Report of the Building Energy Efficiency Subcommittee to the Secretary of Energy Advisory Board

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Executive Summary

Buildings use 40% of total energy in the United States – more than either the industrial or transportation sectors. Technical improvements and cost reductions (see Appendix 3) in building materials, components and energy management systems are enabling progress in reducing the nation's energy consumption and consequent greenhouse gas emissions with payback periods as low as 24 months. With responsibility and funding for the nation's largest set of building energy-related research, development and deployment programs, the Department of Energy (DOE) should lead efforts to ensure building energy efficiency is a national priority.

One of the most important things DOE can do to reduce the country's energy use and dependence on fossil fuels is to actively lead the national initiatives to significantly improve building energy efficiency.

The potential for energy savings is substantial. A recent Deutsche Bank and Rockefeller Foundation study found that up to $279 billion could be invested in building efficiency retrofits in the U.S. and that such an investment would yield up to $1 trillion in energy savings.[1] The National Academy of Sciences' *America's Energy Future* report states that "full deployment of cost-effective energy efficiency technologies in buildings alone could eliminate the need to construct any new electricity-generating plants in the United States" until 2030.[2] And, a recent McKinsey & Co. study concluded "Energy efficiency offers a vast, low-cost energy resource for the U.S. economy – but only if the nation can craft a comprehensive and innovative approach to unlock it."[3]

The President is an outspoken advocate for the role buildings must play in the Federal government's overall objectives to increase energy efficiency. Executive Order 13514 requires DOE and other government agencies to *"…design, construct, maintain, and operate high performance sustainable buildings in sustainable locations…"*[4]

Secretary Chu has also been a strong advocate for improving building energy efficiency: "Improving building energy efficiency on a large scale is a challenge we can't afford not to take. It will create jobs, reduce energy waste, save our businesses and institutions

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[1] Baker, Jake, Ron Herbst, Margot Brandenburg, John Cleveland, Joel Rogers, and Chinwe Onyeagoro. United States Building Energy Efficiency Retrofits: Market Sizing and Financing Models. Rep. Ed. Mark Fulton. Mar. 2012. The Rockefeller Foundation, DB Climate Change Advisors. <http://www.rockefellerfoundation.org>.

[2] Overview and Summary of America's Energy Future: Technology and Transformation. Rep. 2009. National Academy of Sciences-National Academy of Engineering-National Research Council. <http://www.nap.edu/catalog.php?record_id=12943>.

[3] Granade, Hannah C., Jon Creyts, Anton Derkach, Philip Farese, Scott Nyquist, and Ken Ostrowski. Unlocking Energy Efficiency in the U.S. Economy. Rep. July 2009. McKinsey & Company. <http://www.mckinsey.com/client_service/electric_power_and_natural_gas/latest_thinking/unlocking_energy_efficiency_in_the_us_economy>.

[4] For more information, see http://www.whitehouse.gov/assets/.../2009fedleader_eo_rel.pdf

money, and reduce our dependence on foreign oil."[5]

As a subcommittee of the Secretary of Energy Advisory Board, we have reviewed the overall scope of the DOE's complete set of building efficiency activities, examined the coordination across the Department and more broadly across the Federal government, and looked at the way the DOE's building-related activities interact with state and local programs and with the private sector.

As detailed in the following report, we find DOE is making clear and significant progress. We also believe there are a number of opportunities to make DOE's building efficiency portfolio even more effective. This Executive Summary lists the report's primary recommendations. Recommendations are listed within four broad categories (Organizational and leadership; Program vision, goals and communication, and specific programs; Financing; Codes, standards and government regulations to enhance deployment) and are not listed in an implied order of priority. Full details of the work process, analysis and recommendations follow in the body of this report.

[5] Department of Energy. "Obama Administration Announces 14 Initial Partners in the Better Buildings Challenge." Press release. 30 June 2011. <http://energy.gov/articles/obama-administration-announces-14-initial-partners-better-buildings-challenge>.

Primary Recommendations

A) Organizational and leadership recommendations:

1. The Secretary should create a single "line of business" owner for all elements of its buildings program (the Office of Building Energy Efficiency or OBEE) across the Energy, Advanced Research Projects Agency-Energy (ARPA-E), Science and Policy offices. This position should report directly to the Under Secretary for Energy (see Section 1 for more information).
2. OBEE should increase its regional outreach to ensure full access to its building energy efficiency activities and should more actively promote its activities through the DOE's existing small business office efforts (see Section 5 for more information).

B) Program vision, goals and communication, and specific program recommendations:

1. OBEE must have a roadmap for its program elements and evaluate its progress against that roadmap (see Section 1 for more information).
2. The Energy Information Agency (EIA) produces databases and survey results for commercial (CBECS) and residential (RECS) buildings that are critical to the development and tracking of energy efficiency solutions and results. The Secretary and the EIA Administrator should prioritize funding for this effort to allow a properly executed, statistically sound and programmatically relevant survey, using the most efficient statistical and survey techniques, every four years (see Section 2 for more information).

C) Financing recommendations:

1. The Secretary should establish a dedicated DOE policy office, the Energy Policy and Systems Analysis (EPSA) Office, that produces and integrates economic analysis of building systems based on modeling, simulation and engineering data (see Section 5 for more information).
2. The Secretary should work to remove current restrictions to Property Assessed Clean Energy (PACE) financing. OBEE should cooperate closely with the Federal Housing Authority (FHA), Federal Housing Finance Agency (FHFA), Fannie Mae, Freddie Mac, and the Treasury Department to make financing available for residential and small business energy efficiency through programs like PACE and On-Bill Financing (see Sections 2 and 5 for more information).

D) Codes, standards and government regulation recommendations to enhance deployment:

1. The Secretary should lead the effort with the General Services Administration (GSA) and the Department of Defense (DOD) to ensure that Federal agencies are authorized to enter into energy-saving performance contracts (ESPCs) for long-termed leased facilities, in addition to those owned by the government (see Section 4 for more information).

2. The Secretary should initiate senior level discussions between DOE and the American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) to modernize Standard 90.1 (air conditioning, water heating, and building "envelopes") (see Section 2 for more information).
3. OBEE and EPSA should lead an interagency collaboration to ensure that energy efficiency criteria are integrated into residential building loan underwriting standards. They should also develop policies to require energy efficiency disclosure in new and existing home sales (see Section 3 for more information).
4. OBEE should work closely with DOD, GSA, and the Office of Management and Budget (OMB) to ensure life-cycle and social costs are considered when evaluating energy efficiency purchases, and incorporate this methodology into agency procurements (see Section 4 for more information).

Introduction and Methodology

Given the important role buildings play in U.S. energy utilization, Secretary Chu asked that a subcommittee of the Secretary of Energy Advisory Board (SEAB) be formed to review the Department's buildings-related activities. The Subcommittee on Building Energy Efficiency's charter states that:

> Given the impact building energy reduction can have on U.S. energy consumption and greenhouse gas emission, it is important to review whether the buildings program is properly focused, executing and making progress against clear objectives, shaping clear and consistent policy, and is connected to cooperation opportunities and best practices of industry, federal, state, local and foreign governments.

The full text of the charter given to the Subcommittee is included in Appendix 1 of this report.

