development, transportation, distribution and storage of natural gas resources. The Program comprises two subprograms: Natural Gas Infrastructure Research and Development and Gas Hydrates. Given the importance of natural gas in our energy system, it is critical to ensure the safety and reliability of related infrastructure to protect energy access. To that end, the new Natural Gas Infrastructure Research and Development subprogram will support early-stage R&D focused on innovative sensors, materials and systems that enable industry to detect and mitigate resource loss and improve the reliability and operational efficiency of natural gas transmission, distribution, and storage facilities. Additionally, the subprogram will develop alternative technologies to reduce flaring and venting of natural gas during production and transportation through conversion of the natural gas to high-value, readily transportable products.

While shale gas has been discovered in sufficient quantities to support and warrant U.S. liquefied natural gas (LNG) exports, the most plentiful supplies of natural gas throughout the world may, in fact, be the methane molecules trapped in ice-like structures called hydrates. The Gas Hydrates subprogram supports unique early-stage research to evaluate the occurrence, nature, and behavior of the potentially enormous naturally-occurring gas hydrate resources within the United States, with particular focus on the Arctic, Gulf of Mexico, and Atlantic Coastal regions.

Highlights of the FY 2021 Budget Request

The Natural Gas Technologies Program will pursue the following major activities in FY 2021:

- The Natural Gas Infrastructure Research and Development (R&D) subprogram will develop technologies in targeted areas such as advanced materials, sensors, data management tools, in-pipe inspection and repair technologies, and more dynamic compressor research and development. When these technologies are deployed by industry they will reduce emissions and improve the operational efficiency of natural gas transmission, distribution, and storage facilities.
- The FY 2021 Request will seek to develop advanced modular technologies capable of being deployed near wellheads and natural gas processing and transportation infrastructure for the purpose of beneficially utilizing otherwise flared, vented, or stranded natural gas.
- The Gas Hydrates subprogram will evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates. The subprogram will assess the fundamental properties of hydrate bearing sediments for this potentially vast resource. In FY 2021, the subprogram intends to translate potential hydrate resources into latent energy assets via numerical simulations and pore scale visualization of hydrate bearing sediments.
- The Gas Hydrates subprogram will build upon past activities by utilizing the data obtained from the successful drilling of a stratigraphic test well on the Alaska North Slope (ANS) in FY2019 to inform and validate ongoing modeling efforts.

- Proposes closeout and termination of the Environmentally Prudent Development subprogram.
- Proposes closeout and termination of the Emissions Mitigation from Midstream Infrastructure subprogram.
- Proposes closeout and termination of the Emissions Quantification from Natural Gas Infrastructure subprogram.

Natural Gas Technologies
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Natural Gas Technologies				
Gas Hydrates	20,000	20,000	2,000	-18,000
Emissions Mitigation from Midstream Infrastructure	10,000	12,000	0	-12,000
Emissions Quantification from Natural Gas Infrastructure	5,000	6,000	0	-6,000
Environmentally Prudent Development	16,000	13,000	0	-13,000
Natural Gas Infrastructure Research	0	0	13,000	+13,000
Total, Natural Gas Technologies	**51,000**	**51,000**	**15,000**	**-36,000**

SBIR/STTR:

- FY 2019 Transferred: SBIR $1,687: STTR: $191
- FY 2020 Request: SBIR $1,385: STTR: $195
- FY 2021 Request: SBIR $407: STTR: $57

Natural Gas Technologies
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Natural Gas Technologies	
Gas Hydrates: Decrease in funding focuses efforts on laboratory research activities.	**-18,000**
Emissions Mitigation from Midstream Infrastructure: No funding is requested for the Emissions Mitigation from Midstream Infrastructure subprogram in FY 2021.	**-12,000**
Emissions Quantification from Natural Gas Infrastructure: No funding is requested for the Emissions Quantification from Natural Gas Infrastructure subprogram in FY 2021.	**-6,000**
Environmentally Prudent Development: No funding is requested for the Environmentally Prudent Development subprogram in FY 2021.	**-13,000**
Natural Gas Infrastructure Research: Funding reflects research on advanced materials, data management tools, sensors, compressors, and analysis technologies for emissions reduction in midstream infrastructure, as well as conversion technologies for stranded and vented gas.	**+13,000**
Total, Natural Gas Technologies	**-36,000**

Natural Gas Technologies

Description

Gas Hydrates

The Gas Hydrates subprogram will continue to evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates. In order to take advantage of the immense, potential future energy supply from hydrates, the subprogram is leading efforts to characterize hydrate resources through early-stage laboratory research. Laboratory research is focused on numerical simulations, fundamental property characterization, and pore-scale visualization of hydrate-bearing sediments. This unique R&D will provide preliminary motivation for industry investment in development and transformation of these resources to energy assets. Industry funding for research on developing gas hydrate energy resources, even in collaboration with the federal government, remains limited due to the current abundant supply of economically recoverable natural gas resources and constraints within industry that prevent dedicating technical staff and other resources to long-range projects over near-term corporate profitability.

Subprogram activities funded in FY 2021 will focus on characterization of laboratory-synthesized and field-obtained hydrate bearing sediments, which will provide critical input parameters for reservoir simulation of gas production. Numerical simulation efforts are designed to isolate and understand fundamental aspects of gas hydrate system behavior. This work will provide new insight into interactions between hydrate structure and matrix, and surrounding fluids and material. The subprogram intends to develop a suite of models for hydrate characterization and enhanced understanding of hydrate behavior in natural settings.

Natural Gas Infrastructure Research

The new Natural Gas Infrastructure Research subprogram is committed to generating knowledge that industry can use to develop advanced, cost-effective technologies to improve operational reliability and reduce emissions from natural gas transmission, distribution, and storage facilities. Priority areas for the subprogram include early-stage research in advanced materials for pipeline integrity, initiation of research on passive sensor platforms, data management tools that employee artificial intelligence, and more efficient and flexible compressors to adapt to varying pipeline conditions and additional fluids.

The subprogram will accelerate advances in materials science that, with additional scale up by industry, can enhance pipe integrity, reduce leaks, and improve the efficiency of midstream infrastructure operations. FER&D will specifically focus on early development of novel alloys and other composite materials that can be utilized in liners and coatings. The subprogram will also support early-stage research through competitively selected DOE National Lab R&D on low cost, low maintenance novel sensor technologies that can provide predictive analytics on pipeline corrosion rates via detection and monitoring of temperature, pressure, natural gas composition, vibration and strain. The proposed research entails topics and categories not addressed through efforts in other agencies, such as the Pipeline and Hazardous Materials Safety Administration, and that industry will not fund because the Federal and State gas pipeline operators and local utility distribution systems, which achieve a return on their investment through rate cases are currently prohibited from including an R&D fee in customer rates and billing. Additionally, there is continuing reluctance within industry to dedicate technical assets and funds to projects with limited immediate discernible impact on profitability.

The subprogram will also develop advanced modular technologies capable of being deployed near wellheads and natural gas processing and transportation infrastructure for the purpose of beneficially utilizing otherwise flared, vented, or stranded natural gas. The program envisions an R&D effort focused on developing and field testing new and disruptive technologies aimed at converting the otherwise wasted resource, consisting primarily of methane and ethane into electricity or value-added, easily-transportable products.

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Natural Gas Technologies $51,000,000	**$15,000,000**	**-$36,000,000**
Gas Hydrates $20,000,000	**$2,000,000**	**-$18,000,000**
• Conduct early-stage research such as numerical simulations, fundamental property characterization, and pore-scale visualization of hydrate bearing sediments. • Prepare for long-term reservoir flow test on the North Slope of Alaska.	• Conduct early-stage research such as numerical simulations, fundamental property characterization, and pore-scale visualization of hydrate bearing sediments.	• Decrease in funding focuses on laboratory research activities.
Emissions Mitigation from Midstream Infrastructure $12,000,000	**$0**	**-$12,000,000**
• Develop advanced technologies to detect and mitigate methane emissions from natural gas transmission, distribution, and storage infrastructure.	• No funding requested within the Natural Gas Technologies Budget Request.	• No funding requested.
Emissions Quantification from Natural Gas Infrastructure $6,000	**$0**	**-$6,000**
• Develop technologies, sensors, and models focused on better quantifying methane emissions from the natural gas value chain.	• No funding requested within the Natural Gas Technologies Budget Request.	• No funding requested.
Environmentally Prudent Development $13,000,000	**$0**	**-$13,000,000**
• Research to reduce the impact of unconventional oil and gas development, as well as improve understanding of shale geology, fracture dynamics, chemical interactions, and fluid flow in unconventional reservoirs.	• No funding requested within the Natural Gas Technologies Budget Request.	• No funding requested.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Natural Gas Infrastructure Research $0	**$13,000,000**	**+$13,000,000**
• No funding appropriated for Natural Gas Infrastructure Research.	• Funding will support research on advanced materials, data management tools, sensors, compressors, and analysis technologies for emissions reduction in midstream infrastructure. • Funding to develop advanced modular conversion technologies for stranded and flared natural gas.	• Increase reflects research focus on improving the safety and efficiency of natural gas production, transmission, and storage infrastructure, as well as conversion technologies for stranded and vented gas.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
46,000	46,000	17,000	-29,000

Overview

The overall mission of the Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies Program is to provide information and generate knowledge that can be advanced by industry to enable sustainable and responsible development of domestic unconventional fossil energy resources. The prudent development of these natural resources supports the Nation's continued energy resilience and security.

Historically, most of the Nation's oil and natural gas has come from geologic formations that are termed "conventional": they have reservoir characteristics such as permeability and porosity, which typically make production and volumetric assessments relatively straightforward. With the advent of production from shales over the past decade, the United States has increasingly turned to "unconventional" reservoirs for domestic production. These "unconventional" reservoirs require complicated engineering measures, such as hydraulic fracturing, to improve reservoir access and enable production of oil and gas at commercially viable rates. The United States' unconventional oil and natural gas resources has provided America with energy security and is responsible for the country's transition to a net exporter of natural gas.

Despite the dramatic success by industry in producing hydrocarbons from shales, there remain key technical and scientific questions that require early-stage R&D, and which are best addressed through targeted federal investment. At the Request level the program will conduct both lab-based and field work on specific topics and challenges that, while of ultimate interest to industry, are early-stage and hence not yet able to attract industry investment without Federal partnerships. These include novel mechanisms for breaking rock to dramatically increase recovery factors, beyond the current industry standard of 7-10% of unconventional formations (conventional reservoirs have typical recovery factors of 25-40% of the original oil in place). It also includes better understanding of flow mechanisms and mechanics, and enhancing the ability to dynamically engineer the subsurface.

Highlights of the FY 2021 Budget Request

The Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies Program will pursue the following major activities in FY 2021:

- Field laboratory research to improve understanding of shale geology and fracture dynamics in key and emerging shale plays. These projects conduct field testing that complements research, modeling, and experimentation related to unconventional oil and natural gas development. Activities of these projects include borehole tests on the efficacy of production methods, surface and borehole geophysical and geochemical sampling of rocks and fluids, and determination and monitoring of water and gas chemistry at active oil and natural gas production sites.
- Field and laboratory research to improve Enhanced Oil Recovery (EOR) methodologies, technologies, and processes in unconventional reservoirs.
- Basin-specific research and analysis on fluid flow and chemical interactions in unconventional reservoirs.
- Improved subsurface characterization, visualization, and diagnostics, including the development of predictive models and simulations using high-performance computing.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Unconventional Fossil Energy Oil Technologies from Petroleum – Oil Technologies				
Unconventional Fossil Energy Oil Technologies from Petroleum – Oil Technologies	**46,000**	**46,000**	**17,000**	**-29,000**
Total, Unconventional Fossil Energy Oil Technologies from Petroleum – Oil Technologies	**46,000**	**46,000**	**17,000**	**-29,000**

SBIR/STTR:

- FY 2019 Transferred: SBIR $1,500: STTR: $190
- FY 2020 Request: SBIR $1,249: STTR: $176
- FY 2021 Request: SBIR $462: STTR: $65

Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies:	
• The decrease in funding will focus research on the current field test sites as well as fundamental laboratory-based research.	**-29,000**
• The decrease in funding will not provide for any additional new field test sites, produced water treatment technology development, or offshore research.	
Total, Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies	**-29,000**

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies

Description

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies

The Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies Program will conduct early-stage research focused on increasing understanding of shale geology and fracture dynamics through research and technology development at all early-stage technology readiness levels. The research and development activities will be conducted at existing Field Laboratories in key shale plays, gathering field data to inform modeling, and laboratory-based research and analysis. Work will include fundamental research on fluid flow and chemical interactions in unconventional reservoirs, Enhanced Oil Recovery (EOR) research, and high-performance computing for predictive analysis. In FY 2021, these activities will be conducted through existing projects from previous competitive funding solicitations, new projects selected through competitive solicitations, and competitively selected DOE National Laboratory R&D.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies $46,000,000	**$17,000,000**	**-$29,000,000**
• Basin-specific produced water characterization and development of treatment technologies and management tools. • Field laboratory research. • Develop models using high performance computing and big data for predictive analysis. • Research on Enhanced Oil Recovery (EOR) to include the Permian and Bakken formations. • Offshore oil and gas research to include high-pressure high–temperature resistant materials and pipe coatings. • Unconventional oil and gas research on safe and efficient drilling on the Alaska North Slope and artic offshore.	• Field laboratory research at existing and emerging plays. • Research on Enhanced Oil Recovery (EOR) methodologies, technologies, and processes. • Basin-specific research and analysis, to include fluid flow, chemical interactions, and subsurface modeling using high performance computing and big data for predictive analysis.	• The decrease in funding is due to no additional field test sites, produced water treatment technology, or offshore research.

Special Recruitment Programs
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
700	700	900	+200

Overview

The Office of Fossil Energy (FE) utilizes educational programs, such as the Mickey Leland Energy Fellowship (MLEF), Minority Educational Institution Student Partnership Program (MEISPP), and the DOE Scholars Program to support an increase in the number of females and under-represented minorities entering scientific, technology, engineering, and mathematics (STEM) career fields within the U.S. workforce. The MLEF Program, developed by FE, is a ten-week educational program that offers undergraduate, graduate, and post-graduate students majoring in STEM disciplines the opportunity to learn about programs, policies, and research and development initiatives within the Office of Fossil Energy and the challenges in providing clean, affordable energy for future generations. The MEISPP and DOE Scholars Programs also provide students the opportunity to gain work experience and learn about the FE and DOE missions to support preparation for careers in the STEM workforce.

Highlights of the FY 2021 Budget Request

In FY 2021, FE will recruit and select a diverse group of undergraduate, graduate, and post-graduate students in science, technology, engineering, and mathematic majors to participate in the MLEF program. All participants in the MLEF will complete a hands-on research project under the mentorship of a Fossil Energy scientist, researcher, or program official. Students may also be selected into the MEISPP and DOE Scholars Program, as funding permits. MEISPP and DOE Scholars will participate on challenging assignments supporting the FE mission. The Request Level of $900,000 is an increase of $200,000 (28.6%) over the FY 2020 Enacted. The additional funding will result in an increased number of fellowships offered through the MLEF Program.

Special Recruitment Programs
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Special Recruitment Programs	700	700	900	+200
Total, Special Recruitment Programs	**700**	**700**	**900**	**+200**

Special Recruitment Programs
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Special Recruitment Programs: Requested funding level supports expanded recruitment efforts, particularly at Minority Serving Institutions, and an increased number of fellowships offered to students pursuing STEM degrees.	**+200**
Total, Special Recruitment Programs	**+200**

Special Recruitment Programs

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Special Recruitment Programs $700,000	**$900,000**	**+$200,000**
• A diverse group of undergraduate, graduate, and post-graduate students in science, technology, engineering and mathematic majors will be recruited and selected to participate in the MLEF program, the MEISPP, or DOE Scholars program. Provides students opportunity to gain hands-on research and work experience and learn more about the DOE and FE missions.	• A diverse group of undergraduate, graduate, and post-graduate students in science, technology, engineering and mathematic majors will be recruited and selected to participate in the MLEF program, the MEISPP, or DOE Scholars program. Provides students opportunities to gain hands-on research and work experience and learn more about the DOE and FE missions.	• The Budget Request level will support increasing the number of fellowships offered, enable more recruitment, particularly at Minority Serving Institutions, and ensure FE offers compensation that is competitive to other Federal education programs.

Program Direction
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
61,070	61,500	62,451	+951

Overview

Program Direction provides for the Headquarters workforce responsible for the oversight and administration of the Fossil Energy Research and Development (FER&D) program. It also provides for technical staff at the National Energy Technology Laboratory (NETL) who perform Procurement, Finance and Legal functions, as well as Federal workforce and contractor support for Communications. It does not include NETL scientific researchers or project managers.

Also included in Program Direction is funding for the operations of the Import/Export Authorization Office. Import/Export Authorization is managed by the Division of Natural Gas Regulation within the Office of Oil & Natural Gas. The program has responsibility for regulating natural gas and liquefied natural gas (LNG) imports and exports under the Natural Gas Act of 1938, section 3, using both Federal staff and contractor support.

Each of these elements also fund the DOE-wide Human Resources Shared Service Center in Oak Ridge and the FE program office contribution to the DOE Working Capital Fund.

Highlights of the FY 2021 Budget Request

The FY 2021 Budget Request reflects a slight increase from the FY 2020 Enacted amount. This funding level maintains appropriate program oversight and administration of Fossil Energy programs, including the regulation of natural gas and liquefied natural gas imports and exports, supports R&D efforts at NETL to oversee, award, manage, and closeout R&D programs and projects and reduces risk of noncompliance and avoids increase in cycle-time to execute government R&D work. This funding level also supports the Department's efforts to evaluate ways to improve operational efficiency.

Program Direction
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Program Direction Summary				
Washington Headquarters				
Salaries and Benefits	19,313	21,031	21,937	+906
Travel	765	403	394	-9
Support Services	670	558	546	-12
Other Related Expenses	10,857	9,361	8,784	-577
Total, Washington Headquarters	**31,605**	**31,353**	**31,661**	**+308**
National Energy Technology Laboratory				
Salaries and Benefits	15,339	16,206	17,389	+1,183
Travel	450	485	483	-2
Support Services	8,241	7,988	7,452	-536
Other Related Expenses	3,200	3,101	3,086	-15
Total, National Energy Technology Laboratory	**27,230**	**27,780**	**28,410**	**+630**
Import/Export Authorization				
Salaries and Benefits	1,422	1,554	1,557	+3
Travel	20	18	18	0
Support Services	200	231	234	+3
Other Related Expenses	593	564	571	+7
Total, Import/Export Authorization	**2,235**	**2,367**	**2,380**	**+13**

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Total Program Direction				
Salaries and Benefits	36,074	38,791	40,883	+2,092
Travel	1,235	906	895	-11
Support Services	9,111	8,777	8,232	-545
Other Related Expenses	14,650	13,026	12,441	-585
Total Program Direction	**61,070**	**61,500**	**62,451**	**+951**
Federal FTEs – HQ	**113**	**121**	**124**	**+3**
Federal FTEs – NETL[1]	**116**	**121**	**125**	**+4**
Federal FTEs - Total	**229**	**242**	**249**	**+7**
Support Services				
Technical Support				
Headquarters	**670**	**558**	**546**	**-12**
NETL	**0**	**0**	**0**	**0**
Import/Export Authorization	**200**	**231**	**234**	**+3**
Total, Technical Support	**870**	**789**	**780**	**-9**
Management Support				
Headquarters	**0**	**0**	**0**	**0**
NETL	**8,241**	**7,988**	**7,452**	**-536**
Import/Export Authorization	**0**	**0**	**0**	**0**
Total Management Support	**8,241**	**7,988**	**7,452**	**-536**
Total, Support Services	**9,111**	**8,777**	**8,232**	**-545**

[1] Additional NETL FTEs are funded within the NETL Coal Research and Development and NETL Research and Operations budget lines.

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Other Related Expenses				
Headquarters	**10,857**	**9,361**	**8,784**	**-577**
NETL	**3,200**	**3,101**	**3,086**	**-15**
Import / Export Authorization	**593**	**564**	**571**	**+7**
Total, Other Related Expenses	**14,650**	**13,026**	**12,441**	**-585**

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Program Direction $61,500,000	**$62,451,000**	**+$951,000**
Salaries and Benefits $38,791,000	**$40,883,000**	**+$2,2092,000**
• The funding supports HQ Federal staff who provide monitoring (oversight and audit) activities for the FER&D portfolio.	• The funding supports HQ Federal staff who provide monitoring (oversight and audit) activities for the FER&D portfolio.	• HQ increase reflects the addition of 3 FTEs to support FE's mission as well as a 1% pay raise for federal staff, FERS increase, and awards pool funding increase in FY 2021.
• The funding supports the technical Federal staff at the National Energy Technology Laboratory. The staff covered in this area provide for management of the Lab, communications, legal, acquisition and finance activities.	• The funding supports the technical Federal staff at the National Energy Technology Laboratory. The staff covered in this area provide for management of the Lab, communications, legal, acquisition and finance activities.	• NETL increase reflects a shift of 4 FTE from contractor staff to federal staff in the Communications and other Program Direction-funded areas; these positions represent permanent needs (rather than cyclical) in direction-setting roles appropriately staffed with Federal employees as well as a 1% pay raise for federal staff, FERS increase, and awards pool funding increase in FY 2021.
Travel $906,000	**$895,000**	**-$11,000**
• Travel includes funding for management meetings, training, etc.	• Travel includes funding for management meetings, training, etc.	• Travel decreases are minimal reduction.
Support Services $8,777,000	**$8,232,000**	**-$545,000**
• Support Services at Headquarters includes; technical support, IT support, site operations support, administrative support. • Support services at NETL include management and communications support, as well as finance and acquisition technicians.	• Support Services at Headquarters includes; technical support, IT support, site operations support, administrative support. • Support services at NETL include management and communications support, as well as finance and acquisition technicians.	• Support services decreases are minimal reduction at HQ. • NETL decrease of $0.5 million reflects a shift of 4 FTE from contractor staff to federal staff in the Communications area; these positions represent permanent needs (rather than cyclical) in direction-setting roles appropriately staffed with Federal employees.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Other Related Expenses $13,026,000	**$12,441,000**	**-$585,000**
• The activities supported by this line item include E-Government initiatives, Working Capital fund, computer systems and support, contractual services for HQ and environmental, security, safety, and health requirements at HQ and Human Resources shared service center payments.	• The activities supported by this line item include E-Government initiatives, Working Capital fund, computer systems and support, contractual services for HQ and environmental, security, safety, and health requirements at HQ and Human Resources shared service center payments.	• Request reflects a slight decrease due to Working Capital Fund cost efficiencies.