From June 2011 through July 2012 the Subcommittee conducted four half-day briefings with government and private sector stakeholders (three in Washington, D.C. and one in Palo Alto, CA), conducted over twenty individual interviews with government officials and members of the private sector and met in person or by phone on twelve occasions in the course of its work. A full list of those who provided input to the Subcommittee is attached in Appendix 2.

The Subcommittee would like to express its thanks to Alyssa Sullivan and Amy Bodette from the Department of Energy's Office of the Secretary for their guidance and tireless assistance during the generation of this report and to Joel Berman in Steve Westly's office for coordinating the research and writing of the report.

Section 1: *Review, comment and make recommendations on the overall set of current and planned DOE activities related to building energy efficiency as to the clarity of the overall objectives over time, the integration and coherence of the various programs and activities across Energy Efficiency and Renewable Energy (EERE), ARPA-E, Office of Science and the various research constructs now in place (EFRCs, Hubs, etc.), and the connection to the private sector.*

Analysis of Current Programs

DOE manages a large and diffuse set of activities throughout the Department under the overall theme of improving building energy efficiency:

- Science and technology programs range from investments in the fundamental modeling of buildings systems to technology development to improve the capability and efficiency of building components and control systems.
- One of the current six Energy Innovation Hubs (Greater Philadelphia Innovation Cluster's Energy Efficient Buildings Hub) and an Energy Frontier Research Center (EFRC for Solid State Lighting Science) are specifically dedicated to reducing energy use in buildings.
- The Department plays a major role in establishing building component standards through its appliance standards efforts and partnership with the Environmental Protection Agency (EPA) on the Energy Star program.
- EIA collects and communicates comparative asset performance statistics for commercial and residential buildings on a regular basis.
- EERE's residential weatherization program provides deployment support alongside a number of state and tribal deployment assistance programs.
- The Federal Energy Management Program (FEMP) provides training, communication, and technology deployment assistance for the Federal government.

Table 1.1: Overall FY12 spending on building efficiency is approximately $600M:

Estimated FY12 Spending		
Buildings Technology Program		$ 219.1
Commercial Buildings Integration	$ 31.9	
Residential Buildings Integration	$ 31.2	
Lighting and Buildings Hubs	$ 50.1	
Other Technology Programs	$ 34.6	
Equipment & Buildings Standards	$ 58.3	
Validation & Market Introduction	$ 8.5	
SBIR/STTR	$ 4.5	
ARPA-E Building Related Technologies		$ 150.0
Building Integrated Solar PV		$ 76.0
Federal Energy Management Program		$ 29.9
Training, rulemaking, etc.	$ 22.6	
Weatherization and Intergovernmental Programs		$ 128.0
Weatherization Assistance Program	$ 68.0	
State and Tribal Energy Programs	$ 60.0	
Total		$ 603.0

Findings

In assessing the overall internal scope and integration of the DOE's buildings programs, the Subcommittee found DOE:

- Made progress in creating, managing and communicating a broad range of building component standards and energy efficiency progress is clearly evident. As an example, the American Council for an Energy Efficient Economy (ACEEE), estimates that products meeting current energy efficiency standards consumed 7% less electricity in 2010 than they would have had the applicable standards not been enacted.[6] At approximately 280 terawatt-hours and assuming an average cost of $0.10 per kilowatt-hour, this reduced consumption has saved nearly $30 billion per year and reduced the need for at least 100 medium-sized coal-fired power plants. ACEEE also projects savings to 2035 – 720 terawatt-hours – are up by a factor of 2.5. The 2035 estimates are on line one of Table 2.1 in Section 2.

[6] The Efficiency Boom: Cashing In on the Savings from Appliance Standards, Report Number ASAP-8/ACEEE-A123, Lowenberger, Mauer, deLaski, DiMascio, Amann, and Nadel. American Council for an Energy Efficient Economy, March 2012. For more information, see http://www.aceee.org

- Made significant progress on specific building component technologies that have been funded as part of the Building Technologies Program's (BTP) portfolio (see cost reduction chart for compact fluorescent lamps (CFLs) in Appendix 3).
- Expanded the successful residential weatherization program with $5 billion from the American Recovery and Reinvestment Act. The program helped 760,000 families, exceeding the original goal of 600,000 and saving the average family $437 a year on energy bills.[7]
- Several individual technology programs clearly state long-term goals but the overarching goals that cut across program lines are not clearly articulated. Goals tend to be long term and often do not have clear interim milestones.
- There are opportunities to deploy broad scale, cost effective residential and commercial building upgrades that will deliver significant energy and cost saving. For example, Levinson estimates that a national building standard to replace all residential and commercial roofs at the end of their current life with white or "cool" roofs can lead to an annual net energy savings in 2035 of 0.5 quadrillion BTU and an annual cost savings of $3 billion (see Table 2.1).[8]
- The Energy Efficient Buildings Hub has been operational for one year and has the potential to develop deployable-at-scale building systems technology and create the human and financial ecosystem to accelerate the growth of the market for energy efficient building retrofits. The Hub should focus on shorter term deliverables in years two and three.
- There is limited activity to use social science tools to optimize decision-making amongst commercial and residential users of energy efficient technologies and systems. This is fertile ground for coordinated investment by OBEE.

Recommendations

1. The Secretary should create a single "line of business" owner for all elements of its buildings program (the Office of Building Energy Efficiency or OBEE) across the Energy, ARPA-E, Science and Policy offices. This position should report directly to the Under Secretary for Energy (**this is primary recommendation A1, see Appendix 10 for more information of the role of OBEE**).

   OBEE should coordinate all science, technology, market analysis and deployment support activities. While clearly articulating goals to mature technical capabilities, the BTP program is neither driving science development in the Office of Science nor coordinating deployment and market support activities. The Secretary should appoint a senior director, reporting at the Under Secretary level, with responsibility for buildings energy efficiency programs across DOE, and that this be the only program responsibility of this "line of business" individual. Further, this individual should lead all interagency building energy efficiency cooperation.

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[7] Eisenberg, Joel F., ***Weatherization Assistance Program Technical Memorandum Background Data and Statistics*** ORNL/TM-2010/66, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March, 2010.

[8] The Case for Cool Roofs, Levinson, Ronnen, LBNL, May 2012. <http://heatisland.lbl.gov/sites/heatisland.lbl.gov/files/Levinson_2012_Case for cool roofs.pdf>

We also recommend that OBEE restrict its focus to commercial and residential buildings and that industrial energy efficiency continue to remain separate. DOE must support the synergies in the applications of integrated building systems between the two programs. But the additional focus on manufacturing equipment and processes in the industrial programs should not be diluted.

OBEE and the Office of Electricity Delivery and Energy Reliability (OE) should coordinate where possible. We encourage increased programmatic cooperation in the areas of distributed generation and storage, and micro-grid integration.

2. OBEE must have a roadmap for its program elements and evaluate its progress against that roadmap (**this is primary recommendation B1**).

   OBEE should establish and periodically update technology, efficacy and affordability roadmaps for individual component as well as whole building integration and control technologies. The OBEE should articulate and track clear programmatic goals and results for reducing total building energy use as well as other appropriate performance metrics (e.g. lumens per watt and lumens per dollar for LED lighting.) The director should develop these goals with input from the public and private stakeholders and coordinate with the National Institute of Standards and Technology (NIST), DOD and the Department of Housing and Urban Development (HUD). These roadmaps, goals and actions should be included in an annual, publicly available report card.

   BTP has made progress on 2020 energy efficiency goals for new construction as well as residential and commercial retrofits. There has also been significant work and progress within BTP in the area of individual component (appliance) efficiencies. There is an opportunity to create more structured roadmaps with intermediate goals for new and retrofit whole building energy efficiency upgrades.

   OBEE should adopt a clear, consistent format to communicate technology maturation and deployment goals for all component technologies as well as for integrated building lifecycle activities (modeling, design, commissioning and continuous, optimized control). OBEE should report on program deployment against these roadmaps as well as progress against the component and whole building performance goals on an annual basis.

Section 2: *How can we accelerate the adoption of building efficiency? Comment on which activities are operating successfully and make recommendations for changes in processes and organization that the program employs in accomplishing its mission.*

Areas of Strength

1. EIA's RECS and CBECS (Residential – and Commercial Building – Energy Consumption Surveys)

RECS and CBECS provide the only standardized and statistically valid basis to compare energy uses in households and buildings across the U.S. Other data inquiries such as appliance saturation surveys by utilities, whole-building audits by private vendors, and academic case studies of particular end uses offer useful complements. However, they cannot replace these benchmark surveys, which are trusted by both industry and respondents and have voluntary participation rates of 80 percent or better, far above those of private surveys. The RECS and CBECS data are essential to the larger energy efficiency community, which uses survey micro-datasets disseminated by EIA to develop their own tabulations and analyses, and as a basis for EIA's own analyses and projections. The energy efficiency community wants more geographic detail in RECS and additional building types in CBECS.

RECS data for 2009, collected in 2010, have been compiled and issued, but the most recent CBECS dataset is from 2003. CBECS, which covers a wide range of complex building types, is more expensive than RECS, and recent congressional budgets have not adequately funded CBECS. We are pleased to note that CBECS received $7 million for FY12 and is budgeted for a similar amount in FY 13, which should be enough to complete a new CBECS. Future challenges facing RECS and CBECS include keeping information current despite the long periodicity of the survey cycle, reducing the time from field collection to issuance of energy data by building end-use, and limiting costs notwithstanding the technical nature of the survey topics. Insights from a new National Academy report on RECS and CBECS are helping EIA explore options that could limit costs and expand scope. We also suggest the staff consider reducing the number of survey questions to help meet these objectives.

There is a second reason to support CBECS. The U.S. conducts no regular survey of commercial buildings and their physical characteristics. As a result, CBECS has become the de facto buildings survey in addition to its energy responsibilities. For this reason, the value of CBECS extends well beyond the energy data collected.

RECS and CBECS are conducted by a small agency and are multiyear projects whose benefit extends to the broader Department and external efforts to advance energy efficiency in buildings. The continuity, relevance and value of the surveys require ongoing commitment from the Department.

2. Buildings Performance Database

BTP gave the Subcommittee an impressive demonstration of its pilot stage DOE Buildings Performance Database (BPD). This is a case where DOE has done what only DOE has the "clout" to do – to set up a valuable *de facto* standard taxonomy for a buildings database.

Today there is no standard taxonomy or data definition for a building's energy related information, which results in balkanized and incompatible datasets – making it difficult or impossible to compare data sets collected by different parties. This makes all data collection efforts less valuable. If the various parties with an interest in building energy performance began using a standard taxonomy and set of data definitions, then it would be much easier to share or aggregate data for any purpose. DOE has defined a taxonomy for building energy performance data to help standardize national data collection and help building owners, utilities, and others meet their energy savings goals. BPD is an open source database that could connect to EIA's RECS and CBECS, and EPA's Portfolio Manager, and download data. It also allows users to input other kinds of building performance data. For example, a user (e.g. a utility, industry organization, or local government) can translate its database format to the standard taxonomy format to include it in the BPD, and then run analyses across data sets. DOE is also developing an Application Programming Interface (API) for the BPD that will allow third parties to build additional tools and applications to analyze the data in the BPD without exposing any individual building data (personally identifiable information, or PII).

The BPD is supported by user tools such as the Standard Energy Efficiency Data platform (SEED), a software application that will make it easy for data owners to allow access to their data, or to transfer it to other entities for internal or external reporting. SEED is currently in pilot stage with several city and state governments. They use it to manage the data to comply with new laws requiring commercial buildings to benchmark their energy performance and disclose the results. These include San Francisco, New York City, Seattle, Austin, and Washington, DC. California, Washington, and other states have also expressed interest in using it. DOE worked with these jurisdictions in developing SEED to ensure that it meets their needs (see Appendices 4 and 5 for more information).

3. Collaborations with Manufacturers and Retailers – Alliance Programs

BTP manages Commercial Building Energy Alliances (CBEA) that leverage DOE technical expertise to develop energy-saving resources, such as high-performance specifications, that are deployed at scale in member's building portfolios.

In January 2011, DOE joined industry partners in CBEA to release a design specification for 10-ton capacity commercial air conditioners, also known as rooftop units (RTUs), which would reduce energy consumption by as much as 50% relative to equipment built to the current ASHRAE 90.1 standard. The specification was issued as an "RTU Challenge" since it aimed to catalyze the market introduction of cost-effective, energy-saving RTUs that would significantly outperform currently available models. Many Alliance members purchase large volumes of RTUs, so their issuance of a specification outlining common performance requirements and desired features represents a powerful

demand signal to manufacturers. Five participating manufacturers – Daikin McQuay, Carrier, Lennox, 7AC Technologies, and Rheem – have until April 1, 2013 to submit a product for independent evaluation according to the specification. Daikin McQuay's Rebel rooftop unit system was recognized by DOE on May 24, 2012 as the first to meet the RTU Challenge.[9] Nationwide, if all 10 to 20 ton RTUs were replaced with units that met the specification, businesses would annually save approximately 16.7 TWh and $1.9 billion (see Figure 2.1 and Table 2.1).

This initiative teaches two lessons:

1) Government/industry/stakeholder partnerships can make great strides in improving energy efficiency. We throw a bouquet to EERE and the Buildings Technology Program team.

2) It also illustrates how far ASHRAE Standard 90.1 has fallen behind time and fails to incorporate modern technology like variable-speed motors; thus it specifies only that air conditioners shall have an Energy Efficiency Ratio (EER) of > 11.0. The problem is that the EER rating procedure measures efficiency at only peak load operation, which is typically only a small percentage of total operating hours. The RTU Challenge specification references the more granular (integrated) IEER rating methodology, which captures performance in four load conditions – full, 75%, 50%, and 25%. In this case, the EER rating of one of the new RTU Challenge units at 75% load, which typically comprises 60% of the operating hours, exceeds 22 EER.