NETL Infrastructure
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
45,000	50,000	43,100	-6,900

Overview

The NETL Infrastructure Program supports the fixed costs of NETL's laboratory footprint in three geographic locations: Morgantown, WV; Pittsburgh, PA; and Albany, OR. Table 1 below provides relevant information on the relative sizes of the sites.

The NETL Infrastructure Program comprises the following subprograms:

(1) **High-Performance Computer (Super Computer)** provides funding for the renewal of a 3-year lease of Joule, NETL's high-performance computer (HPC). The current Joule configuration was funded via a 3-year lease, with funding first provided in FY 2017. This FY 2021 Request includes $6.0 million for the 2nd year of a new 3-year lease upon the expiration of the current lease.

(2) **Laboratory and Site-Wide Facilities** includes repairs to existing laboratory facilities, general-purpose buildings, and site-wide infrastructure and the continued reduction of deferred maintenance balances. Priorities for funding are established to ensure compliance with life safety standards, ensure critical laboratory research facilities and infrastructure, and comply with High-Performance Sustainable Building goals.

(3) **Safeguards and Security** provides funds to ensure protection of workers (physical and cyber), the public, the environment, facilities, and operations in performing the FER&D mission.

(4) **Environmental Restoration** supports NETL's Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) obligations across all NETL sites and two off-site locations in Wyoming.

Table 1[1]: Comparison of Physical Footprint, Workforce, and Value of Assets by Campus and in Total, National Energy Technology Laboratory as of July 31, 2019

	Morgantown	Pittsburgh	Albany	Total NETL
Buildings	43	30	38	111
Sq. Ft. of Building Space	453,098	430,918	253,894	1,137,910
Acres	136.0	57.4	43.9	237.3
NETL Federal Workforce (FTEs)	211	210	38	462[2]
NETL Contractor Workforce (FTEs)	329	346	80	757[3]
Assets Replacement Value	$252.6M	$221.4M	$120.0M	$594.0M

[1] Table 1 uses on board employees as of November 30, 2018 and Table 2 uses authorized and requested FTEs.

[2] Total NETL includes two employees located in Houston, TX and one located in Germantown, MD.

[3] Total NETL includes two contractors located in Houston, TX.

Table 2: Reconciliation of FER&D Federal Employees (FTEs)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
NETL Coal Research & Development	165	175	185
NETL Program Direction	116	121	125
NETL Research & Operations	236	240	245
TOTAL NETL	517	536	555
FE-HQ Program Direction	113	121	124
TOTAL FER&D	**630**	**657**	**679**

Highlights of the FY 2021 Budget Request

The NETL Infrastructure Budget Request is $6.9 million lower than the FY 2020 enacted. The FY 2020 enacted included incremental funding for the design and construction of a sensitive compartmented information facility (SCIF) and for a Computational Science and Engineering (CSE) Center. The FY 2021 Request does not contain funding related to these projects.

FY 2021 Departmental Crosscuts ($K)

	Cybersecurity	
	2020 Enacted	2021 Budget Request
NETL Infrastructure	4,461	4,772

Within the FY 2021 Budget Request, the NETL Infrastructure line supports one Departmental crosscut: Cybersecurity. For FER&D, this includes operation and enhancement of the FER&D cybersecurity policy and program as it relates to the enterprise computing environment at field locations. Key activities include cybersecurity policy implementation, governance and oversight activities, incident detection and response through continuous monitoring and diagnostics, and meeting Departmental requirements for the Identity Control and Access Management initiative. Within the FY 2021 Budget Request for NETL Infrastructure, $4.772 million will be used to support these crosscutting cyber activities. Cybersecurity is funded under the Safeguards and Security subprogram.

NETL Infrastructure
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
NETL Infrastructure				
Super Computer	5,500	6,000	6,000	0
Laboratory- & Site-Wide Facilities	30,400	34,500	27,300	-7,200
Safeguards and Security	7,000	7,500	7,800	+300
Environmental Restoration	2,100	2,000	2,000	0
Total, NETL Infrastructure	**45,000**	**50,000**	**43,100**	**-6,900**

NETL Infrastructure
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
NETL Infrastructure: The FY 2020 enacted included incremental funding for the design and construction of a sensitive compartmented information facility and for a Computational Science and Engineering Center. The FY 2021 Request does not contain funding related to these projects.	**-6,900**
Total, NETL Infrastructure	**-6,900**

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
NETL Infrastructure $50,000,000	**$43,100,000**	**-$6,900,000**
High Performance Computer (Super Computer) $6,000,000	**$6,000,000**	**$0**
• Funding is for the renewal of a 3-year lease of Joule, NETL's high performance computer. Funding was first provided for a 3-year lease to refresh the processing units in FY 2017.	• Funding is for the 2nd year of a 3-year lease of Joule, NETL's high performance computer. Funding was first provided for a 3-year lease to refresh the processing units in FY 2017. This Request includes funding to maintain a new 3-year lease.	• No change
Laboratory and Site wide Facilities $34,500,000	**$27,300,000**	**-$7,200,000**
• Funding includes repairs to existing laboratory facilities and general-purpose buildings and site-wide infrastructure. Funding is also provided for the design and construction of a sensitive compartmented information facility and for a Computational Science and Engineering Center. Priorities for funding are established to ensure compliance with life safety standards, ensure critical laboratory research facilities and infrastructure, and comply with High Performance Sustainable Building goals.	• Funding includes repairs to existing laboratory facilities and general-purpose buildings and site-wide infrastructure. Priorities for funding are established to ensure compliance with life safety standards, ensure critical laboratory research facilities and infrastructure, and comply with High Performance Sustainable Building goals.	• The FY 2021 Request does not contain funding related to the SCIF and CSE Center projects.
Safeguard and Securities $7,500,000	**$7,800,000**	**$300,000**
• Funding is to ensure protection of workers (physical and cyber), the public, the environment, facilities, and operations in performing the FER&D mission.	• Funding is to ensure protection of workers (physical and cyber), the public, the environment, facilities, and operations in performing the FER&D mission.	• A $0.3 million increase in cyber security costs reflects new departmental cybersecurity requirements.

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Environmental Restoration $2,000,000	**$2,000,000**	**$0**
• Continue active operation and maintenance of the air sparge remediation system at Rock Springs Sites 4, 6, 7, 9, and 12 as well as well as a 10-year surface revegetation at the Hoe Creek Site. Continue RCRA-related on-site regulatory, corrective, preventative, and maintenance activities – such as asbestos and lead abatement, waste minimization, and pollution prevention – along with the NETL Albany ground water investigation and compliance activities.	• Continue active operation and maintenance of the air sparge remediation system at Rock Springs Sites 4, 6, 7, 9, and 12 as well as well as a 10-year surface revegetation at the Hoe Creek Site. Continue RCRA-related on-site regulatory, corrective, preventative, and maintenance activities – such as asbestos and lead abatement, waste minimization, and pollution prevention – along with the NETL Albany ground water investigation and compliance activities.	• No change

Plant and Capital Equipment
Capital Summary ($K)

	Total	Prior Years	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Capital Operating Expenses Summary (including Major Items of Equipment (MIE))						
Plant Projects (GPP and IGPP) (<$10M)	n/a	n/a	17,000	23,000	17,000	-6,000
Total, Capital Operating Expenses	**n/a**	**n/a**	**17,000**	**23,000**	**17,000**	**-6,000**
Plant Projects (GPP and IGPP) (Total Estimated Cost (TEC) <$10M)						
Total Plant Projects (GPP/IGPP) (Total Estimated Cost (TEC) <$5M)	n/a	n/a	17,000	23,000	17,000	-6,000
Total, Plant Projects (GPP/IGPP) (Total Estimated Cost (TEC) <$10M)	**n/a**	**n/a**	**17,000**	**23,000**	**17,000**	**-6,000**
Total, Capital Summary	**n/a**	**n/a**	**17,000**	**23,000**	**17,000**	**-6,000**

NETL Research and Operations
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
50,000	50,000	46,000	-4,000

Overview

NETL supports the DOE mission to advance the energy security of the United States, as well as Administration interests in domestic energy production, clean coal technologies, and reviving America's coal industry. NETL has expertise in coal, natural gas, and oil technologies; contract and project management; and analysis of fossil energy systems.

The NETL Research and Operations Program supports variable costs in NETL's science and technology activities. The Program comprises three subprograms:

(1) **Research and Development** funds NETL science and technology development functions, including technical program management. Specifically, Research and Development funding supports salaries and benefits, travel, and other employee costs for the NETL staff of engineers and technical project managers who conduct collaborative research activities for Fossil Energy Research and Development (FER&D) programs. This subprogram also funds contractor costs related to these collaborative research activities.

(2) **Site Operations** includes funding for: (a) building operations and maintenance such as structural repairs, utilities, and janitorial support; and (b) grounds maintenance including parking lot repair, mowing, snow removal, etc.

(3) **Program Oversight** includes funding for Federal employees and contractors performing research-enabling functions such as financial assistance, and legal and finance oversight of research grants and awards.

Highlights of the FY 2021 Budget Request

The NETL Research and Operations Request is $4.0 million lower than the FY 2020 Enacted level. The FY 2021 Budget Request reduces funding for site operations. Efforts will be focused on the highest priority operational needs.

NETL Research and Operations
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
NETL Research and Operations				
Research and Development	26,000	26,000	26,000	-
Site Operations	15,000	15,000	11,000	-4,000
Program Oversight	9,000	9,000	9,000	-
TOTAL NETL Research and Operations	**50,000**	**50,000**	**46,000**	**-4,000**
Federal FTEs	**236**	**240**	**245**	**+5**

Federal FTEs shown above include technical project managers and procurement and finance personnel providing support to DOE's Office of Energy Efficiency and Renewable Energy (EERE), Office of Cybersecurity, Energy Security, and Emergency Response (CESER), and Office of Electricity (OE). These NETL personnel are funded by those non-FER&D offices to the extent that their time is spent supporting those offices. The FY 2021 Request increases federal FTEs by five in the Project Management and Contract Management areas to reduce project risk and increase the likelihood of successful technology development.

Explanation of Major Changes
($K)

	FY 2021 Request vs FY 2020 Enacted
NETL Research and Operations: The FY 2021 Budget Request reduces funding for site operations. Efforts will be focused on the highest priority operational needs..	**-4,000**
Total, NETL Research and Operations	**-4,000**

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
NETL Research and Operations $50,000,000	**$46,000,000**	**-$4,000,000**
$26,000,000	**$26,000,000**	**$0**
• Research and Development funding at NETL provides for collaborative research and development activities, including Federal salaries/benefits, travel and employee costs for engineers, and technical project managers associated with the fossil energy programs. • Funding also provides for the cost of contractors supporting the collaborative research activities. • Funding also provides for ongoing operation and maintenance of project management information systems.	• Research and Development funding at NETL provides for collaborative research and development activities, including Federal salaries/benefits, travel and employee costs for engineers, and technical project managers associated with the fossil programs. • Funding also provides for the cost of contractors supporting the collaborative research activities. • Funding also provides for ongoing operation and maintenance of project management information systems.	• No change.
Site Operations $15,000,000	**$11,000,000**	**-$4,000,000**
• Site Operations funding supports variable costs of operating NETL's laboratories and research sites. Funding provides for operations personnel along with support contractors for building operations, grounds maintenance, utilities, etc.	• Site Operations funding supports variable costs of operating NETL's laboratories and research sites. Funding provides for operations personnel along with support contractors for building operations, grounds maintenance, utilities, etc.	• Efforts will be focused on the highest priority operational needs.
Program Oversight $9,000,000	**$9,000,000**	**$0**
• Program Oversight funding at NETL supports salaries/benefits for federal employees performing research-enabling support functions necessary for the performance of NETL's research activities.	• Program Oversight funding at NETL supports salaries/benefits for federal employees performing research-enabling support functions necessary for the performance of NETL's research activities.	• No change.

Fossil Energy Research and Development
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.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost	FY 2020 Planned Cost	FY 2021 Planned Cost
National Energy Technology Laboratory	15,631	15,238	15,695	16,166
Total, Direct-Funded Maintenance and Repair	**15,631**	**15,238**	**15,695**	**16,166**

Report on FY 2019 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. Conf. Rep. No. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2019 to the amount planned for FY 2019, including Congressionally directed changes.

Total Costs for Maintenance and Repair ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost
National Energy Technology Laboratory	15,631	15,238
Total, Direct-Funded Maintenance and Repair	**15,631**	**15,238**

In review of the planned vs actual costs for FY 2019, the National Energy Technology Laboratory utilized an additional $393(K) of capital funding above planned operational funding toward multiple small projects for maintenance and repair to limit growth in deferred maintenance levels. The Actual Cost includes funding from program direction and Plant and Capital Equipment accounts. Planned funding is identified from program direction.

Excess Facilities

Excess Facilities are facilities no longer required to support the Department's needs, present or future missions or functions, or the discharge of its responsibilities. In this table, report the funding to deactivate and dispose of excess infrastructure, including stabilization and risk reduction activities at high-risk excess facilities, resulting in surveillance and maintenance cost avoidance and reduced risk to workers, the public, the environment, and programs. This includes maintenance of excess facilities (including high-risk excess facilities) necessary to minimize the risk posed by those facilities prior to disposition.

Instructions and guidance for the "Excess Facilities" section of the **Congressional** Budget Justifications.

Fossil Energy Research and Development
Excess Facilities

Costs for Direct-Funded Excess Facilities ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost	FY 2020 Planned Cost	FY 2021 Planned Cost
National Energy Technology Laboratory (All)	143	250	125	125
NA	0,000	0,000	0,000	0,000
Total, Direct-Funded Excess Facilities	143	250	125	125

Fossil Energy Research & Development
Capital Summary ($K)

	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Capital Operating Expenses Summary (including (Major Items of Equipment (MIE))			
Plant Projects (GPP and IGPP) (<$10M)	23,000	17,000	-6,000
Total, Capital Operating Expenses	**23,000**	**17,000**	**-6,000**
Plant Projects (GPP and IGPP) (Total Estimated Cost (TEC) <$10M)			
Total Plant Projects (GPP/IGPP) (Total Estimated Cost (TEC) <$5M)	23,000	17,000	-6,000
Total, Plant Projects (GPP/IGPP) (Total Estimated Cost (TEC) <$10M)	**23,000**	**17,000**	**-6,000**
Total, Capital Summary	**23,000**	**17,000**	**-6,000**

Fossil Energy Research and Development
Research and Development
($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Basic	32,934	34,022	558,256	+524,234
Applied	625,751	646,411	139,564	-506,847
Development	0	0	0	0
Subtotal, R&D	**658,685**	**680,433**	**697,820**	**+17,387**
Equipment	22,500	29,000	23,000	-6,000
Construction	0	0	0	0
Total, R&D	**681,185**	**709,433**	**720,820**	**+11,387**

Fossil Energy Research and Development
Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR)
($K)

	FY 2019 Enacted/ Transferred	FY 2020 Enacted Projected Transfer	FY 2021 Request/ Projected Transfer	FY 2021 Request vs FY 2020 Enacted
CCS and Power Systems				
SBIR	14,558	10,636	12,546	+1,910
STTR	1,762	1,495	1,765	+270
Natural Gas Technologies				
SBIR	1,687	1,385	407	-978
STTR	191	195	57	-138
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies				
SBIR	1,500	1,249	462	-787
STTR	190	176	65	-111
Total, SBIR/STTR	**19,888**	**15,136**	**15,302**	**+166**

Fossil Energy Research and Development
Safeguards and Security ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Protective Forces	2,840	2,983	3,072	+89
Physical Security Systems	151	159	1,195	+1,036
Information Security	91	273	319	+46
Cyber Security*	3,881	4,416	4,772	+356
Personnel Security	154	225	285	+60
Material Control and Accountability	0	0	0	0
Research and Development	0	0	0	0
Program Management	254	456	491	+35
Security Investigations	0	0	0	0
Transportation Security	0	0	0	0
Construction	0	0	0	0
Total, Safeguards and Security	**7,371**	**8,512**	**10,134**	**+1,622**

*Does not include Fossil Energy R&D-funded HQ cybersecurity (FY 2019, $884K; FY 2020, $920K; FY 2021, $1,170K)

NETL - Within the Budget Request, the NETL Infrastructure line supports one Departmental Crosscut: Cybersecurity. For FER&D, this includes operation and enhancement of the FER&D cybersecurity policy and program as it relates to the enterprise computing environment at field locations. Key activities include cybersecurity policy implementation, governance and oversight activities, incident detection and response through continuous monitoring and diagnostics, and meeting Departmental requirements for the Identity Control and Access Management initiative. The $1,000,000 increase for the Physical Security Systems line-item is for a one-time expenditure, investing in a Video Surveillance Project at NETL's Albany, Morgantown, and Pittsburgh facilities to enhance on-site threat detection and mitigation capabilities. The NETL totals for Cybersecurity are: FY 2021= $4.772M; FY 2020 = $4.416M; FY 2019 =$3.881M.

DEPARTMENT OF ENERGY
Funding by Site Detail
TAS_0213 - Fossil Energy Research and Development BY2021
(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Ames Laboratory			
Advanced Energy Systems	500	835	1,792
Cross Cutting Research	300	0	0
Advanced Coal Energy Systems & CCUS	800	835	1,792
Total Ames Laboratory	**800**	**835**	**1,792**
Argonne National Laboratory			
Advanced Coal Energy Systems & CCUS	0	30	40
Unconventional Fossil Energy from Petroleum - Oil Technologies	150	150	55
Total Argonne National Laboratory	**150**	**180**	**95**
Idaho National Laboratory			
Carbon Capture Utilization and Storage	0	130	73
Advanced Energy Systems	0	434	931
Advanced Coal Energy Systems & CCUS	0	564	1,004
Total Idaho National Laboratory	**0**	**564**	**1,004**
Lawrence Berkeley National Laboratory			
Carbon Capture Utilization and Storage	2,281	3,402	1,921
Cross Cutting Research	2,400	81	108
Advanced Coal Energy Systems & CCUS	4,681	3,483	2,029
Unconventional Fossil Energy from Petroleum - Oil Technologies	1,672	1,672	618
Natural Gas Technologies Research	1,525	1,338	323
Total Lawrence Berkeley National Laboratory	**7,878**	**6,493**	**2,970**
Lawrence Livermore National Laboratory			
Carbon Capture Utilization and Storage	475	2,242	1,266
Advanced Coal Energy Systems & CCUS	475	2,242	1,266
Unconventional Fossil Energy from Petroleum - Oil Technologies	1,000	1,000	370
Natural Gas Technologies Research	22	22	2
Total Lawrence Livermore National Laboratory	**1,497**	**3,264**	**1,638**
Los Alamos National Laboratory			
Carbon Capture Utilization and Storage	3,295	3,474	1,962
Advanced Coal Energy Systems & CCUS	3,295	3,474	1,962
Unconventional Fossil Energy from Petroleum - Oil Technologies	1,279	1,279	473
Natural Gas Technologies Research	1,100	894	298
Total Los Alamos National Laboratory	**5,674**	**5,647**	**2,733**
National Energy Technology Lab			
STEP Supercritical CO2	22,430	2,000	0
Transformational Coal Pilots	25,000	20,000	0
CCS and Power Systems	47,430	22,000	0
Carbon Capture Utilization and Storage	75,941	27,643	15,611
Advanced Energy Systems	61,052	34,331	73,674
Cross Cutting Research	33,435	11,415	15,200
NETL Coal Research and Development - Fossil Energy	36,000	38,000	36,000
Advanced Coal Energy Systems & CCUS	206,428	111,389	140,485
Program Direction - Fossil Energy	27,230	27,780	28,410
Unconventional Fossil Energy from Petroleum - Oil Technologies	38,489	38,489	14,224
Natural Gas Technologies Research	22,441	22,106	6,218
NETL Research and Operations - Fossil Energy	50,000	50,000	46,000

NETL Infrastructure - Fossil Energy	45,000	50,000	43,100
Total National Energy Technology Lab	**437,018**	**321,764**	**278,437**
National Renewable Energy Laboratory			
Cross Cutting Research	0	172	229
Advanced Coal Energy Systems & CCUS	0	172	229
Total National Renewable Energy Laboratory	**0**	**172**	**229**
Oak Ridge National Laboratory			
Carbon Capture Utilization and Storage	0	1,075	607
Advanced Energy Systems	0	12,499	26,823
Advanced Coal Energy Systems & CCUS	0	13,574	27,430
Total Oak Ridge National Laboratory	**0**	**13,574**	**27,430**
Pacific Northwest National Laboratory			
Carbon Capture Utilization and Storage	829	3,952	2,232
Advanced Energy Systems	0	494	1,060
Cross Cutting Research	320	0	0
Advanced Coal Energy Systems & CCUS	1,149	4,446	3,292
Unconventional Fossil Energy from Petroleum - Oil Technologies	500	500	185
Natural Gas Technologies Research	599	699	377
Total Pacific Northwest National Laboratory	**2,248**	**5,645**	**3,854**
Sandia National Laboratories			
Carbon Capture Utilization and Storage	350	812	459
Advanced Energy Systems	250	0	0
Cross Cutting Research	2,495	0	0
Advanced Coal Energy Systems & CCUS	3,095	812	459
Unconventional Fossil Energy from Petroleum - Oil Technologies	1,800	1,800	665
Natural Gas Technologies Research	566	502	171
Total Sandia National Laboratories	**5,461**	**3,114**	**1,295**
SLAC National Accelerator Laboratory			
Unconventional Fossil Energy from Petroleum - Oil Technologies	252	252	93
Natural Gas Technologies Research	1,150	934	311
Total SLAC National Accelerator Laboratory	**1,402**	**1,186**	**404**
Washington Headquarters			
CCS and Power Systems	0	14,000	0
Carbon Capture Utilization and Storage	115,596	175,070	98,869
Advanced Energy Systems	95,881	101,407	217,620
Cross Cutting Research	7,400	37,302	49,673
Advanced Coal Energy Systems & CCUS	218,877	313,779	366,162
Program Direction - Fossil Energy	31,605	31,353	31,661
Special Recruitment Programs	700	700	900
Import Export Authorization	2,235	2,367	2,380
Unconventional Fossil Energy from Petroleum - Oil Technologies	858	858	317
Natural Gas Technologies Research	23,597	24,505	7,300
Total Washington Headquarters	**277,872**	**387,562**	**408,720**

Naval Petroleum and Oil shale Reserves

Naval Petroleum and Oil shale Reserves

Naval Petroleum and Oil Shale Reserves
Proposed Appropriation Language

For Department of Energy expenses necessary to carry out naval petroleum and oil shale reserve activities, [$14,000,000] *$13,006,000* to remain available until expended: *Provided*, That notwithstanding any other provision of law, unobligated funds remaining from prior years shall be available for all naval petroleum and oil shale reserve activities: *Provided further*, up to $242,000,000 in proceeds from the sale of crude oil from the Strategic Petroleum Reserve shall be made available until expended to complete comprehensive remediation activities at the Naval Petroleum Reserve-1 site as provided for in section 309 of this title.