[9] For more information, see http://buildingsdatabook.eren.doe.gov/

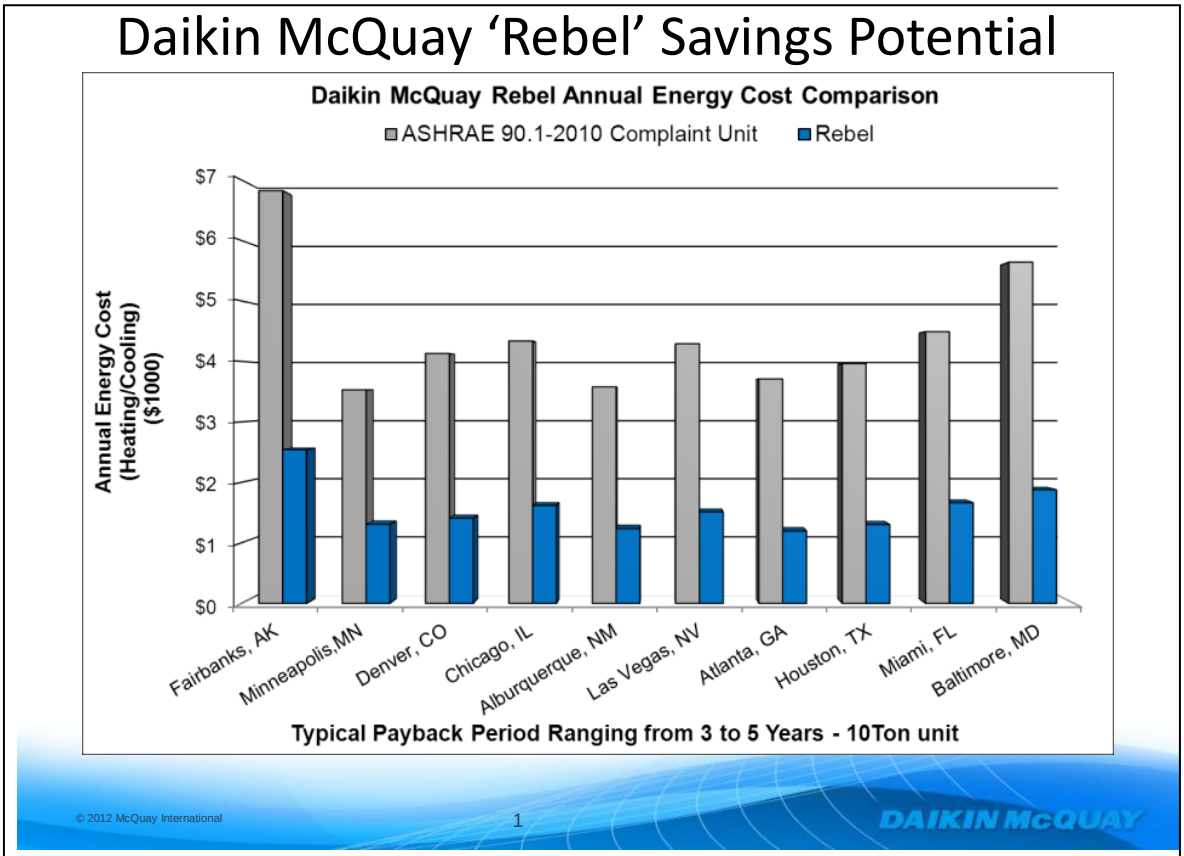

Figure 2.1 – High Performance RTU Energy Cost Savings Estimates. *The figure, provided by Daikin McQuay, shows the estimated costs for the new "Rebel" 10-ton RTU in various locations around the U.S. This innovative equipment combines best-in-class components to deliver a highly efficient air-cooled heat pump with a gas section for auxiliary heat. As part of the DOE RTU Challenge, these operating costs will be validated through performance mapping tests and calibrated energy simulations.*

Packaged commercial air conditioners – mainly RTUs – are used in nearly half of all air-cooled conditioned commercial floor space in the United States.[10] The potential energy and cost savings, with a claimed 3-5 year simple payback and 20-year service life, are enormous. If building owners replace all RTUs in the range of 10-20 tons (as they wear out) with units that comply with the Challenge, then annual savings, after full stock replacement in 2035, will be approximately 21.5 TWh and $2.4 billion (see table 2.1). This is a conservative estimate, as it assumes that all current RTUs meet the minimum 11 EER of ASHRAE Standard 90.1.

[10] For more information, see http://buildingsdatabook.eren.doe.gov/

Table 2.1: Annual Electricity Savings in year 2035 (in 2010 dollars)				
Efficiency Measure/Potential	**Electricity Savings (TWh in 2035)**	**Electric Bill Savings (2010 dollars)**	**Mid-size Power Plants avoided (500MW each)***	**Notes and Sources**
All Standards to date	720	$72 billion	240 plants	ACEEE (2012)
White Roofs (if flat)	30	$3 billion	10 plants	Levinson (2012)**
RTU Challenge	21.5	$2.4 billion	7.2 plants	Risser (2012)***

*Following Koomey et al. (2010), we assume a typical 500MW power plant operates at a 70% load factor, with 7% T&D losses. Displacing this plant saves annually 3TWh (3 BkWh) at the meter and, if coal-fired, avoids emitting 3 million metric tonnes of CO2. For more information, see http://iopscience.iop.org/1748-9326/5/1/014017/pdf/1748-9326_5_1_014017.pdf

**White roofs savings are for real TWhs saved. Levinson (2012) adjusts for winter heating penalty, but excludes additional savings from the "albedo effect" (i.e. cooling the urban heat island and cooling the entire world).

***See letter from Roland Risser (Appendix 6). Risser provides smaller annual savings estimates (16.7 TWh, $1.9 B/year) based on the unrealistic assumption that every existing RTU is suddenly replaced in 2010. To stay consistent with the 2035 timeframe in the first two rows of the table, we have adjusted the RTU Challenge savings according to the predicted 20-year growth in commercial floor space, which is an estimated 29% in the 2011 EIA Annual Energy Outlook, Table A.5.

Table 2.1 - Annual electricity savings from the RTU Challenge. *Here it is compared with the annual savings in 2035 from all past standards and further compared with another "bright idea" – White Roofs – which DOE is also promoting. For white roofs we forecast the 2035 savings if building standards (for U.S. climate zones with hot summers) require that flat roofs be white. This would apply to new roofs and re-roofs at the end of useful life. All numbers are rounded. A TWh is frequently called a BkWh (Billion kilowatt hours).*

To put the savings in perspective we list here total U.S. electricity sales in 2011, which were about 4000 TWh, costing about $400 billion and generated by 1,300 mid-size power plants. EIA predicts that in 2035, sales will have grown 25-30% to 5,000 TWh costing $500 billion/year and generated by 1700 mid-size power plants.

To capture a significant share of this newly recognized potential, ASHRAE should promptly tighten its Standard 90.1. This requires switching from the primitive metric of EER to the more complete IEER (Integral EER) and to tighten IEER from its current value of 11.2 to close to the RTU Challenge level of 18.

Note that IEER is already well established; indeed ASHRAE 90.1(2010) itself requires either a weak EER of 11.0 OR a slightly tighter IEER of 11.2. Furthermore, AHRI (American Heating and Refrigeration Institute) has adopted Test Procedure 340/360 for both EER and IEER. Canada has dropped EER but ASHRAE has not yet dropped EER because ASHRAE is constrained by a consensus process whereby a few dissenting votes frequently stall progress – the third line of Table 3 reminds us how costly these delays are.

4. ASHRAE Voluntary "Stretch" Standard 189.1

We suggest a possible compromise: We praise ASHRAE for introducing Voluntary Standard 189.1, which allows new ideas and technologies to be introduced on a modest scale and tested for about three years to see if they are ready for "prime time" (i.e.

Standard 90.1). A voluntary, advanced, standard is particularly useful for the design of public, owner-occupied, or just "green" buildings. It is already largely incorporated in the goals of the DOD, GSA, U.S. Green Building Council, and other "green" jurisdictions.

DOE could suggest a flexible procedure whereby DOE recommends a new, tighter energy efficiency measure for Standard 90.1, but, if not accepted, the measure would automatically be considered by the 189.1 Committee, which has a wider mandate to innovate.

Please refer to Appendix 6 for Roland Risser's memo that outlines the RTU Challenge.

5. Cross department collaboration on white roofs

We found there was excellent collaboration among DOE program offices (OE, Science, ARPA-E, EIA, etc.). The Subcommittee praises the collaboration on the white roofs campaign between support for the domestic side of the program by EERE and the Office of Science, and support for the international side by the international team in the Office of Policy and International Affairs (PI).

Areas for Improvement

1. Financing for Retrofits

FEMP has pre-qualified several large Energy Service Companies (ESCOs) to retrofit Federal buildings and this program seems to be working well. ESCOs have also achieved some traction in state and local public buildings, and even in private owner-occupied buildings, but have not taken root in the rest of the private sector. When DOE was planning its original building stimulus program it was enthusiastic about PACE (Property Assessed Clean Energy) loans. Its hopes for the residential sector were dashed by FHFA, Fannie Mae and Freddie Mac, all of whom objected strongly to the seniority of PACE loans over their own mortgages. Even when PACE worked briefly in California, almost all the loan applications were not for no-cost/low-cost efficiency investments with short payback times but disappointingly were for photovoltaic installations with simple payback times measured in decades.

We support a related proposal to provide access to capital for retrofitting residential and non-residential buildings with "on-bill financing," which means "on-utility bill with levelized monthly repayment added to the customer's utility bill." The National Action Plan for Energy Efficiency (now the State and Local Energy Efficiency Action Network, or SEE Action) proposed pilots for "on-bill" financing.[11]

Pilots are underway under California's $1 billion/year Energy Efficiency program administered by the California Investor-owned utilities, and on its own initiative by Sacramento Municipal Utility District, and in several other states. Vermont has

[11] For more information, see http://www1.eere.energy.gov/seeaction

demonstrated that on-bill financing works well for municipalities (for example for street lighting retrofits), school districts, etc. but again it has not taken root in residential properties, and homeowners and small businesses still have no really convenient access to capital for private residential retrofit (see Section 5 for more information on DOE finance policy-making).

Recommendations

1. EIA produces databases and survey results for commercial (CBECS) and residential (RECS) buildings that are critical to the development and tracking of energy efficiency solutions and results. The Secretary and the EIA Administrator should prioritize funding for this effort to allow a properly executed, statistically sound and programmatically relevant survey, using the most efficient statistical and survey techniques, every four years (**this is primary recommendation B2**).

2. DOE Buildings Performance Database shows promise of becoming a highly valuable and innovative tool. The Secretary should promote and fund this innovative effort. The team merits praise.

3. The CBEA has written stretch goals for voluntary specifications that have shown notable success. The Secretary should recognize the team's innovative work and consider expanding the program to other DOE offices (Electricity and Industry).

4. The Energy Policy Act of 1992 (EPACT 1992) assigned ASHRAE the responsibility for setting standards for heating air and water, and for air conditioning, but appears to give the Secretary of Energy the power to modify obsolete test procedures (and probably standards) by showing "clear and convincing evidence" of need. We believe that the RTU Challenge discussion above is adequate evidence, and we strongly recommend that the Secretary initiate senior level discussions between staff of DOE and ASHRAE to accelerate air conditioning standards to capture all cost-effective savings. DOE could suggest an agreement with ASHRAE that DOE routinely propose innovative, tighter energy efficiency measures to be tested on a modest scale for inclusion in mandatory Standard 90.1. If not accepted, the committee responsible for voluntary Standard 189.1, which has a wider mandate to innovate, would automatically consider the measure (**this is primary recommendation D2**).

5. The Secretary should work to remove current restrictions to PACE financing. OBEE should cooperate closely with FHA, FHFA, Fannie Mae, Freddie Mac, and the Treasury Department to make financing available for residential and small business energy efficiency through programs like PACE and On-Bill Financing (**this is primary recommendation C2**).

Section 3: *Explore, comment and make recommendations regarding the coordination and cooperation between the EERE buildings program and the other capabilities and resources within DOE.*

Innovation in energy efficiency technology is happening more quickly than expected—and could accelerate economic growth and improve sustainability. Most of the energy efficiency technologies that could prove disruptive are familiar—LED lighting, advanced heating, air-conditioning and building controls, local storage and power electronics, smart meters and load management systems. The accelerating pace of energy innovation means technology prices are falling rapidly, saving customers more than expected and delivering much faster than many observers expect.

Areas of Strength

DOE has been very successful in accelerating energy efficiency technology innovation. The Recovery Act provided funding to expand DOE's energy efficiency programs significantly. ARPA-E has successfully funded some of the most innovative research in the energy efficiency market (e.g. compressor-less air conditioners and advanced power electronics). The Office of Energy Efficiency and Renewable energy has funded some of the most advanced energy efficient lighting programs in the world. The Office of Science has been leading cutting edge research on energy efficient building system integration opportunities. Many of the national labs have made major contributions to energy efficiency research and modeling.

Developing technologies may remain uneconomical on average, even as leading innovators approach breakthroughs. But once a technology delivers materially superior cost and performance versus the status quo, it may well be adopted *en masse*. For example, as LED lighting costs come down over the next 18-24 months, LEDs should begin to replace compact fluorescent lighting as the most economic alternative for many consumers, leaving the old incandescent bulbs as an inefficient fashion statement.

Interagency cooperation has made material progress. DOE and EPA are working very well together on the Energy Star labeling and standard setting programs. DOE and the Justice Department have been very active in enforcing Energy Star requirements for the first time in a decade, ensuring those companies that make the best products are able to protect their brand in the market place. DOE and HUD have worked closely together to increase energy efficiency in public and multi-family housing.

Within DOE, there is evidence of greater collaboration across the Department. The buildings program within EERE is coordinating with the Office of Science, the Office of Electricity, and ARPA-E to ensure alignment of research efforts and good hand-offs as new technologies move through the project stage gates for development.

Areas for Improvement

However, the energy efficiency markets remain inefficient. Consumers need better information about the operating costs of the products they buy. Companies need to better understand the major performance thresholds each technology must meet to reach mass market attractiveness and need to have some confidence that the market will be there when they breakthrough. Most of the energy efficiency economic analyses published to date reflect engineering estimates for energy efficiency impact—measuring "how good it should be"—rather than econometric measures of actual market impact—measuring "how good it actually was." As a result of the lack of transparency and the limits to good data, the financing market for energy efficiency remains very thin.

Even with the expanding intradepartmental outreach, there remain gaps in the flow of ideas. DOE has struggled at times to frame policy debates on major energy efficiency issues in a comprehensive fashion given fragmented accountabilities. Likewise, the reports from one part of the Department (EIA, for example) do not always reflect the best thinking from elsewhere in the Department (EERE)—the programs have different roles, so they need not be perfectly aligned, but there does need to be a dialogue. And, the Inspector General has been critical of the Department's own energy efficiency practices.

Conclusion

In this context, the Department has an important role to play to help develop the energy efficiency market. Success for DOE will require much tighter coordination of the energy efficiency programs than ever before, linking tightly across DOE and the Federal government.