Explanation of Changes

A total of $255 million is the estimated requirement to complete comprehensive remediation activities at the Naval Petroleum Reserve No. 1 (NPR-1) site during the next five-year remediation contract. New FY 2021 budget authority of $13 million will fund continued NPR-1 environmental assessment and remediation activities. An additional $242 million in proceeds from the proposed sale of 15 million barrels of crude oil from the Strategic Petroleum Reserve (SPR) will be used to fund the completion of all NPR-1 remediation work. Completing remediation activities by 2025 with the additional $242 million cuts an estimated 40 years and $400 million from the current cost and schedule estimate (completion in 2068 at a cost of $667 million).

Public Law Authorizations

- P.L. 94-258, U.S. Naval Petroleum Reserves Production Act of 1977
- P.L. 95-91, U.S. Department of Energy Organization Act of 1977
- P.L. 104-106, The National Defense Authorization Act For Fiscal Year 1996
- P.L. 105-261, The Strom Thurmond National Defense Act for Fiscal Year 1999
- P.L. 109-58, Energy Policy Act of 2005

Naval Petroleum and Oil Shale Reserves
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
10,000	14,000	13,006	-994

Overview

The Naval Petroleum and Oil Shale Reserves (NPOSR) program manages five legal agreements that were executed as part of the 1998 sale of Naval Petroleum Reserve 1 (NPR-1) in Elk Hills, California. The legal agreements direct post-sale work, including environmental restoration and remediation, contract closeout, and records disposition. Legal agreements also include payment for post-employment medical and dental benefits to former NPR-1 Management & Operating (M&O) contractor employees. The NPR-1 program continues to work towards closing out the remaining environmental findings at the site, as required by the 2008 agreement between the Department of Energy (DOE) and the California Department of Toxic Substances Control (DTSC).

DOE also operated Naval Petroleum Reserve 3 (NPR-3) and the Rocky Mountain Oilfield Testing Center (RMOTC), co-located near Casper, Wyoming, until its sale in January 2015. DOE retains responsibility for Industrial Landfill number 2 (IND-2) located at NPR-3 until a closure permit is issued by the Wyoming Department of Environmental Quality (WDEQ). Landfill remediation activities were completed in FY 2017 and ground water sampling began in compliance with WDEQ requirements. The period of sampling will be specified by WDEQ but is expected to continue for two to five years. No new FY 2021 budget authority is required nor requested for NPR-3.

The program will continue the ongoing activities to attain release from the remaining environmental findings related to the sale of NPR-1. All 131 areas of concern (AOC) have undergone an initial investigation and the program has made recommendations to California's DTSC for either no further action (NFA) required status, additional field work investigation, or remedial action.

Highlights and Major Changes in the FY 2021 Budget Request

A total of $255 million is required to complete remediation activities at the NPR-1 site during the next five-year remediation contract. New FY 2021 budget authority of $13 million will support continued work with the California DTSC and other stakeholders on the environmental remediation and cultural resource activities in accordance with the 2008 DTSC Corrective Action Consent Agreement to obtain NFA status for all 131 AOCs. An additional $242 million in proceeds from the proposed sale of 15 million barrels of SPR crude oil will be used to fund the completion of all NPR-1 remediation work.

Also included is the payment to former NPR-1 M&O contractor employees for post-employment medical and dental benefits**.** NPR-3 will continue groundwater sampling activities for the landfill closure with oversight by the Washington Headquarters office.

Naval Petroleum and Oil Shale Reserves
Funding by Congressional Control ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Naval Petroleum and Oil Shale Reserves				
Production Operations	8,000	12,000	11,000	-1,000
Management	2,000	2,000	2,006	+6
Total, Naval Petroleum and Oil Shale Reserves	**10,000**	**14,000**	**13,006**	**-994**
Federal FTEs	**4**	**4**	**4**	

Naval Petroleum and Oil Shale Reserves
Production Operations

Overview

The NPR-1 program continues to work towards closing out the remaining environmental restoration and remediation activities for 131 AOCs, as required by the 2008 agreement between DOE and California's DTSC. DOE will continue the monitoring and oversight of environmental remediation of the Elk Hills site and the work on records disposition.

The NPR-3 program will continue post-sale activities for the closure of the landfill using prior-year balances. No new FY 2021 Budget Authority is required for NPR-3.

Highlights of the FY 2021 Budget Request

The current appropriation schedule of $10 million to $14 million per year is not sufficient to complete NPR-1 remediation during the next five-year remediation contract beginning in 2021. In fact, at the current funding level, remediation will not be complete until FY 2068. To complete remediation activities at the NPR-1 site during the next five-year remediation contract, a total of $255 million is required. The Department is requesting new FY 2021 budget authority of $13 million and is also proposing to sell 15 million barrels of SPR crude oil to raise up to the additional $242 million needed to fund the completion of remediation work at the NPR-1 site.

Of the 131 AOCs for which DOE is responsible for environmental cleanup, as of January 2020, 98 AOCs have received NFA certification from California's DTSC, and 4 AOCs are under DTSC review for NFA certification. The remaining 29 AOCs that require remediation are larger-scale projects with substantial funding requirements. New FY 2021 budget authority of $13 million supports remediation of 3 sub-AOCs.

Production Operations
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
NPR-1 Closeout	8,000	12,000	11,000	-1,000
NPR-3 Disposition	0	0	0	0
Total, Production Operations	**8,000**	**12,000**	**11,000**	**-1,000**

Production Operations
Explanation of Major Changes
($K)

	FY 2021 Request vs FY 2020 Enacted
NPR-1 Closeout FY 2021 budget authority will finance continued environmental assessment and remediation activity, in accordance with NPR-1 post-sale legal agreements. Additional funding of $242 million in SPR crude oil sale proceeds is needed to fund the completion of remediation work at the NPR-1 site.	**-1,000**
NPR-3 Disposition: No FY 2021 budget authority is requested. NPR-3 ongoing post-sale remediation monitoring activities will continue through NPR-3 closeout in two to five years.	**0**
Total, Production Operations	**-1,000**

Production Operations

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Production and Operations $12,000,000	**$11,000,000**	**-$1,000,000**
NPR-1 Closeout $12,000,000	**$11,000,000**	**-$1,000,000**
• Program will continue the ongoing activities to attain release from the remaining environmental findings related to the sale of NPR-1. The FY 2020 Enacted amount includes funding that supports remediation of 5 AOCs and 6 sub-AOCs.	• Program will continue the ongoing activities to attain release from the remaining environmental findings related to the sale of NPR-1. This FY 2021 Budget Request includes funding that supports remediation of 3 sub-AOCs.	• Additional funding of $242 million in SPR crude oil sale proceeds is needed to fund the completion of remediation work at the NPR-1 site.
NOR-3 Disposition $0	**$0**	**$0**
• Disposition completed; post-sale remediation monitoring activities for the landfill are ongoing.	• Disposition completed; post-sale remediation monitoring activities for the landfill are ongoing.	• No change.

Naval Petroleum and Oil Shale Reserves
Management

Overview

Management provides the Federal staffing resources and associated costs required to provide overall direction and execution of the NPOSR. There are a variety of inherently governmental functions, such as program management, contract administration, and budget formulation and execution that require a dedicated Federal workforce. NPOSR uses contractor support services and other related expenses to support the field environmental assessment, remediation and management of the program.

Highlights of the FY 2021 Budget Request

The NPR-1 funding supports Federal staff that provide oversight, monitor environmental clean-up, and manage disposition activities. The sales agreements also includes payments to former NPR-1 M&O contractor employees for post-medical and dental benefits.

NPR-3/RMOTC final office closeout was completed December 30, 2015; however, administrative oversight of the landfill closure will continue to be conducted by the Department of Energy Headquarters office. No new FY 2021 budget authority is required for NPR-3.

Management
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs. FY 2020 Enacted
Washington Headquarters				
Salaries and Benefits	525	525	531	+6
Travel	50	50	50	0
Support Services	425	425	425	0
Other Related Expenses	1,000	1,000	1,000	0
Total, Washington Headquarters	**2,000**	**2,000**	**2,006**	**+6**
NPR – Wyoming				
Salaries and Benefits	0	0	0	0
Travel	0	0	0	0
Support Services	0	0	0	0
Other Related Expenses	0	0	0	0
Total, NPR – Wyoming	**0**	**0**	**0**	**0**
Total Management				
Salaries and Benefits	525	525	531	+6
Travel	50	50	50	0
Support Services	425	425	425	0
Other Related Expenses	1,000	1,000	1,000	0
Total, Management	**2,000**	**2,000**	**2,006**	**+6**
Federal FTEs	**4**	**4**	**4**	
Support Services				
Technical Support				
Environmental, Safety, Security & Health	0	0	0	0
Technical Services	400	400	400	0
Total, Technical Support	**400**	**400**	**400**	**0**
Management Support				
Business Administration	0	0	0	0
IT Support	25	25	25	0
Total Management Support	25	25	25	0
Total, Support Services	**425**	**425**	**425**	**0**

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs. FY 2020 Enacted
Other Related Expenses				
Rent to Others	0	0	0	0
Communications, Utilities & Misc.	0	0	0	0
Other Services	1,000	1,000	1,000	0
Operation and Maintenance of Equipment	0	0	0	0
Supplies and Materials	0	0	0	0
Total, Other Related Expenses	**1,000**	**1,000**	**1,000**	**0**

Management
Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Management$2,000,000	**$2,006,000**	**+$6,000**
Salaries and Benefits $525,000	**$531,000**	**+$6,000**
Continue monitoring activities at NPR-1 (cultural resources mitigation, environmental clean-up, oversight and audit).	Continue monitoring activities at NPR-1 (cultural resources mitigation, environmental clean-up, oversight and audit). No new FY 2021 budget authority is required for NPR-3.	Includes funding to support an increase to the award pool for FY 2021.
Travel $50,000	**$50,000**	**$0**
Federal travel will be required for environmental cleanup at NPR-1.	Federal travel will be required for environmental cleanup at NPR-1. No new FY 2021 budget authority is required for NPR-3.	No change.
Support Services $425,000	**$425,000**	**$0**
Support Services for environmental clean-up of NPR-1.	Support Services for environmental clean-up of NPR-1. No new FY 2021 budget authority is required for NPR-3.	No change.
Other Related Expenses $1,000,000	**$1,000,000**	**$0**
As in prior years, funding provides for post-employment medical and dental benefits for former M&O contractor employees at NPR 1.	As in prior years, funding provides for post-employment medical and dental benefits for former M&O contractor employees at NPR 1. No new FY 2021 budget authority is required for NPR-3.	No change.

DEPARTMENT OF ENERGY

Funding by Site Detail

TAS_0219 - Naval Petroleum and Oil Shale Reserve BY2021

(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Naval Petroleum Reserve No 1			
Naval Petroleum & Oil Shale Reserves	8,000	12,000	11,000
Total Naval Petroleum Reserve No 1	**8,000**	**12,000**	**11,000**
Washington Headquarters			
Naval Petroleum & Oil Shale Reserves	2,000	2,000	2,006
Northeast Home Heating Reserve	962	962	0
Total Washington Headquarters	**2,962**	**2,962**	**2,006**
Undesignated LPI			
Northeast Home Heating Reserve	9,038	9,038	0
Total Undesignated LPI	**9,038**	**9,038**	**0**

Strategic Petroleum Reserve

Strategic Petroleum Reserve

Strategic Petroleum Reserve
Proposed Appropriation Language

For Department of Energy expenses necessary for Strategic Petroleum Reserve facility development and operations and program management activities pursuant to the Energy Policy and Conservation Act (42 U.S.C. 6201 et seq.), [$195,000,000] *$187,081,000*, to remain available until expended.

Explanation of Changes

Decrease reflects reductions to the Cavern Integrity Program, preventive/corrective maintenance activities, and technical support service activities alongside an increase to the Major Maintenance Program.

Public Law Authorizations
Public Law 109-58, "Energy Policy Act of 2005"

Strategic Petroleum Reserve
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
235,000[1]	195,000	187,081	-7,919

Overview

The Strategic Petroleum Reserve (SPR) protects the U.S. economy from disruptions in critical petroleum supplies and meets the U.S. obligations under the International Energy Program (Energy Policy and Conservation Act, P.L. 94-163, as amended, Section 151). The SPR benefits the United States by providing an insurance policy against potential interruptions in U.S. petroleum supplies, whether originating from domestic or international supply disruptions, natural disasters, sabotage, or acts of terrorism.

FY 2021 funds support the program's operational readiness and drawdown capabilities. The SPR will continue conducting multiple non-emergency crude oil sales in FY 2021 as directed by the Bipartisan Budget Act of 2015 (P.L. 114-74, Section 403) and Consolidated Appropriations Act, 2018 (P.L. 115-141, Section 501). In accordance with the Bipartisan Budget Act of 2015, Section 403 directs the sale of 5 million barrels in FY 2021. Under Section 501 of the Consolidated Appropriations Act, 2018, the Secretary of Energy is directed to drawdown and sell a total of 10 million barrels of SPR crude oil during the time period encompassing FYs 2020 and 2021.

Consistent with prior budget requests, the Administration is re-proposing to disestablish the Northeast Gasoline Supply Reserve (NGSR) in the FY 2021 budget. Accordingly, the Secretary of Energy will disestablish the NGSR and drawdown and sell that reserve's one million barrels of refined petroleum product from the Strategic Petroleum Reserve during fiscal year 2021 with $19 million of the proceeds from the sale to be deposited into the SPR Petroleum Account for congressionally-mandated crude oil sale logistical/transportation costs and shall remain available until expended. Any proceeds in excess of $19 million collected from the sale of refined petroleum product shall be deposited into the general fund of the Treasury during fiscal year 2021 and dedicated to deficit reduction.

The NGSR was administratively established in 2014 as part of the Strategic Petroleum Reserve (SPR) to ease regional shortages resulting from sudden/unexpected supply interruptions (i.e., Superstorm Sandy). The NGSR consists of 1 million barrels of gasoline blendstock stored in leased commercial storage terminals located Maine, Massachusetts, and New Jersey. The NGSR is not cost efficient or operationally effective. An Annual Coordinating Meeting of Entity Stockholders (ACOMES) benchmarking study of other oil stockpiling countries indicates that NGSR operating costs are twice as much as the next highest-cost country's gasoline reserve, and four times as costly as the third highest-cost country's gasoline reserve. Additionally, the NGSR represents less than one day of gasoline consumption in the Northeast, and it has never never been used for its intended purpose of providing emergency gasoline supply to the Northeast during a time of disruption.

Highlights and Major Changes in the FY 2021 Budget Request.

The SPR Program will pursue the following major activities in FY 2021:

- Conduct cavern wellbore diagnostic and remediation activities utilizing 1 workover rig and crew that includes 8 cavern wellbore workovers and 1 cavern wellbore remediation. Continue Mechanical Integrity Testing required for cavern wells and adjust priority planned schedule to accommodate any that have either failed hydraulically or failed 5-year state-required testing cycle.
- Conduct equipment and facility maintenance for drawdown capability.
- Continuation of legislatively directed non-emergency multi-year crude oil sales.
- Supports Security Program and maintenance of security related infrastructure items.

Major changes from FY 2020 includes the utilization of one rig and workover rig crew to perform 1 cavern wellbore

[1] FY 2018 and 2019 Appropriation includes funding of $29 million directed to Northeast Gasoline Supply Reserve to maintain annual lease. Remaining funding is for the operations of the Strategic Petroleum Reserve.

remediation and 8 cavern wellbore workovers within the Cavern Integrity Program compared to 6 cavern wellbore workovers in FY 2020 and 1 cavern wellbore remediation. Unanticipated cavern issues may require reprioritization of projects to fund emergency repairs with consideration to tasks being completed for normal operations, multi-year crude oil sales and the Life Extension II Project. Planned Major Maintenance construction projects will increase to 12 compared to 3 in FY 2020. Preventive and corrective maintenance activities will include planned purchases of pumps, valves, actuators, and motors. A decrease to the Security Program in Physical Security Personnel training, assessments, and equipment replacements is expected. However, the Security Program can retain capable effectiveness in providing a deterrence and response posture to adversarial threats.

Cybersecurity: DOE is engaged in three categories of cyber-related activities: protecting the DOE enterprise from a range of cyber threats that can adversely impact mission capabilities; bolstering the U.S. Government's capabilities to address cyber threats; and, improving cybersecurity in the electric power subsector and the oil and natural gas subsector. The cybersecurity crosscut supports central coordination of the strategic and operational aspects of cybersecurity and facilitates cooperative efforts such as the Joint Cybersecurity Coordination Center for incident response and the implementation of Department-wide Identity Credential and Access Management.

	Cyber-security	Total
Facilities Development and Operations	2,664	2,664

Strategic Petroleum Reserve
Funding by Congressional Control ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Strategic Petroleum Reserve				
Facilities Development and Operations	180,026	168,235	159,174	-9,061
Management	25,974	26,765	27,907	+1,142
Northeast Gasoline Supply Reserve	29,000	0[2]	0	0
Total, Strategic Petroleum Reserve	**235,000**	**195,000**	**187,081**	**-7,919**
Federal FTEs	**126**	**126**	**126**	**0**

[2] FY 2018 and 2019 Appropriation includes funding of $29 million directed to Northeast Gasoline Supply Reserve to maintain annual lease. In FY 2020, the NGSR will be supported with prior-year balances. This budget assumes that the NGSR will be disestablished in FY 2021.

Strategic Petroleum Reserve

Overview

The Strategic Petroleum Reserve (SPR) protects the U.S. economy from disruptions in critical petroleum supplies and meets the U.S. obligations under the International Energy Program (Energy Policy and Conservation Act, P.L. 94-163, as amended, Section 151). The SPR benefits the United States by providing an insurance policy against potential interruptions in U.S. petroleum supplies whether originating from domestic and international supply disruptions, natural disasters, sabotage, and acts of terrorism.

The SPR has 635 million barrels of crude oil inventory (as of December 31, 2019) stored in underground cavern storage, providing the United States with multiple geostrategic benefits, and anchoring the world's collective energy security system. A release of petroleum from the SPR can mitigate the potential economic damage of an actual disruption in international or domestic petroleum supplies and the accompanying price increases. The SPR avails the United States of international emergency assistance through its participation in the International Energy Agency (IEA) energy supply security initiatives. IEA members are required to maintain 90 days' worth of net petroleum import protection in government-owned and/or commercial stocks, and have a commitment to participate with other stockholding nations in a coordinated release of stocks in the event of a major supply disruption. The inventory of 635 million barrels of crude oil as of December 31, 2019 would provide about 1,270 days of 2019 net import protection and 161 days of net crude oil import protection (based on net petroleum imports of 0.50 million barrels per day and net crude oil imports of 3.94 million barrels per day as estimated in the U.S. Energy Information Administration's December 2019 Short-Term Energy Outlook). The SPR has a maximum drawdown capability of over 4 million barrels per day, which could be made available in the event of an IEA collective action. The United States percentage share of an IEA collective action release is 41.9%, as of June 2019.

To accomplish its mission and address the challenges outlined above, the SPR program is organized into two subprograms: Facilities Development and Operations, and Management. The Facilities Development and Operations subprogram funds all requirements associated with developing and maintaining facilities for the storage of petroleum, operations activities associated with placing petroleum into storage, and operational readiness initiatives associated with drawing down and distributing the inventory within 13 days' notice in the event of an emergency. The Management subprogram funds personnel and administrative expenses related to maintaining the Project Management Office (New Orleans, LA) and the Program Office (Washington, DC), as well as contract services required to support management and technical analysis of program initiatives and issues.

Highlights of the FY 2021 Budget Request

SPR's underground storage caverns require maintenance to assure their storage capability and integrity. Ongoing oil sale activities increase equipment usage and run times and will require consistent preventive, predictive and corrective maintenance to prevent or address equipment failures.

Cavern Integrity

The Casing Inspection and Cavern Remediation Program was developed in 2010 to remediate the anomalies in cavern wellbore casings. This is necessary to maintain the required level of operational and drawdown capability. Cavern remediation and diagnostic workovers anticipate and remediate cavern wellbore failures that cause caverns to be removed from service, and in preventing potential environmental releases.

Maintenance and Major Maintenance

Maintenance of SPR equipment and facilities are provided to support drawdown readiness in a safe and environmentally compliant manner. Major Maintenance and Maintenance of facilities and equipment will require ongoing monitoring with increased usage due to multi-year crude oil sales. It includes the maintenance of infrastructure items that support Physical Security.

Major changes in FY 2021 include increased Major Maintenance planned construction projects, and reduced maintenance activities to include preventive and corrective maintenance, and equipment and facility maintenance. The Cavern Integrity Program will perform 1 cavern well remediation and 8 cavern wellbore well workovers. A decrease to the Security Program in Physical Security Personnel training, assessments, and equipment replacements will occur. However, the Security Program can retain capable effectiveness in providing a deterrence and response posture to adversarial threats.

Strategic Petroleum Reserve
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Strategic Petroleum Reserve				
Facilities Development and Operations	180,026	168,235	159,174	-9,061
Management	25,974	26,765	27,097	+1,142
Northeast Gasoline Supply Reserve	29,000	0[3]	0	0
Total, Strategic Petroleum Reserve	**235,000**	**195,000**	**187,081**	**-7,919**

[3] FY 2018 and 2019 Appropriation includes funding of $29 million directed to Northeast Gasoline Supply Reserve to maintain annual lease. In FY 2020, the NGSR will be supported with prior-year balances. This budget assumes that the NGSR will be disestablished in FY 2021.