Recommendations

1. OBEE and EPSA should lead an interagency collaboration to ensure that energy efficiency criteria are integrated into residential building loan underwriting standards. They should also develop policies to require energy efficiency disclosure in new and existing home sales (**this is primary recommendation D3, EPSA is discussed in more detail in Section 5**).

2. OBEE should build clear technology roadmaps for each major technology, linking the advances in Science, ARPA-E, and EERE, analyzing adoption rates for new technology, and mapping the impact of these new technologies on building energy efficiency nationally. OBEE staff should integrate advanced energy efficiency technology cases into the EIA Annual Energy Outlook, including specifically a high technology energy efficiency case and expanding EIA's annual energy efficiency survey requirements. DOE needs to keep the market and policy makers focused on where technology is going rather than looking backward to where technology has been.

3. FEMP and GSA should develop advanced technology energy efficiency standards across the Federal government. This would ensure the Federal government is able to purchase the most advanced technology in the market for trial and scale up those

technologies that are most economical. DOE should play a major role in hosting these advanced technologies and DOE's energy efficiency metrics should be monitored closely to measure the rapid improvement enabled by these technological advances.

4. The Secretary should seek congressional authority to expand the 1705 loan program authority to include energy efficiency technology. DOE should work with HUD and the Federal Financing Agencies to integrate energy efficiency criteria into home and building loan underwriting standards and developing policies to require energy efficiency disclosure in new and existing home sales.

Section 4: *Explore, comment and make recommendations regarding the coordination between the buildings program and other government agencies (notably DOD, GSA, HUD and EPA) in areas such as technology development, demonstration and deployment, regulation, standards, and best practices.*

Analysis of Current Programs

DOE is the lead Federal agency for research, development and demonstration of energy efficient technologies for buildings. But there are many Federal agencies that work with DOE and have responsibilities to accelerate the innovation and adoption of energy efficient technologies and systems for buildings (see Table 4.1). Appendix 8 is an email from Deputy Assistant Secretary Kathleen Hogan and BTP Program Manager Roland Risser that gives a good summary of the current BTP collaborative efforts with other agencies. Over the past three years, there has been a positive, proactive increase in the collaborations, particularly with HUD. There has been a long-term relationship with EPA, which led to the successful Energy Star program.

The Federal government is a major consumer of products that use and supply energy. In 2008 the Federal government used 1.1% of the 99.3 Quads of energy used in the U.S. The government owns or operates 3.5 billion square feet of building space. Most Federal government buildings are under the jurisdiction of GSA or DOD, with 50% of GSA space being owned and the rest leased. The President issued Executive Order 13514 on October 5, 2009 to encourage the Federal government to use its purchasing power to accelerate the introduction of more energy efficient technologies in its facilities.

There have been recent studies recommending the government use its purchasing power.[12] BTP, as seen in Section 3, has started to work more closely with FEMP, who works with DOD and GSA on a regular basis. As stated in Appendix 8, President Obama committed Federal agencies to undertake $2 billion in energy efficiency building improvements using performance based contracts, through which ESCOs and utilities pay for the upfront costs. FEMP will be assisting in the role. BTP and FEMP need to work closely together on this initiative.

DOE and DOD signed a Memorandum of Understanding (MOU) in July 2010 to underscore their cooperation in enhancing the energy security of the U.S. The MOU includes activities such as evaluating energy systems and technology management solutions that meet DOD objectives, and maximizing DOD access to DOE technical expertise and assistance through cooperation in deployment and testing of emerging energy technologies. This has been actively implemented through the Office of Electricity Reliability. There are two active, co-funded projects: 1) SPIDERS: Smart Power Infrastructure Demonstration for Energy, Reliability, and Security – this is a microgrid project in which DOD is investing $38 million and DOE, $9 million; and 2) the installation of fuel cells as back-up power units at 8 military installations, in which DOD and DOE are each investing about $4 million. DOE and DOD identified areas of potential

[12] President's Council of Advisors on Science and Technology, Nov. 2010; NRC, Report on High Performing Federal Facilities, Sept. 2011.

collaboration. A concept paper has been drafted between BTP and DOD's Office of the Secretary of Defense, Environmental Security Trust and Certification Program (ESTCP) for a collaborative Building Demonstration Partnership. The partnership, planned to start in 2014, will leverage existing expertise of the ESTCP demonstration program using similar approaches, guidelines and templates. BTP will be initially identifying high priority areas of potential interest to DOD for demonstration of new products in the marketplace that are highly energy efficient and cost effective.

Table 4.1 from the Quadrennial Technology Review shows the various agencies and gives examples of the types of activities that are being undertaken. The Subcommittee endorses the activities with other agencies and encourages their expansion.

Department/ Agency	R&D	Regulation	Finance	Information
Agriculture			Rural Energy for America Program (REAP)	
Commerce	NIST Intelligent Manufacturing Standards Program			Renewable Energy & Energy Efficiency Export Initiative
Defense	Defense Research & Engineering		Procurement	
Environmental Protection Agency				ENERGY STAR ®
Housing and Urban Development	Sustainable Communities Program	Building Code Standards	PowerSavers Program	Sustainable Communities Database
Labor				Green Career Program
Treasury			Energy Efficiency Tax Credits	
General Services Administration			Procurement	
Federal Housing Financing Authority			Federal Underwriting Standards	
Small Business Administration			Green 504 Program	

Table 4.1. *Summary of Non-DOE Federal Agency Activities in Stationary End-Use with Examples.*[13]

Recommendations

l. The Secretary should lead the effort with GSA and DOD to ensure that Federal agencies are authorized to enter into ESPCs for long-termed leased facilities, in addition to those owned by the government. The 2010 President's Council of Advisors on Science

[13] Department of Energy. Report on the First Quadrennial Technology Review. Sept. 2011. <http://energy.gov/downloads/report-first-quadrennial-technology-review>.

and Technology (PCAST) report made a similar recommendation but there has been a lack of action by DOE over the past two years (**this is primary recommendation D1**).

2. OBEE should work closely with DOD, GSA, and the Office of Management and Budget (OMB) to ensure life-cycle and social costs are considered when evaluating energy efficiency purchases, and incorporate this methodology into agency procurements. One option for DOD cooperation is a pilot program at one base of each service branch where DOD incentivizes base commanders to achieve life-cycle costs savings in order to evaluate the effect on procurement decisions (**this is primary recommendation D4**).

3. BTP is currently working with ARPA-E and NIST to review their R&D programs, goals, roadmaps, outcomes and gaps. BTP will also review their R&D programs with DOD, including the Defense Advanced Research Projects Agency (DARPA). This will provide alignment among agencies, preventing unnecessary duplication. This effort should be followed up with a public meeting involving all of the public and private sector stakeholders for further input.

4. Joint BTP-DOD RD&D projects should be undertaken through the existing MOU or other mechanisms.

5. OBEE should establish a methodology to measure the outcomes of the interagency programs and to determine best practices.

6. Coordination and collaboration both within DOE and with other Federal agencies is very important. Program managers and the appropriate people in their programs should have performance objectives to coordinate with other government agencies as part of their annual performance goals and evaluation.