Strategic Petroleum Reserve
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Facilities Development and Operations: The Request reflects decreases to the Cavern Integrity Program (-$497); the Maintenance Program to include preventive/corrective maintenance related to corrosion and life-cycle maintenance tasks (-$1,878); IT life-cycle upgrades and replacements for support systems projects and contractor service support (-$9,267); Physical Security Program for all sites (-$822); with an offsetting increase to Major Maintenance Projects (+$3,403).	**-9,061**
Management: The Request reflects an increase for salaries and benefits escalation, field site building leases, hurricane planning activities.	**+1,142**
Total, Strategic Petroleum Reserve	**-7,919**

Strategic Petroleum Reserve
Facilities Development and Operations

Description

The Facilities Development and Operations subprogram funds activities to maintain the SPR's operational readiness capability for successful drawdowns and operate the sites in a safe, secure, and environmentally acceptable manner. Despite a significant reduction in U.S. reliance on imported petroleum, with significant global reserves in regions of the world subject to political unrest, the United States economy remains vulnerable to price increases related to petroleum supply disruptions. The SPR's stockpile of petroleum products diminishes this vulnerability to the effects of supply disruptions.

The SPR's underground storage caverns require maintenance to assure their storage capability and integrity. Surface and sub-surface infrastructure and systems that must be maintained to meet operational readiness requirements have been identified, and are funded in this subprogram.

Facilities Development and Operations

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Facilities Development and Operations		
$168,235,000	**$159,174,000**	**-$9,061,000**
Casing Inspections and Remediations • Funding level supports 1 cavern workover rig and leased crew to execute 6 cavern wellbore diagnostic workovers and 1 cavern wellbore remediation.	*Casing Inspections and Remediations* • Funding level supports 1 cavern workover rig and leased crew to execute 1 remediation and 8 cavern wellbore diagnostic workovers.	*Casing Inspections and Remediations (-$497)* • Minor decrease in overall funding of the Cavern Integrity Program that allows for 1 cavern well remediation and 8 cavern wellbore diagnostic workovers utilizing one leased rig and crew for cavern integrity operations to insure drawdown capability.
Major Maintenance • Continue approach to repair, replace, or upgrade equipment including Security, Environmental, Safety & Health (ESH), Drawdown and Non-Drawdown critical systems.	*Major Maintenance* • Continue approach to repair, replace, or upgrade equipment including Security, Environmental, Safety & Health (ESH), Drawdown and Non-Drawdown critical systems.	*Major Maintenance (+$3,403)* • Increased funding level allows for 12 of 13 planned construction projects that supports operational readiness, given multi-year crude oil sales.

Maintenance • Supports maintenance of the SPR equipment and facilities to ensure drawdown readiness in a safe and environmentally compliant manner.	*Maintenance* • Provides reduced level of preventive/corrective/predictive maintenance of the SPR equipment and facilities to support drawdown readiness in a safe and environmentally compliant manner.	*Maintenance (-$1,878)* • Decrease for preventive/corrective maintenance of pumps, motors, valves, and actuators of drawdown critical equipment while maintaining an acceptable level of risk of equipment failures which could affect drawdown operations.
Security • Protect and defend personnel, property and resources against assault, sabotage, vandalism, theft, trespass and compromise of sensitive as well as classified information.	*Security* • Protect and defend personnel, property and resources against assault, sabotage, vandalism, theft, trespass and compromise of sensitive as well as classified information.	*Security (-$822)* • A decrease for replacement of security equipment will not hamper the Security Program to provide for a safe and secure workplace to meet DOE and Federal requirements for the protection of resources and information and ensuring drawdown readiness.
Data Systems & Support • Data Systems to support the mission of drawdown readiness, processing, sale and receipt of goods (oil), communications, reporting, providing protection from malware and computer viruses, and all other activity associated with the use of data and information systems.	*Data Systems & Support* • Data Systems to support the mission of drawdown readiness, processing, sale and receipt of goods (oil), communications, reporting, providing protection from malware and computer viruses, and all other activity associated with the use of data and information systems. Compliance requirements for Fire Protection, DOT 5-year Navigable Waterway Inspection, Risk Management Approach Implementation Plan (Cyber Security), Multi-Factor Authentication and Piping Assurance Program.	*Data Systems & Support (-$9,267)* • Funding level reflects a decrease for replacement of life-cycle site operations equipment, data system server hardware and software upgrades, Piping Integrity Program activities and reduced technical services support activities.

Strategic Petroleum Reserve
Capital Summary[4] ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Capital Operating Expenses Summary (including MIE)				
Capital Equipment > $500K (including MIE)	8,594	3,101	5,798	+2,697
Plant Projects (GPP >$10M)	0	0	0	0
Total, Capital Operating Expenses	**8,594**	**3,101**	**5,798**	**+2,697**
Capital Equipment > $500K (including MIE)				
Total Non-MIE Capital Equipment (>$500K)	8,594	3,101	5,798	+2,697
Total, Capital Equipment (including MIE)	**8,594**	**3,101**	**5,798**	**+2,697**
Plant Projects (GPP - Total Estimated Cost >$10M)				
Total, Plant Projects (GPP – Total Estimated Cost	**0**	**0**	**0**	**0**
Total, Capital Summary	**8,594**	**3,101**	**5,798**	**+2,697**

[4] This list of projects is illustrative and can be adjusted based on operational requirements, priorities, and/or funding.

Strategic Petroleum Reserve
Capital Summary[5] Outyears ($K)

	FY 2022 Estimate	FY 2023 Estimate	FY 2024 Estimate	FY 2025 Estimate
Capital Operating Expenses Summary (including MIE)				
Capital Equipment > $500K (including MIE)	4,236	4,374	3,174	3,799
Plant Projects (GPP >$10M)	0	0	0	0
Total, Capital Operating Expenses	**4,236**	**4,374**	**3,174**	**3,799**
Capital Equipment > $500K (including MIE)				
Total Non-MIE Capital Equipment (>$500K)	4,236	4,374	3,174	3,799
Total, Capital Equipment (including MIE)	**4,236**	**4,374**	**3,174**	**3,799**
Plant Projects (GPP - Total Estimated Cost >$10M)				
Total, Plant Projects (GPP – Total Estimated Cost	**0**	**0**	**0**	**0**
Total, Capital Summary	**4,236**	**4,374**	**3,174**	**3,799**

[5] This list of projects is illustrative and can be adjusted based on operational requirements, priorities, and/or funding.

Strategic Petroleum Reserve
Management

Overview

Management provides funding for the salaries and related requirements of the Headquarters federal workforce responsible for providing programmatic policy, planning and oversight, to include strategic project planning, budget formulation and financial management, operations, engineering, safety, security, and technical analysis of programmatic activity of the SPR. The additional Federal workforce of the SPR Project Management Office directs program execution and establishes technical performance standards as well as scope, cost, and schedule milestones for the Management and Operations contractor.

Highlights of the FY 2021 Budget Request

The Federal staff remains at 126 FTEs with additional technical support contractors. Travel is for operational field support and oversight, including site and vendor visits. Other related expenses include field building leases and telecommunications activities**.**

Management
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Program Direction Summary				
Washington Headquarters				
Salaries and Benefits	5,476	5,646	5,674	+28
Travel	130	130	130	0
Support Services	2,140	2,137	2,081	-56
Other Related Expenses	1,254	1,087	1,087	0
Total, Washington Headquarters	**9,000**	**9,000**	**8,972**	**-28**
Strategic Petroleum Reserve Project Management Office				
Salaries and Benefits	14,664	15,119	15,172	+53
Travel	443	587	604	+17
Support Services	525	461	450	-11
Other Related Expenses	1,342	1,598	2,709	+1,111
Total, SPR Project Management Office	**16,974**	**17,765**	**18,935**	**+1,170**
Total Management				
Salaries and Benefits	20,140	20,765	20,846	+81
Travel	573	717	734	+17
Support Services	2,665	2,598	2,531	-67
Other Related Expenses	2,596	2,685	3,796	+1,111
Total, Management	**25,974**	**26,765**	**27,907**	**+1,142**
Federal FTEs	**126**	**126**	**126**	**0**

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Support Services				
Technical Support				
Economic & Environmental Analysis	570	570	570	0
Total, Technical Support	**570**	**570**	**570**	**0**
Management Support				
Training and OPM Recruitment	157	150	150	0
Technical Support	1,938	1,878	1,811	-67
Total Management Support	**2,095**	**2,028**	**1,961**	**-67**
Total, Support Services	**2,665**	**2,598**	**2,531**	**-67**
Other Related Expenses				
Rent to Others	653	609	636	+27
Communications, Utilities, Misc.	100	75	77	+2
Other Services	1,418	1,576	2,583	+1,007
Supplies and Materials	50	50	50	0
Equipment	375	375	450	+75
Total, Other Related Expenses	**2,596**	**2,685**	**3,796**	**+1,111**

Management

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Management $26,765,000	**$27,907,000**	**+$1,142,000**
Salaries and Benefits $20,765,000	**$20,846,000**	**+$81,000**
The funding supports salaries and benefits for 126 FTEs and associated costs required to provide overall direction and execution of the SPR. The SPR mission is carried out by a workforce composed largely of M&O contractors, although there are a variety of functions that are inherently governmental (i.e., program management, contract administration, budget formulation, and interagency/international coordination) that require a dedicated Federal workforce.	The funding supports salaries and benefits for 126 FTEs and associated costs required to provide overall direction and execution of the SPR. The SPR mission is carried out by a workforce composed largely of M&O contractors, although there are a variety of functions that are inherently governmental (i.e., program management, contract administration, budget formulation, and interagency/international coordination) that require a dedicated Federal workforce.	Increase reflects escalation.
Travel $717,000	**$734,000**	**+$17,000**
Provides travel to assure capability to achieve Level 1 Performance criteria for drawdown and distribution of the Reserve.	Provides travel to assure capability to achieve Level 1 Performance criteria for drawdown and distribution of the Reserve.	Continue travel required to ensure the reserve is drawdown ready.
Support Services $2,598,000	**$2,531,000**	**-$67,000**
Activities support project-planning efforts to maintain technical, mission essential support capabilities.	Activities support project-planning efforts to maintain technical, mission essential support capabilities.	Decrease reflects reduced project-planning efforts for technical analyses which support programmatic planning and capability requirements.
Other Related Expenses $2,685,000	**$3,796,000**	**+$1,111,000**
Provides teleconferencing capabilities between sites; field site building leases; analytical support services and materials; Information Technology (IT) hardware and software materials and services support; and contingency for DOE field employee evacuation expenses in the event of a hurricane.	Provides teleconferencing capabilities between sites; field site building leases; analytical support services and materials; Information Technology (IT) hardware and software materials and services support; and contingency for DOE field employee evacuation expenses in the event of a hurricane.	Increase for field site building leases, IT hardware and software materials and services. Also supports the requirement for DOE field employee evacuation expenses in the event of a hurricane.

Strategic Petroleum Reserve
Facilities Maintenance and Repair

The SPR Program's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. The Facilities Maintenance and Repair activities funded by this budget and displayed below are intended to halt asset condition degradation.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost	FY 2020 Planned Cost	FY 2021 Planned Cost
Strategic Petroleum Reserve	44,754	38,887	28,406	32,294
Total, Direct-Funded Maintenance and Repair	**44,754**	**38,887**	**28,406**	**32,294**

Report on FY 2019 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2018 to the amount planned for FY 2019, including congressionally directed changes.

Total Costs for Maintenance and Repair ($K)

	FY 2019 Actual Cost	FY 2019 Planned Cost
Strategic Petroleum Reserve	44,754	38,887
Total, Direct-Funded Maintenance and Repair	**44,754**	**38,887**

Strategic Petroleum Reserve
Safeguards and Security ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Protective Forces	18,354	21,355	20,100	-1,255
Physical Security Systems	1,067	1,193	1,092	-101
Information Security	232	251	256	+5
Cyber Security	3,175	3,235	2,664	-571
Personnel Security	598	580	565	-15
Material Control and Accountability	0	0	0	0
Research and Development	0	0	0	0
Program Management	1,464	1,713	1,658	-55
Security Investigations	0	0	0	0
Transportation Security	0	0	0	0
Construction	0	1,764	0	-1,764
Total, Safeguards and Security	**24,890**	**30,091**	**26,335**	**-3,756**

18-E-001, Strategic Petroleum Reserve (SPR) Modernization
Various locations

Project Data Sheet is for Design and Construction

1. Summary, Significant Changes, and Schedule and Cost History

Summary

Initially, the SPR Modernization Program was comprised of two subprograms: the Life Extension Phase II (LE2) project, and the Marine Terminal Distribution Capability Enhancements (MTE) project; however, the MTE project has since been cancelled due to lack of current mission need. The LE2 subprogram will modernize aging SPR infrastructure through systems upgrades and associated equipment replacement to ensure continued ability to meet mission requirements for the next 25 years. LE2 activities will occur at the Bryan Mound, Big Hill, West Hackberry, and Bayou Choctaw storage sites.

The Energy Security and Infrastructure Modernization (ESIM) Fund was established as the funding source for the SPR Modernization Program. The ESIM fund contains offsetting collections from the sale of SPR crude up to the authorized annual revenue ceiling. These sales are limited to the period of fiscal years 2017 through 2020.

Significant Changes

LE2 Project:

This Construction Project Data Sheet (CPDS) is an update from Fiscal Year 2020 and does not include a new start for the budget year. The Administration's FY 2019 Budget Request included a provision proposing changes that would reduce funding for SPR modernization to $1 billion. The St. James Terminal site has been deleted from the LE2 scope due to the Administration's cancelation of the MTE project. Based on continued site operations during scope development and finalization, adjustments have been made, the most significant of which is the addition of drilling 17 new wells into existing caverns at two sites to address resiliency issues identified in the Long Term Strategic Review. The new wells had previously been left un-addressed due to funding limitations of $2 billion, which was to be used for the combination of the LE2 project and the MTE project (together they made up the ESIM Fund). With the cancelation of the MTE project, the Program thought it prudent to address this unresolved resiliency issue from the Long Term Strategic Review.

The most recent DOE O 413.3B approved Critical Decision (CD) for LE2 is CD-1 that was approved 22 December 2016 with a total project cost range of $750 million to $1.4 billion and a CD-4 completion date range of September 2022 to September 2025. A Federal Project Director (FPD) has been assigned to this project and has approved this Construction Project Data Sheet (CPDS).

MTE Project:

The Marine Terminal Distribution Capability Enhancements project scope did not receive Congressional funding authority in fiscal year 2018. On May 21, 2018, the Under Secretary of Energy signed a memorandum approving the cancelation of the Strategic Petroleum Reserve Marine Terminal Distribution Capability Enhancement project.

The most recent DOE O 413.3B Critical Decision (CD) for MTE is CD-0 that was approved by the Deputy Secretary of Energy on August 12, 2016, with a preliminary cost range of $0.5 billion to $1.5 billion and a CD-4 range of FY 2024 to 2025.

Life Extension Phase II:

Critical Milestone History

	CD-0	Conceptual Design Complete	CD-1	CD-2	Final Design Complete	CD-3	CD-4
FY 2018*	10/30/15	09/01/16	12/22/16	3rd Qtr 2019	3rd Qtr 2019	3rd Qtr 2019	4th Qtr 2024
FY 2019*	10/30/15	09/01/16	12/22/16	3rd Qtr 2019	3rd Qtr 2019	3rd Qtr 2019	4th Qtr 2024
FY 2020*	10/30/15	09/01/16	12/22/16	4th Qtr 2020	4th Qtr 2020	4th Qtr 2020	4th Qtr 2024
FY 2021*	10/30/15	09/01/16	12/22/16	2nd Qtr 2021	2nd Qtr 2021	2nd Qtr 2021	4th Qtr 2024**

CD-0 – Approved Mission Need for a construction project with a conceptual scope and cost range
Conceptual Design Complete – Actual date the conceptual design was completed (if applicable)
CD-1 – Approve Alternative Selection and Cost Range
CD-2 – Approve Performance Baseline
Final Design Complete – Estimated/Actual date the project design will be/was complete(d)
CD-3 – Approve Start of Construction
D&D Complete –Completion of D&D work
CD-4 – Approve Start of Operations or Project Completion
PB – Indicates the Performance Baseline

***Project does not have CD-2 approval and has not been baselined.**
The costs are only estimates and consistent with the high end of the cost ranges.
****CD-4 for three sites is currently estimated FY 2024; West Hackberry estimated CD-4 is 3rd Quarter FY 2025.**

Fiscal Year	Performance Baseline Validation	CD-3A	CD-3B	CD-3C	CD-3D
FY 2017		07/14/17			
FY 2018					
FY 2019			11/20/18	10/25/2019	
FY 2020					Est. 05/2020
FY 2021	TBD				

CD-3A – Approve Long-Lead Procurements, Original Scope
CD-3B – Approve Long-Lead Procurements, Revised Scope
CD-3C – Approve Long-Lead Procurements, Revised Scope
CD-3D – Approve Long-Lead Procurements, Revised Scope

Project Cost History

	TEC, Design ($000)	TEC, Construction ($000)	TEC, Total ($000)	OPC Except D&D ($000)	OPC, D&D ($000)	OPC, Total ($000)	TPC ($000)
FY 2018	$100,628	$1,299,372	$1,400,000	$6,711	$0	$6,711	$1,406,711
FY 2019	$199,749*	$800,251	$1,000,000**	$5,250	$0	$5,250	$1,005,250
FY 2020	$276,383	$1,163,617***	$1,440,000***	$5,250	$0	$5,250	$1,445,250***
FY 2021	$392,886	$1,047,114	$1,440,000	$5,250	$0	$5,250	$1,445,250

The costs are only estimates as of December 2019 and consistent with the high end of the cost ranges. No construction funds, except for approved long lead procurement, will be used until the project performance baseline for each sub-project has been validated and CD-3 has been approved.

***The increase in design cost is due to: 1) competing the design contract instead of using a reach-back contract to the M&O contractor partner; 2) adding fee to competed contract; 3) adding escalation to schedule delay caused by competing design contract; and 4) adding engineering cost associated with additional scope (deleted scope was represented completely in construction cost).**
****The maximum range project cost of $1.4B was approved at CD-1.**
*****The Project Scope has been expanded to include drilling 17 new wells at two sites. The costs for FY 2020 entry have been revised to reflect the increase in scope.**

2. Project Scope and Justification

Scope

The Strategic Petroleum Reserve-Life Extension 2 (SPR-LE2) project involves work at four storage sites: Bryan Mound, Big Hill, West Hackberry, and Bayou Choctaw. The SPR-LE2 project will be managed as four sub-projects based on site location for baseline development, field execution, and project completion. Completion of the SPR-LE2 project will extend SPR key equipment and infrastructure capabilities for an additional 25 years and assure the required drawdown of 4.4 million barrels per day. The scope at each of the four SPR storage facilities includes modernization of aging SPR infrastructure through systems upgrades and associated equipment replacement including repair or replace crude oil transfer systems, raw water systems, brine disposal systems, drilling 17 new cavern wells, power distribution and lighting systems, and physical security systems. It also includes building and installing a new degasification plant at the Bayou Choctaw site.

Justification

In August 2016, the Department of Energy published a Long-Term Strategic Review (LTSR) of SPR capabilities and infrastructure. The LTSR compared current operational capability to Level 1 Technical and Performance Criteria and identified gaps within the storage site infrastructure and distribution system necessary to provide the design delivery rate of 4.4 million barrels per day, now and for the next 25 years. The results indicated that a significant investment in infrastructure and process equipment is critical to ensure the SPR can maintain readiness, meet mission requirements, and operate in an environmentally responsible manner. The SPR-LE2 Project addresses these requirements. Current surface assets and systems are more than halfway through their original design life of 25 years and early analysis suggests the required Life Extension Program (LEP) could take up to six years to complete. Revitalization of many, but not all, of those assets and systems last occurred from 1995 to 2000 under the first LEP. As these assets continue to age, modernization will be required – either through additional maintenance and/or repair, or outright replacement.

The project is being conducted in accordance with the project management requirements in DOE O 413.3B, Program and Project Management for the Acquisition of Capital Assets.

Preliminary Key Performance Parameters (KPPs)

The Threshold KPPs represent the minimum acceptable performance that the project must achieve. Achievement of the Threshold KPPs will be a prerequisite for approval of CD-4, Project Completion. The Objective KPPs represent the desired project performance. The preliminary KPPs will be finalized when the project is baselined at CD-2.

Preliminary Performance Measure	Threshold	Objective
Raw Water Withdrawal Rate	TBD	4.5 MMBD*
Peak Sustained Drawdown Rate	TBD	4.4 MMBD*
Site Fill Rate	TBD	605 MBD**

***MMBD is Million Barrels per day.**

****MBD is Thousand Barrels per day.**

3. Project Cost and Schedule

Financial Schedule

($K)

	Appropriations	Obligations	Costs
Total Estimated Cost (TEC)			
Design			
FY 2015	N/A	$0	$0
FY 2016	N/A	$0	$0
FY 2017	N/A	$137,215	$4,159
FY 2018	N/A	$130,732	$58,950
FY 2019	N/A	$124,939	$61,540
FY 2020	N/A	$0	$96,115
FY 2021	N/A	$0	$45,664
FY 2022	N/A	$0	$40,222
FY 2023	N/A	$0	$39,015
FY 2024	N/A	$0	$29,448
FY 2025	N/A	$0	$17,773
Total, Design **a**	N/A	$392,886	$392,886
Construction			
FY 2015	N/A	$0	$0
FY 2016	N/A	$0	$0
FY 2017	N/A	$27,400	$0
FY 2018 **b**	N/A	$323,929	$569
FY 2019	N/A	$206,000	$14,082
FY 2020	N/A	$489,785	$39,400
FY 2021	N/A	$0	$267,510
FY 2022	N/A	$0	$302,832
FY 2023	N/A	$0	$235,039
FY 2024	N/A	$0	$113,516
FY 2025	N/A	$0	$74,166
Total, Construction	N/A	$1,047,114	$1,047,114

($K)

	Appropriations	Obligations	Costs
TEC			
FY 2015	N/A	$0	$0
FY 2016	N/A	$0	$0
FY 2017	N/A	$164,615	$4,159
FY 2018	N/A	$454,661	$59,519
FY 2019	N/A	$330,939	$75,622
FY 2020	N/A	$489,785	$135,515
FY 2021	N/A	$0	$313,174
FY 2022	N/A	$0	$343,054
FY 2023	N/A	$0	$274,054
FY 2024	N/A	$0	$142,964
FY 2025	N/A	$0	$91,939
Total, TEC	N/A	$1,440,000	$1,440,000
Other Project Cost (OPC)			
FY 2015 **c,d**	$88	$88	$88
FY 2016 **c,d**	$4,190	$4,190	$4,190
FY 2017 **d**	$972	$972	$699
FY 2018 **d**	$0	$0	$273
FY 2019	$0	$0	$0
FY 2020	$0	$0	$0
FY 2021	$0	$0	$0
FY 2022	$0	$0	$0
FY 2023	$0	$0	$0
FY 2024	$0	$0	$0
FY 2025	$0	$0	$0
Total, OPC	$5,250	$5,250	$5,250

(dollars in thousands)

	Appropriations	Obligations	Costs
Total Project Cost (TPC)			
FY 2015	$88	$88	$88
FY 2016	$4,190	$4,190	$4,190
FY 2017 **e**	$340,972	$165,587	$4,858
FY 2018 **f**	$350,000	$454,661	$59,792
FY 2019 **g, i**	$300,000	$330,939	$75,622
FY 2020 **h**	$450,000	$489,785	$135,515
FY 2021	$0	$0	$313,174
FY 2022	$0	$0	$343,054
FY 2023	$0	$0	$274,054
FY 2024	$0	$0	$142,964
FY 2025	$0	$0	$91,939
Total, TPC **d,j**	$1,445,250	$1,445,250	$1,445,250

a: DOE and DOE support labor; M&O project support
b: Bayou Choctaw CD-3A Degas Plant
c: Includes costs for Office of Project Management
d: Funding requirements are included in the Facilities Appropriation 089X0218.
e: FY 2017 Omnibus authorized oil sales target of $340,000,000 (Appropriation). Actual proceeds were $323,195,827.
f: FY 2018 Omnibus authorized oil sales target of $350,000,000 (Appropriation). Actual proceeds were $347,828,624
g: FY 2019 Omnibus authorized oil sales target of $300,000,000 (Appropriation). Actual proceeds were $299,999,961
h: FY 2020 Omnibus authorized oil sales target of $450,000,000 (Appropriation).
i: Includes costs for Office of Project Management EIR which will be funded from the DOE Contingency within LE 2 funds
j: The Total Project Cost (TPC) of $1.4B was approved at CD-1, and final scope will be established at CD-2. The TPC for obligations and costs is the total of funds from Facilities Appropriation and funding received through the sale of SPR crude oil.

Note: Project is being funded through the sale of SPR crude oil and not through the normal congressional appropriations process.

Details of Project Cost Estimate at High Range at CD-1

(dollars in thousands)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
Design (PED)			
Design	$392,886	$287,681	N/A
Contingency	$13,137	$25,016	N/A
Total,PED	$406,023	$312,697	N/A
Land Acquisition			
Construction			
Site Facilities Construction	$392,730	$293,276	N/A
Off-Site Facilities	$29,735	$26,661	N/A
Drilling/Wellhead/Casings	$261,341	$333,268	N/A
Pipeline Construction	$70,776	$199,961	N/A
Construction Management	$84,923	$133,307	N/A
Project Support	$109,366	$159,970	N/A
Contingency	$85,106	$186,630	N/A
Total, Construction	$1,033,977	$1,333,073	N/A
Total, TEC	$1,440,000	$1,645,770	N/A
Contingency, TEC	$98,243	$211,646	N/A
Other Project Cost (OPC)			
OPC except D&D			
Conceptual Design	$1,366	$1,366	N/A
Other OPC Costs	$3,884	$3,884	N/A
Start-up	$0	$0	N/A
Contingency	$0	$0	N/A
Total, OPC except D&D	$5,250	$5,250	N/A
D&D			
D&D			N/A
Contingency			N/A
Total, D&D	$0	$0	N/A
Total, OPC	$5,250	$5,250	N/A
Contingency, OPC	$0	$0	N/A
Total, TPC	$1,445,250	$1,651,020	N/A
Total, Contingency	$98,243	$211,646	N/A

Note: Project is being funded through the sale of SPR crude oil and not through the normal congressional appropriations process.

Schedule of Appropriations Requests

Section 404 of the Bipartisan Budget Act authorizes drawdown and sale of SPR crude oil over four fiscal years (FY 2017 – FY 2020) to finance SPR modernization. This CPDS reflects the high end of the cost ranges. The Total Project Cost (TPC) of $1.4B was approved at CD-1, and final scope will be established at CD-2. The intent is to execute SPR modernization within the authorized revenue ceiling proposed in the FY 2020 budget request shown below.

($000)

Request		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	Total
FY 2018	TEC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	OPC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	TPC	$ -	$ -	$375,400	$350,000	$174,600	$100,000	$ -	$ -	$ -	$ -	$ -	$1,000,000
FY 2019	TEC	$ -	$ -	$ 340,000 *	$ 350,000	$ 300,000	$ 10,000	$ -	$ -	$ -	$ -	$ -	$1,000,000
	OPC	$ 88	$ 4,190	$ 972	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$5,250
	TPC	$ 88	$ 4,190	$ 340,972	$ 350,000	$ 300,000	$ 10,000	$ -	$ -	$ -	$ -	$ -	$1,005,250
FY 2020	TEC	$ -	$ -	$ 340,000 *	350,000 **	$ 300,000	$ 450,000	$ -	$ -	$ -	$ -	$ -	$1,440,000
	OPC	$ 88	$ 4,190	$ 972	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$5,250
	TPC	$ 88	$ 4,190	$ 340,972	$ 350,000	$ 300,000	$ 450,000	$ -	$ -	$ -	$ -	$ -	$1,445,250
FY 2021	TEC	$ -	$ -	$ 340,000 *	$ 350,000 **	$300,000 ***	$450,000 ****	$ -	$ -	$ -	$ -	$ -	$1,440,000
	OPC	$ 88	$ 4,190	$ 972	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$5,250
	TPC	$ 88	$ 4,190	$ 340,972	$ 350,000	$ 300,000	$ 450,000	$ -	$ -	$ -	$ -	$ -	$1,445,250

***** FY 2017 Omnibus authorized oil sales target of $340,000,000 (Appropriation). Actual proceeds were $323,195,827.

****** FY 2018 Omnibus authorized oil sales target of $350,000,000 (Appropriation). Actual proceeds were $347,828,624.

*** FY 2019 Omnibus authorized oil sales target of $300,000,000 (Appropriation). Actual proceeds were $299,999,961.

**** FY 2020 Omnibus authorized oil sales target of $450,000,000 (Appropriation).

4. Related Operations and Maintenance Funding Requirements

Not applicable for PED.

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	Establish at CD-2
Expected Useful Life (number of years)	25
Expected Future Start of D&D of this capital asset (fiscal quarter)	N/A

(Related Funding requirements)

(dollars in thousands)

	Annual Costs		Life Cycle Costs	
	Current Total Estimate	Previous Total Estimate	Current Total Estimate	Previous Total Estimate
Operations		N/A		N/A
Maintenance & Repair		N/A		N/A
Total *		N/A		N/A

*** Funding requirements are included in the Facilities Appropriation 089X0218.**

5. D&D Information

This project does not require D&D funding.

6. Acquisition Approach

The existing Strategic Petroleum Reserve Management and Operating Contractor did originally procure the Architect-Engineer contractor. With the S-3 concurrence, the M&O Contractor is self-performing the remaining A-E scope and will procure all Government Furnished Property and firm fixed priced construction contracts.

SPR Petroleum Account
Proposed Appropriation Language

Notwithstanding sections 161 and 167 of the Energy Policy and Conservation Act (42 U.S.C. 6241, 6247), $19,000,000 of proceeds from the sale of one million barrels of refined petroleum product from the Strategic Petroleum Reserve's Northeast Gasoline Supply Reserve shall be deposited in the SPR Petroleum Account and shall remain available until expended.

Explanation of Changes

In its FY 2020 Congressional Budget Justification, the Department requested authorization to deposit into the SPR Petroleum Account up to $27 million in proceeds from the proposed sale of one-million barrels of refined petroleum product (gasoline blendstock) from the Strategic Petroleum Reserve's (SPR) Northeast Gasoline Supply Reserve (NGSR). In this FY 2021 Budget Request, the Department re-proposes selling the NGSR's one-million-barrel reserve, and requests authorization to deposit into the SPR Petroleum Account up to $19 million in proceeds from the proposed sale. Proceeds will be used as a source of funding for drawdown costs related to Congressionally-directed, multi-year sales of crude oil from the SPR. The current drawdown cost estimate for FY 2021 sales of SPR crude oil is approximately $7.5 million. The NGSR has never been used for its intended purpose and is a poor value for taxpayers.

Public Law Authorizations
Energy Policy and Conservation Act, Public Law 94-163, as amended.

SPR Petroleum Account
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request[1]	FY 2021 Request vs FY 2020 Enacted
10,000	10,000	0	-10,000

Overview

The SPR Petroleum Account funds activities related to the acquisition, transportation, and injection of petroleum products into the Strategic Petroleum Reserve; test sales of petroleum products from the Reserve; and, the drawdown, sale, and delivery of petroleum products from the Reserve. This FY 2021 Budget Request does not include a request for direct appropriation; instead, the Department is re-proposing the sale of the NGSR's one-million barrels of refined petroleum product (gasoline blendstock) and requesting authorization to deposit into the SPR Petroleum Account up to $19 million in proceeds from the proposed sale.

Highlights and Major Changes in the FY 2021 Budget Request

Sections 403 and 404 of the Bipartisan Budget Act of 2015 (P.L. 114-74) and Section 501 of the Consolidated Appropriations Act of 2018 (P.L. 115-141) direct non-emergency, multi-year oil sales. To finance drawdown costs associated with mandatory sales of SPR crude oil, the Department's FY 2020 Congressional Budget Justification included a proposal to sell one-million barrels of gasoline blendstock from the NGSR and to deposit into the SPR Petroleum Account up to $27 million in proceeds from the proposed sale. This FY 2021 Budget Request re-proposes selling the NGSR's one-million-barrel reserve, and requests authorization to deposit into the SPR Petroleum Account up to $19 million in proceeds from the proposed sale.

[1] This FY 2021 Budget Request does not include a request for direct appropriation; instead, the Department is re-proposing the sale of the NGSR's one-million barrels of refined petroleum product (gasoline blendstock) and requesting authorization to deposit into the SPR Petroleum Account up to $19 million in proceeds from the proposed sale. The current drawdown cost estimate for FY 2021 sales of SPR crude oil is approximately $7.5 million.

SPR Petroleum Account
Funding by Congressional Control
($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request[1]	FY 2021 Request vs FY 2020 Enacted
SPR Petroleum Account				
Petroleum Acquisition, Transportation and Drawdown	10,000	10,000	0	-10,000
Total, SPR Petroleum Account	**10,000**	**10,000**	**0**	**-10,000**
Federal FTEs	**0**	**0**	**0**	**0**

[1] This FY 2021 Budget Request does not include a request for direct appropriation; instead, the Department is re-proposing the sale of the NGSR's one-million barrels of refined petroleum product (gasoline blendstock) and requesting authorization to deposit into the SPR Petroleum Account up to $19 million in proceeds from the proposed sale. The current drawdown cost estimate for FY 2021 sales of SPR crude oil is approximately $7.5 million.

SPR Petroleum Account

Overview

The SPR Petroleum Account funds activities related to the acquisition, transportation, and injection of petroleum products into the Strategic Petroleum Reserve; test sales of petroleum products from the Reserve; and, the drawdown, sale, and delivery of petroleum products from the Reserve. SPR Petroleum Account activities can include: 1) the incremental costs of withdrawing oil from the storage caverns and transporting it to the sales point where purchasers take title; 2) petroleum inventory acquisitions and associated transportation costs; 3) U.S. Customs duties; and 4) terminal throughput charges and other related miscellaneous costs.

SPR Oil Acquisition/Transportation/Drawdown

As of December 31 2019, the SPR crude oil inventory is 635 million barrels. Currently, the Department is undergoing a series of non-emergency, multi-year oil sales pursuant to the Bipartisan Budget Act (BBA) of 2015 (Public Law 114–74), the 21st Century Cures Act (Public Law 114-255), the Fixing America's Surface Transportation (FAST) Act (Public Law 114-94), the Act to provide for reconciliation pursuant to titles II and V of the concurrent resolution on the budget for fiscal year 2018 (Public Law 115-97), the Bipartisan Budget Act of 2018 (P.L. 115-123), and the Consolidated Appropriations Act of 2018 (P.L. 115-141). Drawdown and sales are scheduled as follows:

- From FY 2018 through FY 2025 (eight consecutive years) – sell 58 million barrels of crude oil, with 5 million barrels to be sold in FY 2018. Proceeds will be deposited into the General Fund of the Treasury (BBA, Section 403).
- From FY 2017 through FY 2020 (four consecutive years) – sell the required volumes of SPR inventory to raise up to the authorized revenue ceiling to be deposited into the Energy Security and Infrastructure Modernization Fund (BBA, Section 404). In FY 2017, 6.3 million barrels were sold; in FY 2018, 4.7 million barrels were sold, with revenues for both years totaling approximately $671.0 million.
- From FY 2017 through FY 2019 (three consecutive years) – sell 10 million barrels of crude oil in FY 2017, 9 million barrels in FY 2018, and 6 million barrels in FY 2019, for a total of 25 million barrels. Proceeds will be deposited in the General Fund of the Treasury (21st Century Cures Act, Section 5010).
- From FY 2023 through FY 2025 (three consecutive years) – sell 16 million barrels of crude oil in FY 2023, 25 million barrels in FY 2024, and 25 million barrels in FY 2025, for a total of 66 million barrels. Proceeds will be deposited in the General Fund of the Treasury (Fixing America's Surface Transportation Act, Section 32204).
- From FY 2026 through FY 2027, sell 7 million barrels of crude oil. Proceeds shall be deposited in the General Fund of the Treasury during the fiscal year in which the sale occurs (An Act to provide for reconciliation pursuant to titles II and V of the concurrent resolution on the budget for fiscal year 2018, Section 20003).
- From FY 2020 through FY 2021, sell 10 million barrels of crude oil. Proceeds will be deposited in the General Fund of the Treasury (Consolidated Appropriations Act, 2018, Section 501).
- From FY 2022 through FY 2027, sell 100 million barrels of crude oil. Proceeds will be deposited in the General Fund of the Treasury (Bipartisan Budget Act of 2018, Section 30204).
- In FY 2028, sell 5 million barrels of crude oil. Proceeds will be deposited in the General Fund of the Treasury (America's Water Infrastructure Act of 2018, Section 3009).

This FY 2021 Budget Request assumes the Department will receive authorization to deposit into the SPR Petroleum Account up to $19 million in proceeds from the proposed sale of the NGSR's one-million barrels of gasoline blendstock from the SPR to provide a source of funding for drawdown costs related to multi-year sales of SPR crude oil. The current drawdown cost estimate for FY 2021 is approximately $7.5 million. Balances in excess of FY 2021 drawdown costs will be apportioned and allotted to future fiscal years for continuing drawdown sales.

SPR Petroleum Account
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request[1]	FY 2021 Request vs FY 2020 Enacted
SPR Petroleum Account				
Petroleum Acquisition, Transportation and Drawdown	10,000	10,000	0	-10,000
Total, SPR Petroleum Account	**10,000**	**10,000**	**0**	**-10,000**

[1] This FY 2021 Budget Request does not include a request for direct appropriation; instead, the Department is re-proposing the sale of the NGSR's one-million barrels of refined petroleum product (gasoline blendstock) and requesting authorization to deposit into the SPR Petroleum Account up to $19 million in proceeds from the proposed sale. The current drawdown cost estimate for FY 2021 sales of SPR crude oil is approximately $7.5 million.

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
SPR Petroleum Account		
Petroleum Acquisition, Transportation and Drawdown $10,000,000	**$0**	**$0**
Non-Emergency Drawdown • In its FY 2020 Congressional Budget Justification, the Department requested authorization to deposit into the SPR Petroleum Account up to $27 million in proceeds from the proposed sale of the NGSR's one-million barrels of gasoline blendstock to fund the cost of drawdown operations.	• The Department is re-proposing the sale of the NGSR's one-million barrels of gasoline blendstock to fund the cost of drawdown operations, and requesting authorization to deposit into the SPR Petroleum Account up to $19 million in proceeds from the proposed sale.	• In lieu of a request for direct appropriation, this FY 2021 Request seeks authorization to deposit up to $19 million from a requested sale of one-million barrels of gasoline blendstock from the NGSR to raise funding for drawdown operations.

DEPARTMENT OF ENERGY

Funding by Site Detail

TAS_0233 - Strategic Petroleum Reserve Petroleum Account BY2021

(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Strategic Petroleum Reserve Project Office			
Naval Petroleum & Oil Shale Reserves	10,000	10,000	0
Total Strategic Petroleum Reserve Project Office	**10,000**	**10,000**	**0**

Northeast Home Heating Oil Reserve

Northeast Home Heating Oil Reserve

Northeast Home Heating Oil Reserve
Proposed Appropriation Language

Notwithstanding section 183 of the Energy Policy and Conservation Act (42 U.S.C. 6250b), the Secretary of Energy shall draw down and sell all barrels of petroleum distillate from the Northeast Home Heating Oil Reserve during fiscal year 2021: *Provided*, That notwithstanding section 184 of the Energy Policy and Conservation Act (42 U.S.C. 6250c), all proceeds collected from such sale shall be deposited into the general fund of the Treasury during fiscal year 2021: *Provided further*, That upon the completion of such sale, the Secretary shall carry out the closure of the Northeast Home Heating Oil Reserve.

Explanation of Changes

In its FY 2020 Congressional Budget Justification, the Department proposed disestablishing the Northeast Home Heating Oil Reserve (NEHHOR). Congress appropriated $10 million to the Department for the NEHHOR's storage, operation, and management activities. No new budget authority is required in FY 2021 to maintain the NEHHOR, as the Department is re-proposing to disestablish the reserve and sell the one-million barrels of government-owned ultra-low sulfur distillate with sale proceeds dedicated to deficit reduction. The NEHHOR has never been used for its intended purpose, is costly to maintain, and generally does not provide value to taxpayers.

Public Law Authorizations

- P.L. 109-58, Energy Policy Act of 2005

Northeast Home Heating Oil Reserve

($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
10,000	10,000	0	-10,000

Overview

The Northeast Home Heating Oil Reserve (NEHHOR) was established in 2000 as a short-term supplement to the Northeast commercial system's supply of heating oil, and was to be used in the event of a supply interruption during severe winter weather. Since the reserve was established, however, it has never been used for its intended purpose to supplement heating oil supplies following a disruption. The Department is re-proposing to disestablish the reserve and sell the one-million barrels of government-owned ultra-low sulfur distillate in this FY 2021 Budget Request.

Highlights and Major Changes in the FY 2021 Budget Request

In its FY 2020 Congressional Budget Justification, the Department proposed disestablishing the NEHHOR. Congress appropriated $10 million to the Department for the NEHHOR's storage, operation, and management activities. The Department is re-proposing to disestablish the reserve in FY 2021. FY 2021 activities will focus on disestablishing the NEHHOR and selling its one-million barrels of ultra-low sulfur distillate for deficit reduction.

Northeast Home Heating Oil Reserve
Funding by Congressional Control ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Northeast Home Heating Oil Reserve				
Northeast Home Heating Oil Reserve	10,000	10,000	0	-10,000
Total, Northeast Home Heating Oil Reserve	**10,000**	**10,000**	**0**	**-10,000**
Federal FTEs	**0**	**0**	**0**	**0**

Northeast Home Heating Oil Reserve
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Northeast Home Heating Oil Reserve				
Commercial Leases	9,200	9,200	0	-9,200
Information Technology Support	700	700	0	-700
Quality Control and Analysis	100	100	0	-100
Total, Northeast Home Heating Oil Reserve	**10,000**	**10,000**	**0**	**-10,000**

Northeast Home Heating Oil Reserve
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Northeast Home Heating Oil Reserve: No new budget authority is requested nor is required in FY 2021 to maintain the NEHHOR, as the Department is requesting authority to disestablish the reserve and sell the one-million barrels of government-owned ultra-low sulfur distillate.	**-10,000**
Total, Northeast Home Heating Oil Reserve	**-10,000**

Energy Security and Infrastructure Modernization Fund
Proposed Appropriation Language

[As authorized by section 404 of the Bipartisan Budget Act of 2015 (Public Law 114–74; 42 U.S.C. 6239 note), the Secretary of Energy shall draw down and sell not to exceed [$300,000,000] $450,000,000 of crude oil from the Strategic Petroleum Reserve in fiscal year 2020: Provided further, That the proceeds from such drawdown and sale shall be deposited into the "Energy Security and Infrastructure Modernization Fund" during fiscal year 2020: Provided further, That such amounts shall be made available and shall remain available until expended for necessary expenses to carry out the Life Extension II project for the Strategic Petroleum Reserve.] None.

Explanation of Changes

No Budget Request is made for FY 2021, as FY 2020 was the final year in which the Department was authorized to raise revenue for the Energy Security and Infrastructure Modernization Fund.

Public Law Authorizations
Public Law 114-74, "Bipartisan Budget Act of 2015"

Energy Security and Infrastructure Modernization Fund
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
300,000	450,000	0	-450,000

Overview

Section 404 of the Bipartisan Budget Act of 2015 directed the Secretary to establish an SPR Modernization Program to protect the United States economy from the impacts of emergency supply disruptions. The Energy Security and Infrastructure Modernization (ESIM) Fund was established in 2016 for the purpose of providing for the construction, maintenance, repair, and replacement of SPR facilities and associated capital equipment. In establishing the ESIM Fund, Congress made the following findings: 1. The SPR is one of the nation's most valuable energy security assets; 2. The age and condition of the SPR have diminished its value as a federal energy security asset; 3. Global oil markets and the location and amount of U.S. oil production and refining capacity have dramatically changed in the 40 years since the establishment of the SPR; and 4. Maximizing the energy security value of the SPR requires a modernized infrastructure that meets the drawdown and distribution needs of changed domestic and international oil and refining market conditions.