Section 5: *Assess the process and effectiveness of the building energy efficiency policy-making processes: 1) technical capabilities in the market 2) align the national resources against energy priorities in a cost effective manner 3) developing appropriate technologies 4) addressing system integration challenges 5) providing necessary information to the market 6) setting appropriate standards 7) creating appropriate incentives 8) using the government buying power effectively, and 9) ensuring finance-ability.*

We found that the DOE has a strong group of people working on building efficiency policy. However, we also found that the policy team and the program offices (e.g. BTP, FEMP, and EIA) may not coordinate as effectively as possible. We also believe that DOE can more effectively coordinate its efforts with the private sector to help the nation rapidly adopt new building efficiency technologies.

Areas of Strength

DOE's appliance standard setting is particularly effective and creates significant energy savings (see Section 2). The energy efficiency of refrigerators has almost doubled since adoption of a national standard in 1990.[14] BTP's "Alliance" programs with the private sector have helped double the efficiency of commercial rooftop unit air conditioners.

The Subcommittee found the BTP and FEMP staffs to be impressive and forward-looking in undertaking new initiatives. They are responsive, knowledgeable, and have the type of private sector and state-level public sector experience necessary to create an ambitious building efficiency agenda. The Buildings Performance Database (see Section 2) is a common sense approach that uses inexpensive sources of publicly available information and encourages the private sector to develop new technological solutions to building energy efficiency. However, we heard consistent feedback that the current DOE structure segregates policy-making and program office staffs, thereby making collaboration more difficult.

The National Laboratories, Energy Innovation Hubs, applied energy offices at DOE, and ARPA-E all conduct research that holds great promise. Due to the unique nature of publicly funded research, their work is aligned with long-term national interests rather than academic pursuits or short-term commercial opportunities. This may create opportunities for commercialization (see Areas for Improvement below). FEMP is developing a Technology Portal that will provide necessary data to Federal agencies to determine site-specific performance and cost savings of various technologies.

DOE is also taking a leadership role in implementing President Obama's Executive Order 13514, which sets clear energy efficiency targets for Federal government buildings. DOE is working closely with GSA, DOD, EPA, Council on Environmental Quality (CEQ), and other departments and agencies, and co-chairs the greenhouse gas accounting portion of the executive order. As each department works to meet the goals set forth in the executive

[14] Cymbalski, John. Data on Annual Energy Use, Volume, and Real Price of New Refrigerators. Raw data. Department of Energy, Washington, DC.

order, the FY10 Scorecard on Sustainability/Energy gives DOE a "green" score for all major buildings-related categories except for a "red" score awarded for the percentage of sustainable green buildings in the DOE building stock.[15] DOE is also leading the effort to make policy recommendations pertaining to energy standards.

Finally, DOE has conducted modest outreach to the private sector. These efforts are largely limited to conducting training sessions, attending conferences, sending newsletters, online outreach, and limited social media activity pertaining to building energy efficiency. The Subcommittee believes these efforts should be expanded as outlined below.

Areas for Improvement

DOE's policy-making approach lacks a clear structure and defined team. The latest Quadrennial Technology Review (QTR) found that DOE is not effectively aligning resources with current national policy priorities.[16] To remedy this, the QTR calls for "the development of strong internal capability in integrated technical, economic, and policy analysis. The Department needs an enduring group to provide an integrated understanding of technology, markets, business, and policy for the planning and operation of technology programs." PCAST and the Technology Transition SEAB Subcommittee also recommend establishing this new Energy Policy and Systems Analysis (EPSA) office. While the Secretary signed off on the recommendations in the QTR, there is not yet a plan within DOE for establishing such a capability. We believe the Secretary needs to actively pursue these efforts. Forming this new policy office also creates an opportunity to more closely align the building energy efficiency policy staff with the new OBEE suggested in Section 1.

The policy-making process also focuses on individual component technologies (e.g. maximizing efficiency of HVAC systems) and does not take a comprehensive approach to building energy efficiency. We believe there should be a greater emphasis on whole building systems and smart grid integration. The Buildings Hub is set up to take this approach and with more time may make a major impact.

There is a gap in the policy staff's ability to address the issues related to financing building energy efficiency projects. The Secretary has appointed a Senior Advisor for Renewable Energy and Energy Efficiency Finance. We hope this person will increasingly focus on building energy efficiency. There is little knowledge of building energy efficiency finance issues within PI. However, PI put out a request for information to market participants, the financial sector, and other stakeholders on what can be done to improve the efficiency of ESPCs. PI is now in the process of evaluating the input they received to improve the use of Federal ESPC authority. This is a prudent effort to engage the financial sector on these issues, and we hope DOE can expand it beyond government contracts to private sector applications as well.

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[15] Office of Management and Budget. FY2010 OMB Scorecard on Sustainability/Energy.

[16] Department of Energy. Report on the First Quadrennial Technology Review. Sept. 2011.

DOE should more actively provide technical guidance in the procurement process and push to include building energy efficiency as part of the bidding process for larger, non-ESPC contracts. FEMP and GSA's Office of Federal High-Performance Green Buildings work well together, and are currently exploring ways to better incorporate DOE's technical research into the government's procurement process. The current research is not easily usable by GSA, DOD, and other departments who need to use it. Closer coordination between DOE and DOD at the outset of testing may overcome a level of distrust within DOD of technologies they have not tested themselves. The Federal government can better help deploy building energy efficiency products and technologies if DOE takes a more active role working with GSA in setting procurement policy based on its technical research.

We also believe DOE can more effectively create building energy efficiency policy with better private sector outreach. At the first meeting of this Subcommittee, the Secretary asked that we look specifically at how DOE can facilitate broader consumer adoption of building efficiency products and technologies. The first step in this process is to work with the private sector to determine those policies that will increase consumer adoption. Our briefings confirmed that large segments of the private sector are unaware of DOE's efforts in building energy efficiency.

Numerous representatives of the venture capital, startup, and corporate communities reported to the subcommittee that DOE bureaucracy can be confusing and difficult to navigate. People reported this was especially true for grant applications that were expensive – in some cases prohibitively so for early-stage companies. One large Silicon Valley company, with a significant government affairs team, expressed frustration with the time and money spent for their ultimately successful grant application. To speed broader adoption of building efficiency products and technologies, DOE needs a clearer plan to communicate relevant policies and national priorities to private industry.

Because DOE is located in Washington, people in many parts of the country do not have easy access to the Department's resources. Additionally, because DOE is a large and complex organization, it can be hard to understand and access all of the opportunities and resources DOE provides. The traditional solution would be to locate satellite offices in different regions throughout the country, but shrinking budgets make that impractical. To more actively promote building energy efficiency on a limited budget, OBEE should commit to aggressively using Facebook, Twitter, and other social networking sites.

DOE's Digital Media team has done a good job expanding DOE's social media presence over the past two years. We commend them for frequently tweeting on a variety of issues and creating a base of over 58,000 followers when this report was written. DOE's Facebook page has over 13,000 fans, second only to the State Department among Federal departments, and staff frequently updates the page. DOE is also active on SlideShare, Tumblr, Google+, and Reddit. However, information related to building energy efficiency is limited and spread across disparate platforms, making it difficult for

consumers to get comprehensive information on DOE's building energy efficiency programs via social networks.

The Digital Media office has been successful creating engagement campaigns – most notably around the Green Button Data Initiative, which received significant media coverage and resulted in 78 people submitting digital consumer applications for electricity use data. Plans are also underway to upgrade DOE's information sharing in common formats (e.g. API format for EIA data). The Digital Media office is also creating strategic partnerships with the private sector to communicate information about tax credits and rebates.