Section 404 also authorizes the drawdown and sale of crude oil from the Strategic Petroleum Reserve (SPR) up to $2 billion worth of SPR crude oil over four fiscal years (2017 through 2020) to finance an SPR Modernization Program.

The Life Extension Phase II project will modernize aging SPR infrastructure through systems upgrades and equipment replacement to ensure the SPR is able to meet mission requirements and maintain operational readiness for the next several decades.

Highlights and Major Changes in the FY 2021 Budget Request

No Budget Request is made for FY 2021, as FY 2020 was the final year in which the Department was authorized to raise revenue for the Energy Security and Infrastructure Modernization Fund.

Energy Security and Infrastructure Modernization Fund
Funding by Congressional Control
($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Energy Security and Infrastructure Modernization Fund				
Oil Sale Revenue Targets	300,000	450,000	0	-450,000
Crude Oil Sales Revenue Offsetting Collections	-300,000	-450,000	0	+450,000
Total, Energy Security and Infrastructure Modernization Fund	**0**	**0**	**0**	**0**
Federal FTEs	**19**	**15**	**23**	**+8**

Energy Security and Infrastructure Modernization Fund

Overview

Section 404 of the Bipartisan Budget Act of 2015 authorizes the drawdown and sale of crude oil from the Strategic Petroleum Reserve (SPR) up to the amount of the authorized revenue ceiling over four fiscal years (FY 2017 – FY 2020) to finance the modernization of the SPR. The Energy Security and Infrastructure Modernization Fund was established in FY 2016 to provide for the construction, maintenance, repair, and replacement of SPR facilities for the purpose of funding an SPR Modernization Program.

The Life Extension Phase II program will modernize aging SPR infrastructure through systems upgrades and associated equipment replacement to ensure that the Reserve is able to meet its mission requirements and maintain operational readiness for the next several decades. The Major Milestones (approved and estimated) for the SPR Modernization Program project, which has yet to be baselined, are as follows:

Life Extension Phase II Critical Decisions (CD):

- CD-0 Approve Mission Need – FY 2016 (Approved October 2015)
- CD-1 Approve Alternative Selection and Cost Range – FY 2016 (Approved December 2016)
- CD-3A Approve Long Lead Time Equipment Procurement Items (Bryan Mound, Big Hill, West Hackberry) (Approved July 2017)
- CD-3A Approve Long Lead Time Equipment Procurement Items (Bayou Choctaw) (Approved November 2018)
- CD-3B Approve Long Lead Time Equipment Procurement Items (Bryan Mound, Big Hill, West Hackberry) (Approved November 2018)
- CD-3B/C Approve Long Lead Time Equipment Procurement Items/ Site Prep (Bayou Choctaw – CD-3B) (Other Sites CD-3C) (Approved October 2019)
- CD-3D Approve Long Lead Time Equipment Procurement Items (Estimated Submittal Feb 2020 & Approval May 2020)
- CD-2 Approve Performance Baseline – (Estimated August 2021)
- CD-3 Approve Start of Construction - (Estimated August 2021)
- CD-4 Approve Project Completion (Big Hill, Bayou Choctaw, Bryan Mound) (Estimated September 2024)
- CD-4 Approve Project Completion (West Hackberry) (Estimated December 2025)

Although Section 404 (d) (2) (B) (ii) of the Act notes that maintenance of the cavern storage integrity may be included as part of the SPR Modernization Program, the current scope of work for the Life Extension Phase II Project does not include maintenance of cavern storage integrity. Expenditures for operations and maintenance activities not directly related to the SPR Modernization Program continue to be financed through the SPR Facilities Account, including the Cavern Storage Integrity subprogram. Because final estimated costs will not be determined until the technical baselines are set for both projects upon approval of CD-2, it would be premature to utilize ESIM funds to finance cavern storage integrity maintenance activities not included in the project scope of work for SPR Modernization Program Projects.

Life Extension**:** The Life Extension Phase II project will extend SPR equipment and infrastructure capabilities for an additional 25 years. The project involves work at the Bryan Mound, Big Hill, West Hackberry, and Bayou Choctaw storage sites. The major components of work activities at each site are:

- Bryan Mound and Big Hill: Process Piping, Pipelines, Process & Rotating Equipment
- West Hackberry: Brine System, Civil and Security Systems, Process Piping, and Process Equipment
- Bayou Choctaw: Brine Disposal System, Degas Plant, Roadways and Lighting, Security and Electrical Systems
- Cavern Secondary Well Drilling Program at Bryan Mound, Bayou Choctaw, and West Hackberry sites.

Energy Security and Infrastructure Modernization Fund
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Energy Security and Infrastructure Modernization Fund				
Oil Sale Revenue Targets	300,000	450,000	0	-450,000
Crude Oil Sales Revenue Offsetting Revenue Collections	-300,000	-450,000	0	+450,000
Total, Energy Security and Infrastructure Modernization Fund	**0**	**0**	**0**	**0**

Energy Security and Infrastruture Modernization Fund
Explanation of Major Changes ($K)

	FY 2021 Request vs FY 2020 Enacted
Oil Sale Revenue Targets: No Budget Request is made for FY 2021, as FY 2020 was the final year in which the Department was authorized to raise revenue for the Energy Security and Infrastructure Modernization Fund.	
Total, Energy Security and Infrastructure Modernization Fund	**0**

Energy Security and Infrastructure Modernization Fund
Life Extension Phase II

Description

The Life Extension Phase II subprogram funds activities to modernize aging SPR infrastructure through systems upgrades and associated equipment replacement to ensure the ability to maintain operational and drawdown readiness capability. The scope of work includes system upgrades and associated equipment replacement for the following systems:

- Crude oil transfer systems
- Raw water systems
- Power distribution and electrical systems
- Physical security systems
- Firefighting systems
- Crude oil processing (degasification) plant
- Auxiliary systems and facilities

FY 2021 activities continue procurement of government furnished equipment with long lead times as well as project design, geotechnical and geo-mechanical analyses, surveys, permitting, Title II and III engineering services, real estate and right-of-way issues, wetland mitigation, and permitting. The project technical baseline, to include final scope of work, cost, and schedule, will be set at CD-2 approval, currently scheduled for the 4th Quarter of FY 2021. Long Lead Procurement (CD-3A and CD-3B) for the program was approved in July 2017 and in November 2018 respectively. Six purchase orders have been issued to date and there are nine procurement solicitations that are active at this time. The LE 2 Architect-Engineer was terminated for convenience by the management and operations (M&O) contractor for performance issues on February 20, 2019, and the LE 2 Project has entered into a transition phase, after which, Title II design will be restarted and self-performed by the M&O contractor. On August 20, 2019, the project management risk committee approved the integrated project team's submission of a third wave of long lead procurement/early works scopes (CD-3B/CD-3C). Final approval of CD-3B/CD-3C was received on October 25, 2019.

FY 2021 Key Milestones

FY 2021 Anticipated Major Milestones:

- CD-2 Approve Performance Baseline – (Estimated August 2021)
- CD-3 Approve Start of Construction - (Estimated August 2021)

Energy Security and Infrastructure Modernization Fund
Activities and Explanation of Changes

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
SPR Modernization $300,000,000	**$450,000,000**	**$0**	**-$450,000,000**
• Provides the third year of revenue targets from crude oil sales. Collection of oil sale receipts will be allocated towards the project's Total Estimated Cost in support of construction; construction management; and project management.	• Provides the fourth and final year of revenue targets from crude oil sales. Collection of oil sale receipts will be allocated towards the project's Total Estimated Cost in support of construction; construction management; and project management.	• No Budget Request is made for FY 2021.	• FY 2020 was the final year in which the Department was authorized to raise revenue for the Energy Security and Infrastructure Modernization Fund.

Management
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
ESIM Program Direction				
Salaries and Benefits	2,860	2,079	0	-2,079
Travel	46	50	0	-50
Other Related Expenses	100	350	0	-350
Total, Management	**3,006**	**2,479**	**0**	**-2,479**
Federal FTEs	**19**	**15**	**23**	**+8**

Office of Indian Energy Policy and Programs

Office of Indian Energy Policy and Programs

Office of Indian Energy

($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
$18,000	$22,000	$8,005

Overview

The Office of Indian Energy Policy and Program's (IE) financial and technical assistance are beneficial to promoting energy development, efficiency, and use, reducing or stabilize energy costs, strengthening energy and economic infrastructure, and bringing electrical power and service to Indian land and homes, with the ancillary benefit of providing employment on Tribal Lands. This assistance is intended to overcome barriers to energy development, increase energy reliability and resiliency, and electrify lands and homes.

The Financial Assistance program will support funding opportunities toward energy infrastructure deployment in Indian Country in the form of competitive grant awards.

From 2010-2019, DOE's Office of Indian Energy has invested nearly $85 million in more than 180 tribal energy projects implemented across the contiguous 48 states and in Alaska. These projects, valued at over $180 million, are leveraged by $100 million in recipient cost share.

In 2019, the Office of Indian Energy awarded 13 grants for energy infrastructure, building on the 14 grants selected in FY 2018 and awarded in 2019. Combined these fuel and technology neutral energy projects valued at nearly $60 million, represents an additional DOE investment of nearly $22.5 million, resulting in tangible results. Specifically, these projects represent over 19 MW in new generation in Indian Country, savings of over $9 million annual for these communities and nearly $260 million over the life of the projects.

Technical Assistance overcomes barriers to project development and builds knowledge and skills necessary to implement energy projects on tribal land. The goal is to address a specific challenge or fulfill a need essential for a current project and is intended to result in tangible product or specific deliverable. Technical analysis is offered to address a specific technical or financial barrier or to assist and assistance with energy planning.

Office of Indian Energy
Funding by Congressional Control

($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Assistance Programs[1]				
Financial Assistance	**12,270**	**15,050**	**4,000**	**-11,050**
Technical Assistance	**930**	**1,950**	**479**	**-1,471**
Total, Assistance Programs	**13,200**	**17,000**	**4,479**	**-12,521**
Program Direction				
Salaries and Benefits	**1,986**	**1,986**	**2,032**	**46**
Travel	**214**	**75**	**74**	**-1**
Support Services	**1,800**	**2,579**	**1,113**	**-1,466**
Other Related Expenses	**800**	**360**	**307**	**-53**
Total, Program Direction	**4,800**	**5,000**	**3,526**	**-1,474**
Total, Office of Indian Energy	**18,000**	**22,000**	**8,005**	**-13,995**
Federal FTEs	**7**	**7**	**7**	**0**

[1] Formerly named Tribal Energy Program which was an EERE Program

Office of Indian Energy
Assistance Programs

Overview

The Office of Indian Energy Policy and Programs serves all Federally-recognized Indian tribes, which include Alaska Native Regional Corporations and Village Corporations, as well as tribal and intertribal organizations, and tribal energy development organizations. Numerous factors burden Indian tribes interested in developing their vast energy resources which at current values, present-day revenue projects for energy resources on Indian lands amount to nearly $1.5 trillion[2] with only 2.1 million acres of the 15 million acres of potential energy and mineral resources[3]. Energy and infrastructure development in Indian Country is limited due to limited funding and financing, inadequate infrastructure, limited technical capacity, and a complicated legal and regulatory structure governing Indian lands. As a result, Native Americans are three times as likely to live in overcrowded housing and with inadequate infrastructure, about one in four (25%) of American Indians and Alaska Natives lives in poverty[4], and unemployment rates are twice as high as those among non-Indians nationally[5]. Additionally, more than 175 Alaska Native villages rely almost exclusively on diesel fuel for electricity and oil for heat. In some communities, electricity costs exceed $1.00/kilowatt-hour, more than eight times the national average of $0.12/ kilowatt-hour.[6]

In consultation with tribal and other stakeholders, IE achieves its mission by promoting Indian energy development, electrifying Indian Country, and helping to reduce/ stabilize the cost of electricity. IE achieves the mission through financial assistance, technical assistance, and education and outreach.

Financial assistance, primarily through competitive grants to Indian tribes support the deployment of energy infrastructure, efficiency and electrification projects, reducing energy costs, increasing reliability and resiliency, and building human capacity within and among tribes.

In the area of Technical Assistance, IE is transitioning to become more effective and efficient through the use of local Subject Matter Experts (SME's) to assist Indian tribes and Alaska Native villages in developing energy projects and providing support for energy planning.

Policy initiatives include coordination and collaboration with various sectors of government that are critical to investment, job creation, project development, and operation of energy systems throughout Indian Country, including the Indian Country Energy and Infrastructure Working Group (ICEIWG). ICEIWG advises the Secretary of

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[2] Indian Energy and Energy Efficiency. Hearing before the Committee on Indian Affairs. Senate. 111th Cong. 1 (2009). (Testimony of Marcus Levings). https://www.indian.senate.gov/sites/default/files/upload/files/October222009.pdf. Accessed April 2017.

[3] Indian Energy Development. Hearing before the Committee on Indian Affairs. Senate. 110th Cong. 2 (2008). (Testimony of Robert Middleton). https://www.indian.senate.gov/sites/default/files/upload/files/May12008.pdf. Accessed April 2017.

[4] U.S. Census Bureau. Macartney, S., Bishaw, A., Fontenot, K. Poverty Rates for Selected Detailed Race and Hispanic Groups by State and Place: 2007 – 2011. https://www.census.gov/library/publications/2013/acs/acsbr11-17.html. Accessed April 2017.

[5] U.S. Department of Housing and Urban Development. Public and Indian Housing, Native American Housing Block Grants 2017 Summary Statement and Initiatives. https://portal.hud.gov/hudportal/documents/huddoc?id=11-Nat.Am_HSNG_BlK_Grants.pdf. Accessed April 2017.

[6] Schwabe, P. (2016). *Solar Energy Prospecting in Remote Alaska: An Economic Analysis of Solar Photovoltaics in the Last Frontier State* (No. NREL/TP-6A20-65834; DOE/IE-0040). NREL (National Renewable Energy Laboratory (NREL), Golden, CO (United States). https://energy.gov/sites/prod/files/2016/02/f29/Solar-Prospecting-AK-final.pdf. Accessed April 2017.

Energy on behalf of Indian tribes on their policy priorities. Policy analysts survey energy needs and energy resources on Indian lands, including available infrastructure support, and develop strategies for electrification and energy deployment and development. Policy initiatives also include coordination and collaboration through a Memorandum of Understanding with the Department of the Interior on issues including electrification and energy development in Indian Country.

Highlights and Major Changes in the FY 2021 Budget Request

IE's FY 2021 budget priorities are financial assistance, technical assistance, and education and outreach.

- Continue the Financial Assistance program to support funding opportunities toward energy development and electrification in Indian Country.
- Technical Assistance: Reconfigure technical assistance by expanding the local network of service providers to improve effectiveness and efficiency and to target needs of tribes based on data collected and analyzed by IE.

Office of Indian Energy
Assistance Programs

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Office of Indian Energy $22,000,000	**$8,005,000**	**-$13,995,000**
Assistance Programs $17,000,000	**$4,479,000**	**-$12,521,000**
Financial Assistance $15,050,000	**$4,000,000**	**-$11,050,000**
• Competitive grant program supporting energy development and electrification in Indian Country, and associated support contracts.	• Competitive grant program supporting energy development and electrification in Indian Country, and associated support contracts. Financial Assistance: Maximize available funding for financial assistance awards and expand opportunities for historically underserved populations, including those who have not received funding from IE.	• Continue to provide grants for energy development, energy cost savings, and electrification in Indian Country.
Technical Assistance $1,950,000	**$479,000**	**-$1,471,000**
• Technical Assistance disseminates information to Indian Country through in-person and on-line training, internships, regional/national workshops, webinars, and printed guides and materials. • On-request assistance efforts provides high-level support for electrification and energy development in Indian Country. • Efforts will also focus on building partnerships and leveraging resources to maximize education, training, and technical assistance.	• Technical Assistance: Reconfigure technical assistance by expanding the network of local service providers to improve effectiveness and efficiency and to target needs of tribes based on data collected and analyzed by IE. • Education and Outreach: Expand STEM education and internship programs to include K-12, vocational/technical opportunities, and non-traditional students, and increase stakeholder outreach efforts to better educate the public on tribal energy development challenges.	• Continue to provide technical assistance focused on energy development, energy cost savings, and electrification in Indian Country.

Office of Indian Energy
Program Direction

Overview

Program direction provides federal staff responsible for the management and execution of IE's programs and activities, as well as the associated support contractors, rent, supplies, travel, and other related expenses. The staff is responsible for providing overall guidance and direction for DOE program offices on tribal energy activities and initiatives necessary to achieve IE's program objectives and provides day-to-day management of financial assistance, technical assistance, and outreach and education. Program direction also provides managerial support for the reporting, compliance, and other statutory responsibilities.

The FY 2021 Budget anticipates 7 federal staff: 3 FTEs in Washington, D.C., 2 FTEs in Anchorage, Alaska, and 2 FTEs in Golden, Colorado. The Washington, D.C. staff includes executive leadership, operations, and policy analysis. The Anchorage, Alaska staff provides education and technical assistance for the nearly 230 Alaska Native villages, over 200 Alaska Native Village Corporations, and 13 Alaska Regional Corporations. The Golden, Colorado staff provides management and oversight for approximately 90 existing financial assistance awards throughout the nation, while delivering technical assistance within the contiguous US for nearly 340 Indian tribes and dozens of tribal and intertribal organizations.

Highlights and Major Changes in the FY 2021 Budget Request

- Education and Outreach: Expand STEM education and internship programs to include K-12, vocational/technical opportunities, and non-traditional students, as well as increasing stakeholder outreach efforts to better educate the public on tribal energy development challenges.
- Support project management and procurement across IE's portfolio of projects, including closing out completed financial assistance awards; and
- Maximize the efficient and effective use of available resources to accomplish IE's core mission while reducing overall expenses and improving the delivery of IE's services in Indian Country.

Program Direction Funding
($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Program Direction Summary				
Washington Headquarters				
Salaries and Benefits	1,986	1,986	2,032	46
Travel	214	75	74	-1
Support Services	1,800	2,579	1,113	-1,466
Other Related Expenses	800	360	307	-53
Total, Washington Headquarters	**4,800**	**5,000**	**3,526**	**-1,474**
Total Program Direction				
Salaries and Benefits	1,986	1,986	2,032	46
Travel	214	75	74	-1
Support Services	1,800	2,579	1,113	-1,466
Other Related Expenses	800	360	307	-53
Total, Program Direction	**4,800**	**5,000**	**3,526**	**-1,474**
Federal FTEs	**7**	**7**	**7**	**0**
Support Services				
Management Support				
Administrative Support Contracts	1,800	2,579	1,113	-1,466
Total Management Support	**1,800**	**2,579**	**1,113**	**-1,466**
Total, Support Services	**1,800**	**2,579**	**1,113**	**-1,466**
Other Related Expenses				
WCF	650	270	222	-48
Other Services	150	90	85	-5
Total, Other Related Expenses	**880**	**360**	**307**	**-53**

Office of Indian Energy
Program Direction

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Program Direction $5,000,000	**$3,526,000**	**-$1,474,000**
Salaries and Benefits $1,986,000	**$2,032,000**	**$46,000**
• Federal Salaries and benefits to implement program activities, monitor over 200 grantee and contractor activities, and provide program management functions.	• Federal Salaries and benefits to implement program activities, monitor over 200 grantee and contractor activities, and provide program management functions. Additionally, an increase to support the award pool funding is included.	• Maintains federal staffing at current on board level and supports an increase in the award pool funding.
Travel $75,000	**$74,000**	**-$1,000**
• Travel required for Federal staff delivery of program management and Office of Indian Energy deployment activities, including outreach and education, technical assistance, and project management to support the 574 federally recognized Indian tribes throughout the nation, many of which are located in remote and rural areas.	• Travel required for Federal staff delivery of program management and Office of Indian Energy deployment activities, including outreach and education, technical assistance, and project management to support the 574 federally recognized Indian tribes throughout the nation, many of which are located in remote and rural areas.	• Anticipates less federal travel.
Support Services $2,579,000	**$1,113,000**	**-$1,466,000**
• Management, administrative, mission and technical support.	• Management, administrative, and operations support.	• Support additional mission and technical support related to the increase funding in the assistance programs.
Other Related Expenses $360,000	**$307,000**	**-$53,000**
• Computer hardware and software provided through the OCIO, Working Capital Fund, office space, registration fees, supplies, and small purchases through the micro-purchase credit card.	• Computer hardware and software provided through the OCIO, Working Capital Fund, office space, registration fees, supplies, and small purchases through the micro-purchase credit card.	• No major changes.

DEPARTMENT OF ENERGY

Funding by Site Detail

TAS_0342 - Office of Indian Energy Policy and Programs BY2021

(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Golden Field Office			
Indian Energy Policy & Programs	300	300	300
Total Golden Field Office	**300**	**300**	**300**
Washington Headquarters			
Indian Energy Policy & Programs	4,350	21,550	7,555
Total Washington Headquarters	**4,350**	**21,550**	**7,555**
Grants			
Indian Energy Policy & Programs	13,350	150	150
Total Grants	**13,350**	**150**	**150**

Advanced Technology Vehicles Manufacturing Loan Program

Advanced Technology Vehicles Manufacturing Loan Program

Advanced Technology Vehicles Manufacturing Loan Program
Proposed Appropriation Language

[For Department of Energy administrative expenses necessary in carrying out the Advanced Technology Vehicles Manufacturing Loan Program, $5,000,000, to remain available until September 30, 2021.]*The unobligated balances available from amounts appropriated for the costs of direct loans in section 129 of the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009 (Public Law 110-329) are hereby permanently cancelled. (Energy and Water Development and Related Agencies Appropriations Act, 2020.)*

Explanation of Changes

The President's FY 2021 Budget eliminates the Advance Technology Vehicles Manufacturing (ATVM) Loan Program and proposes to cancel all $4.3 billion in remaining appropriated credit subsidy. The Loan Programs Office (LPO) will utilize the estimated $5 million in unobligated balances carried forward from prior-year appropriations to cover loan-portfolio monitoring and administrative expenses: salaries for its full time employees as well as the cost of outside advisors for financial, legal, engineering, credit, and market analyses. The ATVM Loan Program's FY 2021 appropriations request is $0. In FY 2021, LPO will stop originating loans for the ATVM Loan Program but will continue to monitor the existing portfolio.

Public Law Authorizations

- P.L. 110-140, Energy Independence and Security Act of 2007
- P.L. 110–329, Consolidated Security, Disaster Assistance, and Continuing Appropriations Act of 2009

Advanced Technology Vehicles Manufacturing Loan Program
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
5,000	5,000	0	-5,000

Overview
The Budget proposes the elimination of the Advanced Technology Vehicle Manufacturing Loan Program because the private sector is better positioned to finance the deployment of commercially viable projects. The Federal role in supporting advanced technologies is strongest in the early stages of research and development. The Government should not be in the business of picking which technologies "win" the commercialization race and displacing private sector investment opportunities. Instead, the Government should recognize the private sector's primary role in taking risks to finance projects in the automobile manufacturing sector. In addition, the relative inactivity of this program indicates it is ineffective at attracting borrowers with viable projects who are unable to secure private sector financing.

History
Section 136 of the Energy Independence and Security Act of 2007 established the Advanced Technology Vehicles Manufacturing (ATVM) Loan Program, consisting of direct loans of up to $25 billion in total loan authority to support the development and manufacturing of advanced technology vehicles and qualifying components in the U.S. The ATVM Loan Program has issued 5 total loans, of which $7.28 billion has been obligated[1] and completely disbursed.

Organization
LPO currently utilizes five divisions to proactively monitor the portfolio: Portfolio Management Division (PMD), the Risk Management Division (RMD), Technical and Project Management Division (TPMD), Legal Division, and Management Operations Division (MOD).

The Portfolio Management Division (PMD) leads LPO's monitoring functions by approving disbursements, repayments, operating budgets, and long-term forecasts. In the event of non-payment and/or default, PMD leads activities to maximize recoveries either through bankruptcy, note sale, or compromise of the claim.

The Risk Management Division (RMD) conducts continuous risk assessments of the assets in the portfolio to comply with regulatory requirements such as OMB Circular No. A-129 of the Federal Credit Reform Action of 1990.

The Technical and Project Management Division (TPMD) evaluates the technical performance of assets and project management throughout the entire lifecycle of the loan to ensure meeting the technical requirements of the loan agreement. TPMD conducts site visits, provides expertise on project construction status and budget, and identifies potential technical risks inhibiting the borrower's ability to meet requirements and repay the loan.

LPO Legal Division supports all on-going monitoring activities, negotiations and documentations of waivers, consents, routine loan amendments, approvals and denials of transfer withdrawals, and legal aspects of any project developments.

In FY 2021 LPO will continue to consolidate and streamline the organizational structure of monitoring activities to effectively manage the loan-portfolios while minimizing the administrative burden. In addition, LPO will explore options to reduce or mitigate the expected administrative cost of monitoring over the tenure of the remaining loans.

Highlights and Major Changes in the FY 2021 Budget Request
In FY 2021, LPO will terminate ATVM direct loan activities and continue to monitor the existing portfolio.

[1] Net of recoveries

Advanced Technology Vehicles Manufacturing Loan Program
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Advanced Technology Vehicles Manufacturing Loan Program				
Administrative Expenses	5,000	5,000	0	-5,000
Total, Advanced Technology Vehicles Manufacturing Loan Program	**5,000**	**5,000**	**0**	**-5,000**
Loan Subsidy Cancellation	*0*	*0*	*-4,333,500*	*-4,333,500*

Advanced Technology Vehicles Manufacturing Loan Program
Explanation of Major Changes ($K)

	FY 2020 Request vs FY 2019 Enacted
Administrative Expenses:	**-5,000**
LPO will utilize approximately $5,000,000 in unobligated balances carried forward from prior appropriations to provide administrative expenses funding to monitor the existing loan portfolio.	
Total, Advanced Technology Vehicles Manufacturing Loan Program	**-5,000**
Loan Subsidy Cancellation:	*-4,333,500*
The FY 2021 Budget proposes to cancel $4.3 billion in unobligated balances appropriated by the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act of 2009 (Pub. L. 110-329). This cancellation is not scorable.	

Advanced Technology Vehicles Manufacturing Loan Program
Administrative Expenses
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Administrative Expenses				
Salaries & Benefits	1,800	1,850	0	-1,850
Travel	20	30	0	-30
Support Services	2,176	2,462	0	-2,462
Other Related Expenses	1,004	658	0	-658
Total, Administrative Expenses	**5,000**	**5,000**	**0**	**-658**
Federal FTEs	12	12	4	-8
Support Services				
Management and Professional Support Services				
Mission Support	2,113	2,128	0	-2,128
IT Support	363	334	0	-334
Total, Management and Professional Support Services	2,476	2,462	0	-2,462
Total, Support Services	**2,476**	**2,462**	**0**	**-2,462**
Other Related Expenses				
Communication and Miscellaneous Charges Related to IT	4	3	0	-3
Other Services	36	36	0	-36
Working Capital Fund	455	410	0	-410
Operation and Maintenance of Facilities	300	0	0	0
O&M of Equipment or IT Equipment	100	100	0	-100
Printing Supplies and Materials	109	109	0	-109
Total, Other Related Expenses	**1,004**	**658**	**0**	**-658**

Administrative Expenses
Funding ($K)

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Salaries and Benefits $1,850	**$0**	**-$1,850**
• Provides for salaries and benefits of 12 full-time equivalent employees to administer the following functions to the office: Executive Director, Origination, Legal, Management Operations, Environmental Compliance, Portfolio Management, Risk Management, and Technical and Project Management. Includes 2% performance award and .75% special act award calculations.	• Prior-year funds estimated at $628,000 will support the salaries and benefits of 4 full-time equivalent employees to administer the following functions to the office: Executive Director, Legal, Management Operations, Environmental Compliance, Portfolio Management, Risk Management, and Technical and Project Management. Estimate includes 2% performance award and .75% special act award calculations.	• In FY 2021 the program is expected to have sufficient unobligated carryover balances to fund salaries and benefits necessary to monitor the existing loan portfolio as proposed.
Travel $30	**$0**	**-$30**
• Supports the travel of staff members for site visits, as well as outreach to applicants, attending meetings and conferences.	• Prior year funds estimated at $30,000 will support the travel of staff members for site visits, as well as attending meetings and conferences.	• In FY 2021 the program is expected to have sufficient unobligated carryover balances to fund travel necessary to monitor the existing loan portfolio as proposed.
Support Services $2,462	**Support Services $0**	**-$2,462**
• Supports range of contract services including administrative support, subject matter experts, legal services, information technology, publications, credit analysis, and market assessments.	• Prior-year funds estimated at $1,684,000 will support range of contract services including administrative support, subject matter experts, legal services, information technology, publications, credit analysis, and market assessments.	• In FY 2021 the program is expected to have sufficient unobligated carryover balances to fund support services necessary to monitor the existing loan portfolio as proposed.
Other Related Expenses $1,070,000	**Other Related Expenses $0**	**Other Related Expenses +$970,000**
• Supports DOE Working Capital Fund, DOE IT Services expenses, and other services.	• Prior-year funds estimated at $658,000 will support DOE Working Capital Fund, DOE IT Services expenses, and LPO federal staff training as needed.	• In FY 2021 the program is expected to have sufficient unobligated carryover balances to fund other related expenses necessary to monitor the existing loan portfolio as proposed.

DEPARTMENT OF ENERGY

Funding by Site Detail

TAS_0322 - Advanced Technology Vehicles Manufacturing Loan Program Account BY2021

(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Oak Ridge National Laboratory			
Advanced Technology Vehicle Manufacturing Loan Program	300	0	0
Total Oak Ridge National Laboratory	**300**	**0**	**0**
Washington Headquarters			
Advanced Technology Vehicle Manufacturing Loan Program	4,700	5,000	0
Total Washington Headquarters	**4,700**	**5,000**	**0**

Title 17 Innovative Technology Loan Guarantee Program

Title 17 Innovative Technology Loan Guarantee Program

Title 17 Innovative Technology Loan Guarantee Program
Proposed Appropriation Language

Such sums as are derived from amounts received from borrowers pursuant to section 1702(b) of the Energy Policy Act of 2005 under this heading in prior Acts, shall be collected in accordance with section 502(7) of the Congressional Budget Act of 1974: *Provided*, That for necessary administrative expenses of the Title 17 Innovative Technology Loan Guarantee Program, as authorized, [$32,000,000]*$3,000,000* is appropriated, to remain available until September 30, [2021]*2022*: *Provided further,* That up to [$32,000,000]*$3,000,000* of fees collected in fiscal year [2020]*2021* pursuant to section 1702(h) of the Energy Policy Act of 2005 shall be credited as offsetting collections under this heading and used for necessary administrative expenses in this appropriation and remain available until September 30, [2021]*2022*: *Provided further*, That to the extent that fees collected in fiscal year [2020]*2021* exceed [$32,000,000]*$3,000,000*, those excess amounts shall be credited as offsetting collections under this heading and shall not be available until appropriated: *Provided further,* That the sum herein appropriated from the general fund shall be reduced (1) as such fees are received during fiscal year [2020]*2021* (estimated at [$20,000,000]*$3,000,000*) and (2) to the extent that any remaining general fund appropriations can be derived from fees collected in previous fiscal years that are not otherwise appropriated, so as to result in a final fiscal year [2020]*2021* appropriation from the general fund estimated at $0: *Provided further*, That the Department of Energy shall not subordinate any loan obligation to other financing in violation of section 1702 of the Energy Policy Act of 2005 or subordinate any Guaranteed Obligation to any loan or other debt obligations in violation of section 609.10 of title 10, Code of Federal Regulations. *Provided further, That the authority provided in prior year appropriations Acts for commitments to guarantee loans under Title XVII of the Energy Policy Act of 2005, excluding amounts for loan guarantee commitments, as defined in the Federal Credit Reform Act of 1990 (2 U.S.C. 661a), made by October 1, 2020, is hereby permanently cancelled: Provided further, That the unobligated balances from prior year appropriations Acts, including amounts available under this heading in the American Recovery and Reinvestment Act of 2009 (Public Law 111-5), for the cost to guarantee loans are hereby permanently cancelled. (Energy and Water Development and Related Agencies Appropriations Act, 2020.)*

Explanation of Changes

The FY 2021 Budget cancels all remaining Title 17 Innovative Technology (Title 17) Loan Guarantee Program loan volume authority. In addition to the $3 million in appropriation offset by $3 million in collections, the Loan Programs Office (LPO) will utilize approximately $26 million in unobligated balances carried forward from prior-year appropriations to cover loan portfolio monitoring and administrative expenses: salaries for its full-time employees as well as the cost of outside advisors for financial, legal, engineering, credit, and market analyses. In FY 2021, LPO will stop originating loans for the Title 17 Innovative Technology Loan Guarantee Program but will continue monitoring the existing portfolio. No projects are assumed to reach conditional commitment and no conditionally committed loans are expected to reach financial close prior to FY 2021.

Public Law Authorizations

- P.L. 109-58, Energy Policy Act of 2005
- P.L. 110-5, Revised Continuing Appropriations Resolution, 2007
- P.L. 111-5, American Recovery and Reinvestment Act of 2009
- P.L. 111-8, Omnibus Appropriations Act, 2009
- P.L. 112-10, Department of Defense and Full-Year Continuing Appropriations Act, 2011

Title 17 Innovative Technology Loan Guarantee Program
($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
12,311	29,000	-160,659	-189,659

Overview

The Budget proposes the elimination of the Title 17 Innovative Technology Loan Guarantee Program because the private sector is better positioned to finance the deployment of commercially viable projects. The Federal role in supporting advanced technologies is strongest in the early stages of research and development. The Government should not be in the business of picking which technologies "win" the commercialization race and displacing private sector investment opportunities. Instead, the Government should recognize the private sector's primary role in taking risks to finance projects in the energy sector. In addition, the relative inactivity of this program indicates it is ineffective at attracting borrowers with viable projects who are unable to secure private sector financing.

History

Section 1703 of the Energy Policy Act of 2005 authorizes DOE to provide loan guarantees for innovative energy projects in categories including advanced nuclear facilities, coal gasification, carbon sequestration, energy efficiency, renewable energy systems, and various other types of projects. Projects supported by DOE loan guarantees must avoid, reduce, or sequester pollutants or anthropogenic emissions of greenhouse gases; employ new or significantly improved technologies compared to commercial technologies in service in the United States at the time the guarantee is issued; and offer a reasonable prospect of repayment of the principal and interest on the guaranteed obligation. Section 406 of the American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5 (Recovery Act) amended Title XVII of the Energy Policy Act of 2005 by establishing Section 1705 as a temporary program for the rapid deployment of renewable energy and electric power transmission projects, as well as leading edge biofuels projects. The authority to enter into new loan guarantees under Section 1705 expired on September 30, 2011, but the program continues to administer and monitor the portfolio of loan guarantees obligated prior to the expiration date.

Over the past decade, LPO has issued 37 Title 17 loan guarantees, of which 32 were issued between 2009 and 2011 using American Reinvestment and Recovery Act authorities that expired September 30, 2011. In total, $24.8 billion has been obligated, $21.4 billion has been disbursed, $5.0 billion of principal has been repaid, and $0.6 billion has been recorded as loss due to default.

Organization

The Loan Programs Office (LPO) currently utilizes five divisions to proactively monitor the portfolio: Portfolio Management Division (PMD), the Risk Management Division (RMD), Technical and Project Management Division (TPMD), Legal Division, and Management Operations Division (MOD).

The Portfolio Management Division (PMD) leads LPO's monitoring functions by approving disbursements, repayments, operating budgets, and long-term forecasts. In the event of non-payment and/or default, PMD leads activities to maximize recoveries either through bankruptcy, note sale, or compromise of the claim.

The Risk Management Division (RMD) conducts continuous risk assessments of the assets in the portfolio to comply with regulatory requirements such as OMB Circular No. A-129 of the Federal Credit Reform Action of 1990.

The Technical and Project Management Division (TPMD) evaluates the technical performance of assets and project management throughout the entire lifecycle of the loan to ensure that the technical requirements of the loan agreement are met. TPMD conducts site visits, provides expertise on project construction status and budget, and identifies potential technical risks that inhibit the borrower's ability to meet requirements and repay the loan.

LPO Legal Division supports all on-going monitoring activities, negotiations and documentations of waivers, consents, routine loan amendments, approvals and denials of transfer withdrawals, and legal aspects of any project developments.

In FY 2021, LPO will continue to consolidate and streamline the organizational structure of monitoring activities to effectively manage the portfolio of loans while minimizing the administrative burden. In addition, LPO will explore options to reduce or mitigate the expected administrative cost of monitoring over the tenor of the remaining loans.

Highlights and Major Changes in the FY 2021 Budget Request.
In FY 2021, LPO will stop originating loans for the Title 17 Loan Guarantee Program but will continue to monitor the existing portfolio. No projects are assumed to reach conditional commitment and no conditionally committed loans are expected to reach financial close prior to FY 2021.

Title 17 Innovative Technology Loan Guarantee Program
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Title 17 Innovative Technology Loan Guarantee Program				
Administrative Expenses	33,000	32,000	3,000	-29,000
Offsetting Collections[1]	-20,689	-3,000	-3,000	0
FY 2011 Loan Subsidy Cancellation	0	-0	-160,659	-160,659
Total, Title 17 Innovative Technology Loan Guarantee Program	**12,311**	**29,000**	**-160,659**	**-189,659**
ARRA Loan Subsidy Cancellation[2]	*0*	*0*	*-488,855*	*-488,855*

Title 17 Innovative Technology Loan Guarantee Program
Explanation of Major Changes ($k)

	FY 2020 Request vs FY 2019 Enacted
Administrative Expenses:	**-29,000**
LPO will utilize approximately $29,000,000 in unobligated balances carried forward from prior appropriations along with the $3,000,000 requested in new budget authority to provide administrative expenses funding to monitor the existing loan portfolio.	
Offsetting Collections:	
$3,000,000 in maintenance fees are estimated to be collected in FY 2021 from existing projects. No change from the FY 2020 estimate.	**0**
Loan Subsidy Cancellation:	**-8,500**
Cancels the $160,659,355.60 in unobligated balances appropriated by the Department of Defense and Full-Year Continuing Appropriations Act of 2011 (Pub. L. 112-10) for the cost of loan guarantees for renewable energy or efficient end-use energy technologies under section 1703 of the Energy Policy Act of 2005.	**-160,659**
Total, Title 17 Innovative Technology Loan Guarantee Program	**-189,659**

[1] In FY 2019 $20,688,522.19 in fees were collected and credited as offsetting collections. In addition, $2,108,157.89 in fees collected in prior years were made available. The Congressional estimate for fees to be received in FY 2019 was $15 million.

[2] The FY2021 Budget proposes to cancel $489 million in remaining, emergency designated, unobligated credit subsidy balances appropriated by the American Reinvestment and Recovery Act of 2009 (Pub. L. 111-5). There are no scoreable savings from this cancellation.

Administrative Expenses
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Administrative Expenses				
Salaries & Benefits	15,219	15,704	3,000	-12,704
Travel	267	300	0	-300
Support Services	12,801	11,190	0	-11,190
Other Related Expenses	4,713	4,806	0	-4,806
Total, Administrative Expenses	**33,000**	**32,000**	**3,000**	**-29,000**
Federal FTEs	79	79	77	-2
Support Services				
Management and Professional Support Services				
Mission Support	10,156	8,542	0	-8,542
IT Support	2,216	2,143	0	-2,143
Total, Management and Professional Support Services	11,372	10,685	0	-10,685
Studies, Analyses, and Evaluations	429	505	0	-505
Total, Support Services	**12,801**	**11,190**	**0**	**-11,190**
Other Related Expenses				
Communication and Miscellaneous Charges Related to IT	29	30	0	-30
Training	27	27	0	-27
Other Services	89	89	0	-89
Working Capital Fund	2,529	2,625	0	-2,625
Operation and Maintenance of Facilities				0
O&M of Equipment or IT Equipment	1,457	1,457	0	-1,457
Printing Supplies and Materials	543	548	0	-548
Equipment	39	30	0	-30
Total, Other Related Expenses	**4,713**	**4,806**	**0**	**-4,806**

Administrative Expenses
Funding ($K)

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Salaries and Benefits $15,704	**$3,000**	**-$12,704**
• Provides for salaries and benefits of 77 full-time equivalent employees to administer the following functions to the office: Executive Director, Origination, Legal, Management Operations, Environmental Compliance, Portfolio Management, Risk Management, and Technical and Project Management. Includes 2% performance award and .75% special act award calculations.	• In addition to prior year funds estimated at $12,400,000, this request will support the salaries and benefits of 77 full-time equivalent employees to administer the following functions to the office: Executive Director, Legal, Management Operations, Environmental Compliance, Portfolio Management, Risk Management, and Technical and Project Management. Estimate includes 2% performance award and .75% special act award calculations.	• In FY 2021, in combination with the $3 million requested, the program is expected to have sufficient unobligated carryover balances to fund salaries and benefits necessary to monitor the existing loan portfolio as proposed.
Travel $300	**$0**	**-$300**
• Supports the travel of staff members for site visits, as well as outreach to applicants, attending meetings, and conferences.	• Prior year funds estimated at $250,000 will support the travel of staff members for site visits, attending meetings and conferences.	• The program is expected to have sufficient unobligated carryover balances to fund travel necessary to monitor the existing loan portfolio as proposed.
Support Services $11,190	**$0**	**-$11,190**
• Supports range of contract services including administrative support, subject matter experts, legal services, information technology, publications, credit analysis, and market assessments.	• Prior year funds estimated at $8,586,000 will support range of contract services including administrative support, subject matter experts, legal services, information technology, publications, credit analysis, and market assessments.	• The program is expected to have sufficient unobligated carryover balances to fund support services necessary to monitor the existing loan portfolio as proposed.
Other Related Expenses $4,806	**$0**	**-$4,806**
• Funds support DOE Working Capital Fund, DOE IT Services expenses, other services and federal staff training.	• Prior year funds estimated at $4,764,000 will supports DOE Working Capital Fund (WCF), DOE IT Services expenses, other services, and federal staff training.	• The program is expected to have sufficient unobligated carryover balances to fund other related expenses necessary to monitor the existing loan portfolio as proposed.

DEPARTMENT OF ENERGY

Funding by Site Detail

TAS_0208 - Title 17 Innovative Technology Loan Guarantee Program BY2021

(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
National Energy Technology Lab			
Loan Guarantee Program	82	150	0
Total National Energy Technology Lab	**82**	**150**	**0**
Washington Headquarters			
Loan Guarantee Program	32,918	31,850	3,000
Total Washington Headquarters	**32,918**	**31,850**	**3,000**

Tribal Energy Guarantee Loan Program

Tribal Energy Guarantee Loan Program

Tribal Energy Loan Guarantee Program
Proposed Appropriation Language

[For Department of Energy administrative expenses necessary in carrying out the Tribal Energy Loan Guarantee Program, $2,000,000, to remain available until September 30, 2021.]*The unobligated balances from prior year appropriations Acts under this heading for the cost to guarantee loans are hereby permanently cancelled. (Energy and Water Development and Related Agencies Appropriations Act, 2020.)*

Explanation of Changes

The FY 2021 Budget eliminates the Tribal Energy Loan Guarantee Program and proposes to cancel the $8,500,000 appropriated for the cost of loan guarantees.

Public Law Authorizations

- P.L.102-486, Energy Policy Act of 1992, as amended

Tribal Energy Loan Guarantee Program
Funding ($K)

FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
1,000	2,000	-8,500	-10,500

Overview

Section 2602 of the Energy Policy Act of 1992, as amended by the Energy Policy Act of 2005, authorized a loan guarantee program at the Department of Energy to support energy development by Indian tribes. The FY 2021 Budget eliminates the Tribal Energy Loan Guarantee Program (TELGP) and proposes to cancel the $8,500,000 appropriated for credit subsidy. The Loan Programs Office (LPO) will utilize unobligated balances carried forward from prior-year appropriations to cover administrative expenses. In FY 2021, LPO will stop originating loans for TELGP but will continue to monitor any loans that may close by October 1, 2020.

History

Authorized by the Energy Policy Act of 2005, funding was first appropriated for the Tribal Energy Loan Guarantee Program in FY 2017. In FY 2018, the U.S. Department of Energy (DOE) issued the first Tribal Energy loan guarantee solicitation to support tribal energy development. To date, TELGP has not issued a tribal energy loan guarantee.

Organization

The Loan Programs Office (LPO) currently utilizes five divisions to proactively monitor the portfolio: Portfolio Management Division (PMD), Risk Management Division (RMD), Technical and Project Management Division (TPMD), Legal Division, and Management Operations Division (MOD).

The Portfolio Management Division (PMD) leads LPO's monitoring functions by approving disbursements, repayments, operating budgets, and long-term forecasts. In the event of non-payment and/or default, PMD leads activities to maximize recoveries either through bankruptcy, note sale, or compromise of the claim.

The Risk Management Division (RMD) conducts continuous risk assessments of the assets in the portfolio to comply with regulatory requirements such as OMB Circular No. A-129 of the Federal Credit Reform Action of 1990.

The Technical and Project Management Division (TPMD) evaluates the technical performance of assets and project management throughout the entire lifecycle of the loan to ensure that the technical requirements of the loan agreement are met. TPMD conducts site visits, provides expertise on project construction status and budget, and identifies potential technical risks that inhibit the borrower's ability to meet requirements and repay the loan.

LPO Legal Division supports all on-going monitoring activities, negotiations and documentations of waivers, consents, routine loan amendments, approvals and denials of transfer withdrawals, and legal aspects of any project developments.

In FY 2021 LPO will continue to consolidate and streamline the organizational structure of monitoring activities to effectively manage the portfolio of loans while minimizing the administrative burden. In addition, LPO will explore options to reduce or mitigate the expected administrative cost of monitoring over the tenure of the remaining loans.

Highlights and Major Changes in the FY 2021 Budget Request

In FY 2021, LPO will terminate the Tribal Energy Loan Guarantee Program.

Tribal Energy Loan Guarantee Program
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Tribal Energy Loan Guarantee Program				
Administrative Expenses	1,000	2,000	0	-2,000
Loan Subsidy Cancellation	0	0	-8,500	-8,500
Total, Tribal Energy Loan Guarantee Program	1,000	2,000	-8,500	-10,500

Tribal Energy Loan Guarantee Program
Explanation of Major Changes ($K)

	FY 2020 Request vs FY 2019 Enacted
Administrative Expenses:	
LPO will utilize up to $2,000,000 in unobligated balances expected to be carried forward from prior appropriations to provide administrative expenses funding to terminate the Tribal Energy Loan Guarantee Program.	**-2,000**
Loan Subsidy Cancellation:	**-8,500**
Cancels the $8,500,000 in unobligated balances appropriated by the Consolidated Appropriations Act of 2017 (P.L. 115-31) for the cost of loan guarantees.	
Total, Tribal Energy Loan Guarantee Program	**-10,500**

Program Direction
Funding ($K)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request	FY 2021 Request vs FY 2020 Enacted
Administrative Expenses				
Salaries & Benefits	775	798	0	-798
Travel	14	29	0	-29
Support Services	151	946	0	-946
Other Related Expenses	60	227	0	-227
Total, Administrative Expenses	**1,000**	**2,000**	**0**	**-2,000**
Federal FTEs	**5**	**5**	**2**	**-3**
Support Services				
Management and Professional Support Services				
Mission Support	99	876	0	--876
IT Support	52	70	0	-70
Total, Management and Professional Support Services	151	946	0	-949
Other Related Expenses				
Communication and Miscellaneous Charges Related to IT	1	2	0	-2
Other Services	26	50	0	-50
Working Capital Fund	20	153	0	-153
O&M of Equipment or IT Equipment	13	22	0	-22
Total, Other Related Expenses	60	227	0	-227

Administrative Expenses

Activities and Explanation of Changes

FY 2020 Enacted	FY 2021 Request	Explanation of Changes FY 2021 Request vs FY 2020 Enacted
Salaries and Benefits $798,000	**$0**	**-$798,000**
• Provides for salaries and benefits of 5 full-time equivalent employees to administer functions across the Loans Programs Office. Estimate includes 2% performance award and .75% special act award calculations.	• Prior year funds of approximately $323,000 will support the salaries and benefits of 2 full-time equivalent employees to administer functions across the Loans Programs office to the office. Estimate includes 2% performance award and .75% special act award calculations.	• The program is expected to have sufficient unobligated carryover balances to fund salaries in FY 2021.
Travel $29,000	**$0**	**-$29,000**
• Supports the travel of staff to attend meetings, conferences, and site visits if needed.	• Prior year funds of approximately $25,000 will support any necessary travel.	• The program is expected to have sufficient unobligated carryover balances to fund any necessary travel in FY 2021.
Support Services $946,000	**$0**	**-$946,000**
• Supports a range of contract services including administrative support, subject matter experts, legal services, information technology, credit analysis, and market assessments.	• Prior year funds of approximately $468,000 will support range of contract services including administrative support, subject matter experts, legal services, information technology, and publications.	• The program is expected to have sufficient unobligated carryover balances to fund support services necessary in FY 2021.
Other Related Expenses $227,000	**$0**	**-$227,000**
• Supports DOE Working Capital Fund, DOE IT Services expenses, equipment, other services including conferences attendance fees, training publications.	• Prior year funds of approximately $184,000 will support DOE Working Capital Fund, DOE IT Services expenses, and other services to support LPO employees.	• The program is expected to have sufficient unobligated carryover balances to fund other related expenses in FY 2021.

DEPARTMENT OF ENERGY

Funding by Site Detail

TAS_0350 - Tribal Energy Loan Guarantee Program Fund BY2021

(Dollars in Thousands)

	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Request
Washington Headquarters			
Administrative Expenses - Tribal Energy Loan Guarantee Program	1,000	2,000	0
Total Washington Headquarters	**1,000**	**2,000**	**0**

GENERAL PROVISIONS—DEPARTMENT OF ENERGY
(INCLUDING TRANSFER AND CANCELLATION OF FUNDS)

SEC. 301. (a) No appropriation, funds, or authority made available by this title for the Department of Energy shall be used to initiate or resume any program, project, or activity or to prepare or initiate Requests For Proposals or similar arrangements (including Requests for Quotations, Requests for Information, and Funding Opportunity Announcements) for a program, project, or activity if the program, project, or activity has not been funded by Congress.

(b)(1) Unless the Secretary of Energy notifies the Committees on Appropriations of both Houses of Congress at least 3 full business days in advance, none of the funds made available in this title may be used to—

(A) make a grant allocation or discretionary grant award totaling $1,000,000 or more;

(B) make a discretionary contract award or Other Transaction Agreement totaling $1,000,000 or more, Including a contract covered by the Federal Acquisition Regulation;

(C) issue a letter of intent to make an allocation, award, or Agreement in excess of the limits in subparagraph (A) or (B); or

(D) announce publicly the intention to make an allocation, award, or Agreement in excess of the limits in subparagraph (A) or (B).

(2) The Secretary of Energy shall submit to the Committees on Appropriations of both Houses of Congress within 15 days of the conclusion of each quarter a report detailing each grant allocation or discretionary grant award totaling less than $1,000,000 provided during the previous quarter.

(3) The notification required by paragraph (1) and the report required by paragraph (2) shall include the recipient of the award, the amount of the award, the fiscal year for which the funds for the award were appropriated, the account and program, project, or activity from which the funds are being drawn, the title of the award, and a brief description of the activity for which the award is made.

(c) The Department of Energy may not, with respect to any program, project, or activity that uses budget authority made available in this title under the heading "Department of Energy-Energy Programs", enter into a multiyear contract, award a multiyear grant, or enter into a multiyear cooperative agreement unless—

(1)the contract, grant, or cooperative agreement is funded for the full period of performance as anticipated at the time of award; or

(2) the contract, grant, or cooperative agreement includes a clause conditioning the Federal Government's obligation on the availability of future year budget authority and the Secretary notifies the Committees on Appropriations of both Houses of Congress at least 3 days in advance.

(d) Except as provided in subsections (e), (f), **[**and**]** (g)*, and (h)*, the amounts made available by this title shall be expended as authorized by law for the programs, projects, and activities specified in the "Final Bill" column in the "Department of Energy" table included under the heading "Title III-Department of Energy" in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act).

(e) The amounts made available by this title may be reprogrammed for any program, project, or activity, and the Department shall notify, and obtain the prior approval of, the Committees on Appropriations of both Houses of Congress at least 30 days prior to the use of any proposed reprogramming that would cause any program, project, or activity funding level to increase or decrease by more than $5,000,000 or 10 percent, whichever is less, during the time period covered by this Act.

(f) None of the funds provided in this title shall be available for obligation or expenditure through a reprogramming of funds that—

(1) creates, initiates, or eliminates a program, project, or activity;

(2) increases funds or personnel for any program, project, or activity for which funds are denied or restricted by this Act; or

(3) reduces funds that are directed to be used for a specific program, project, or activity by this Act.

(g) (1) The Secretary of Energy may waive any requirement or restriction in this section that applies to the use of funds made available for the Department of Energy if compliance with such requirement or restriction would pose a substantial risk to human health, the environment, welfare, or national security.

(2) The Secretary of Energy shall notify the Committees on Appropriations of both Houses of Congress of any waiver under paragraph (1) as soon as practicable, but not later than 3 days after the date of the activity to which a requirement or restriction would otherwise have applied. Such notice shall include an explanation of the substantial risk under paragraph (1) that permitted such waiver.

(h) *EXCLUSIONS.—Subsections (d), (e), and (f) shall not apply to applied energy program funds transferred or reprogrammed under —*

(1) *the small business innovation research program under section 9 of the Small Business Act (15 U.S.C 638); or*

(2) *the small business technology transfer program under that section.*

(**[**h**]***i*) 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. 302. 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. 3094) during fiscal year 2020 until the enactment of the Intelligence Authorization Act for fiscal year 2020.

SEC. 303. None of the funds made available in this title shall be used for the construction of facilities classified as high-hazard nuclear facilities under 10 CFR Part 830 unless independent oversight is conducted by the Office of Enterprise Assessments to ensure the project is in compliance with nuclear safety requirements.

SEC. 304. None of the funds made available in this title may be used to approve critical decision–2 or critical decision–3 under Department of Energy Order 413.3B, or any successive departmental guidance, for construction projects where the total project cost exceeds $100,000,000, until a separate independent cost estimate has been developed for the project for that critical decision.

SEC. 305. (a) None of the funds made available in this or any prior Act under the heading "Defense Nuclear Nonproliferation" may be made available to enter into new contracts with, or new agreements for Federal assistance to, the Russian Federation.

(b) The Secretary of Energy may waive the prohibition in subsection (a) if the Secretary determines that such activity is in the national security interests of the United States. This waiver authority may not be delegated.

(c) A waiver under subsection (b) shall not be effective until 15 days after the date on which the Secretary submits to the Committees on Appropriations of both Houses of Congress, in classified form if necessary, a report on the justification for the waiver.

SEC. 306. Notwithstanding section 161 of the Energy Policy and Conservation Act (42 U.S.C. 6241), upon a determination by the President in this fiscal year that a regional supply shortage of refined petroleum product of significant scope and duration exists, that a severe increase in the price of refined petroleum product will likely result from such shortage, and that a draw down and sale of refined petroleum product would assist directly and significantly in reducing the adverse impact of such shortage, the Secretary of Energy may draw down and sell refined petroleum product from the Strategic Petroleum Reserve. Proceeds from a sale under this section shall be deposited into the SPR Petroleum Account established in section 167 of the Energy Policy and Conservation Act (42 U.S.C. 6247), and such amounts shall be available for obligation, without fiscal year limitation, consistent with that section.

[SEC. 307. Of the offsetting collections, including unobligated balances of such collections, in the "Department of Energy-Power Marketing Administration-Colorado River Basins Power Marketing Fund, Western Area Power Administration", $21,400,000 shall be transferred to the "Department of Interior-Bureau of Reclamation-Upper Colorado River Basin Fund" for the Bureau of Reclamation to carry out environmental stewardship and endangered species recovery efforts.**]**

[SEC. 308. (a) Of the unobligated balances available from amounts appropriated in prior Acts under the heading "Title III-Department of Energy-Energy Programs", $12,723,000 is hereby rescinded.

(b) No amounts may be rescinded under (a) from amounts that were designated by the Congress as an emergency requirement pursuant to a concurrent resolution on the budget or the Balanced Budget and Emergency Deficit Control Act of 1985.**]**

[SEC. 309. Beginning in fiscal year 2021 and for each fiscal year thereafter, fees collected pursuant to subsection (b)(1) of section 6939f of title 42, United States Code, shall be deposited in "Department of Energy-Energy Programs-Non-Defense Environmental Cleanup" as discretionary offsetting collections.**]**

[SEC. 310. During fiscal year 2020 and each fiscal year thereafter, notwithstanding any provision of title 5, United States Code, relating to classification or rates of pay, the Southeastern Power Administration shall pay any power system dispatcher employed by the Administration a rate of basic pay and premium pay based on those prevailing for similar occupations in the electric power industry. Basic pay and premium pay may not be paid under this section to any individual during a calendar year so as to result in a total rate in excess of the rate of basic pay for level V of the Executive Schedule (section 5316 of such title).**]**

SEC. 307. Section 611 of the Energy and Water Development Appropriations Act, 2000 (P.L. 106–60; 10 U.S.C 2701 note) is amended as follows:

(a) *In subsection (a) in the matter preceding paragraph (1), by striking "the Army, acting through the Chief of Engineers" and inserting "Energy".*

(b) *In subsection (a)(6), by striking "by the Secretary of the Army, acting through the Chief of Engineers," and striking ", which may be transferred upon completion of remediation to the administrative jurisdiction of the Secretary of Energy".*

(c) *In subsection (a), by adding after paragraph (6) the following undesignated matter: "Upon completion of remediation of a site acquired by the Secretary of the Army prior to fiscal year 2021, the Secretary of the Army may transfer administrative jurisdiction of such site to the Secretary of Energy.".*

(d) *In subsection (b), by striking "the Army, acting through the Chief of Engineers," and inserting "Energy".*

(e) *In subsection (c), by striking "amounts made available to carry out that program and shall be available until expended for costs of response actions for any eligible site" and inserting "'Other Defense Activities' appropriation account or successor appropriation account and shall be available until expended for costs of response actions for any eligible Formerly Utilized Sites Remedial Action Program Site".*

(f) *By redesignating subsection (f) as subsection (g).*

(g) *By inserting after subsection (e) the following new subsection:*

"(f) The Secretary of Energy, in carrying out subsection (a), shall enter into an agreement with the Secretary of the Army to carry out the remediation functions and activities described in subsections (a)(1) through (a)(6).".

SEC. 308. Section 2307 of the Energy Policy Act of 1992 (42 U.S.C 13526) is repealed.

SEC. 309. Notwithstanding section 161 of the Energy Policy and Conservation Act (42 U.S.C. 6241), the Secretary of Energy shall draw down and sell 15 million barrels of refined petroleum product from the Strategic Petroleum Reserve during fiscal year 2021. Proceeds from sales under this section shall be deposited into the general fund of the Treasury during fiscal year 2021, with the exception of $242,000,000 from such proceeds to be deposited in the "Naval Petroleum and Oil Shale Reserves" account for comprehensive remediation of the Naval Petroleum Reserve–1 site near Elk Hills, California, to remain available until expended.

SEC. 310. Treatment of Lobbying and Political Activity Costs as Allowable Costs under Department of Energy Contracts.—

(a) *Allowable Costs.—*

(1) *Section 4801(b) of the Atomic Energy Defense Act (50 U.S.C. 2781(b)) is amended—*

(A) *by striking "(1)" and all that follows through "the Secretary" and inserting "The Secretary"; and*

(B) *by striking paragraph (2).*

(2) *Section 305 of the Energy and Water Development Appropriation Act, 1988, as contained in section*

101(d) of Public Law 100–202 (101 Stat. 1329–125), is repealed.

(b) *Regulations Revised.—The Secretary of Energy shall revise existing regulations consistent with the repeal of 50 U.S.C. 2781(b)(2) and section 305 of Public Law 100–202 and shall issue regulations to implement 50 U.S.C. 2781(b), as amended by subsection (a) of this section, no later than 150 days after the date of the enactment of this Act. Such regulations shall be consistent with the Federal Acquisition Regulation 48 C.F.R. 31.205–22.*

SEC. 311. Pursuant to a request by the Secretary of Defense, and upon determination by the Director of the Office of Management and Budget in consultation with the Secretary of Energy that such action is necessary, the Secretary of Energy may, with the approval of the Office of Management and Budget, transfer not to exceed $2,500,000,000 of funds made available in this Act to the Department of Energy for National Nuclear Security Administration functions to the Department of Defense, to be merged with and to be available for the same purposes, and for the same time period, as the appropriation or fund to which transferred: Provided, That the Secretary of Energy shall notify the Congress promptly of all transfers made pursuant to this authority or any other authority in this Act: Provided further, That this transfer authority is in addition to any other transfer authority provided in this Act.

TITLE V—GENERAL PROVISIONS
(INCLUDING TRANSFER OF FUNDS)

SEC. 501. None of the funds appropriated by this Act may be used in any way, directly or indirectly, to influence congressional action on any legislation or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. 1913.

[SEC. 502. (a) None of the funds made available in title III of this Act may be transferred to any department, agency, or instrumentality of the United States Government, except pursuant to a transfer made by or transfer authority provided in this Act or any other appropriations Act for any fiscal year, transfer authority referenced in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act), or any authority whereby a department, agency, or instrumentality of the United States Government may provide goods or services to another department, agency, or instrumentality.

(b) None of the funds made available for any department, agency, or instrumentality of the United States Government may be transferred to accounts funded in title III of this Act, except pursuant to a transfer made by or transfer authority provided in this Act or any other appropriations Act for any fiscal year, transfer authority referenced in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act), or any authority whereby a department, agency, or instrumentality of the United States Government may provide goods or services to another department, agency, or instrumentality.

(c) The head of any relevant department or agency funded in this Act utilizing any transfer authority shall submit to the Committees on Appropriations of both Houses of Congress a semiannual report detailing the transfer authorities, except for any authority whereby a department, agency, or instrumentality of the United States Government may provide goods or services to another department, agency, or instrumentality, used in the previous 6 months and in the year-to-date. This report shall include the amounts transferred and the purposes for which they were transferred, and shall not replace or modify existing notification requirements for each authority.**]**

SEC. 503. None of the funds made available by this Act may be used in contravention of Executive Order No. 12898 of February 11, 1994 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations).

SEC. 504. (a) None of the funds made available in this Act may be used to maintain or establish a computer network unless such network blocks the viewing, downloading, and exchanging of pornography.

(b) Nothing in subsection (a) shall limit the use of funds necessary for any Federal, State, tribal, or local law enforcement agency or any other entity carrying out criminal investigations, prosecution, or adjudication activities.

GENERAL PROVISIONS—DEPARTMENT OF ENERGY
(INCLUDING TRANSFER AND CANCELLATION OF FUNDS)

SEC. 301. (a) No appropriation, funds, or authority made available by this title for the Department of Energy shall be used to initiate or resume any program, project, or activity or to prepare or initiate Requests For Proposals or similar arrangements (including Requests for Quotations, Requests for Information, and Funding Opportunity Announcements) for a program, project, or activity if the program, project, or activity has not been funded by Congress.

(b)(1) Unless the Secretary of Energy notifies the Committees on Appropriations of both Houses of Congress at least 3 full business days in advance, none of the funds made available in this title may be used to—

(A) make a grant allocation or discretionary grant award totaling $1,000,000 or more;

(B) make a discretionary contract award or Other Transaction Agreement totaling $1,000,000 or more, Including a contract covered by the Federal Acquisition Regulation;

(C) issue a letter of intent to make an allocation, award, or Agreement in excess of the limits in subparagraph (A) or (B); or

(D) announce publicly the intention to make an allocation, award, or Agreement in excess of the limits in subparagraph (A) or (B).

(2) The Secretary of Energy shall submit to the Committees on Appropriations of both Houses of Congress within 15 days of the conclusion of each quarter a report detailing each grant allocation or discretionary grant award totaling less than $1,000,000 provided during the previous quarter.

(3) The notification required by paragraph (1) and the report required by paragraph (2) shall include the recipient of the award, the amount of the award, the fiscal year for which the funds for the award were appropriated, the account and program, project, or activity from which the funds are being drawn, the title of the award, and a brief description of the activity for which the award is made.

(c) The Department of Energy may not, with respect to any program, project, or activity that uses budget authority made available in this title under the heading "Department of Energy-Energy Programs", enter into a multiyear contract, award a multiyear grant, or enter into a multiyear cooperative agreement unless—

(1)the contract, grant, or cooperative agreement is funded for the full period of performance as anticipated at the time of award; or

(2) the contract, grant, or cooperative agreement includes a clause conditioning the Federal Government's obligation on the availability of future year budget authority and the Secretary notifies the Committees on Appropriations of both Houses of Congress at least 3 days in advance.

(d) Except as provided in subsections (e), (f), **[**and**]** (g)*, and (h)*, the amounts made available by this title shall be expended as authorized by law for the programs, projects, and activities specified in the "Final Bill" column in the "Department of Energy" table included under the heading "Title III-Department of Energy" in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act).

(e) The amounts made available by this title may be reprogrammed for any program, project, or activity, and the Department shall notify, and obtain the prior approval of, the Committees on Appropriations of both Houses of Congress at least 30 days prior to the use of any proposed reprogramming that would cause any program, project, or activity funding level to increase or decrease by more than $5,000,000 or 10 percent, whichever is less, during the time period covered by this Act.

(f) None of the funds provided in this title shall be available for obligation or expenditure through a reprogramming of funds that—

(1) creates, initiates, or eliminates a program, project, or activity;

(2) increases funds or personnel for any program, project, or activity for which funds are denied or restricted by this Act; or

(3) reduces funds that are directed to be used for a specific program, project, or activity by this Act.

(g) (1) The Secretary of Energy may waive any requirement or restriction in this section that applies to the use of funds made available for the Department of Energy if compliance with such requirement or restriction would pose a substantial risk to human health, the environment, welfare, or national security.