We recommend that OBEE aggressively use social media websites to disseminate information about programs, RFPs, new standards, conferences and best practices from around the country. Social media is also an efficient way to quickly gain feedback from consumers and the private sector on OBEE initiatives.

Conclusion

DOE is well positioned to lead the Federal government's building energy efficiency policy, but it must better coordinate between the policy and program offices. However, there is a perception that DOE has moved slowly on building energy efficiency policy. Several factors cause this, including bureaucracy, inadequate policy staff with a financial background, and limited private sector outreach.

DOE's building energy efficiency policy-making process will be more effective if the Department creates the new policy office called for in the QTR as well as by PCAST and the Technology Transition Subcommittee, and improves its outreach to the private sector.

Recommendations

1. OBEE should increase its regional outreach to ensure full access to its building energy efficiency activities and should more actively promote its activities through the DOE's existing small business office efforts (**this is primary recommendation A2**).

2. The Secretary should establish a dedicated DOE policy office, the Energy Policy and Systems Analysis (EPSA) Office, that produces and integrates economic analysis of building systems based on modeling, simulation and engineering data (**this is primary recommendation C1**).

3. Hire an additional one or two policy staff to work on financing building energy efficiency projects.

4. Implement recommendations of Technology Transition Task Force to more effectively transfer energy efficiency technology to the private sector.

5. Work more closely with utilities to provide greater incentives for building energy efficiency.

6. Streamline the remaining loan and grant programs so the length of the process better corresponds to the size of the loan or grant, and to increase efficiency so small firms do not have to hire third-party consultants to navigate the process.

7. Build out OBEE's online and social networking capability:
    a. More proactively send out notices about events, RFP processes, and standard setting on Facebook, Twitter, and other social media and industry websites, which are free and effective.
    b. Create online tutorials on the DOE website (e.g. Khan Academy) that explain how DOE can assist businesses and individuals to adopt building efficiency technologies.[17]

[17] For more information, see http://www.khanacademy.org

Section 6: *Explore, comment and make recommendations regarding the best practice sharing and cooperation opportunities between the DOE's buildings program and of city, states and other foreign governments from around the world.*

Analysis of Current Programs

Ten years ago there was a modest amount of innovation in the building energy efficiency space. Today, it is one of the most rapidly evolving parts of the economy. Federal, state, and local governments are developing new policies to stimulate more energy efficiency. DOE needs to take the lead in systematically identifying and evaluating best practices from all over the world and to share this information with state and local governments and the private sector.

Current DOE efforts in this area are diverse and not fully coordinated. There is no individual or office within EERE coordinating best practices. Each program tracks best practices relevant to its area of expertise. We recommend a two-person team to better coordinate all best practices.

The State and Local Energy Efficiency Action Network (SEE Action) is evaluating best practice policies at the national and sub-national level, and PI has hired a coordinator to look at international best practices.

DOE performed a comprehensive evaluation of best practices during the Bush Administration. With the rapid pace of technological advances in the building energy efficiency space, this data is now out of date. SEE Action is currently examining best practices via two working groups for commercial and residential building energy efficiency and is preparing materials for state and local governments on building benchmarking, building energy disclosure policies, initial and continuous commissioning, and green leasing.

EERE does not include building efficiency benchmark policies in the eligibility or selection criteria for state and local grants, although it has the authority to do this without congressional action. Congress intended for DOE to take this approach with Stimulus Act State Energy Program Funds ($3 billion) by requiring that the Secretary receive letters from governors promising their state would adopt the most recent building codes, and regulations aligning utility incentives for energy efficiency with customer interest. Unfortunately, the legislation was written in a way that made this impossible.

We strongly endorse the recommendations made by PCAST, the QTR, and the American Academy of Arts and Sciences that DOE should conduct comprehensive behavioral studies to better understand the decision-making of individuals and organizations. Doing so will provide valuable insight into the most efficient means of gaining rapid adoption of new technologies in the marketplace, particularly in the buildings sector. As PCAST states in its November 2010 report: "DOE, along with NSF, should initiate a multidisciplinary social science research program to examine the U.S. energy technology innovation ecosystem, including its actors, functions, processes, and outcomes. This

research should be fully integrated into DOE's energy research and applied programs." Such a program could be conducted with a modest budget of $10 million and should yield results that are far greater than the cost.

There are a number of programs within BTP addressing best practices sharing. Examples include the Better Buildings Neighborhood Program for residential retrofits, building code training and enforcement, and the Better Buildings Challenge, which demonstrates effective business model and approaches for investing in energy efficiency.

The Buildings Performance Database addressed in Section 2 of this report is an impressive undertaking that may facilitate building efficiency programs at the state and local level by making the data publicly available and easily searchable. Engaging private sector partners to use the data is a cost-effective approach and should lead to innovative ways for consumers to access and understand the information.

DOE should play an active role in sharing best practices internally and with state and local governments.

Recommendations

1. Add benchmark policies for building energy efficiency to the eligibility and selection criteria for state and local grants. The Department of Education has had success using a similar approach in awarding Race to the Top funds.

2. Conduct comprehensive behavioral studies to better understand the decision-making of individuals and organizations, especially in the buildings sector.

3. Form a national committee comprised of leaders from DOE, the private sector, city and state governments, and international leaders (including the International Energy Agency) to create a comprehensive overview of best practices from around the world.

4. Because of the large number of best practices, and their rapidly changing nature, we recommend designating a person at DOE to update domestic initiatives in the database and collaborate with the International Energy Agency on their international best practices collection efforts – and to share the information with state and local governments as well as throughout the Federal government.

5. Broadly publicize the database – this could include a new website, press outreach, and public events.

Examples of Best Practices

1. New York City Local Law 84 – Requires benchmarking and reporting of energy and water use for all buildings over 50,000 sq. ft. Went into effect August 1, 2011. New York City also recently changed the administrative and building codes (Local Law

21) to require the installation of white roofs during most flat roof surface replacements.

2. EPA Portfolio Manager software tool – "Interactive energy management tool that allows you to track and assess energy and water consumption across your entire portfolio of buildings in a secure online environment."[18]

3. European Union comprehensive building efficiency website (Build Up) – 2,000 publications, upcoming events, and successful case studies.[19]

4. California Governor Jerry Brown issued Executive Order B-18-12, which calls for 50 percent of all new state buildings to be zero net energy facilities by 2020, and all new buildings to be zero net energy by 2025. Any new state building or major renovation of an existing building over 10,000 square feet must generate its own power on-site from clean energy sources and obtain LEED Silver certification. All state agencies must cut their greenhouse gas emissions by 20 percent by 2020, compared to 2010.

Conclusion

Today there is an explosion of building energy efficiency activity at both the sub-national and national levels. The Subcommittee found over 6,000 regulations and initiatives at the municipal level alone.

DOE does not need to track all of these efforts, but it should track the most important ones and make them available through a publically accessible database. DOE is uniquely positioned to perform this role. DOE can also be a catalyst by providing financial support to state and local governments that proactively adopt forward-looking building codes and work with utilities to incentivize more energy efficient consumer behavior. Best practices sharing and policy incentives are concrete actions DOE can quickly take to make a big impact on building energy efficiency.

[18] For more information, see http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

[19] For more information, see http://buildup.eu

Report Conclusion

Improving building energy efficiency is one of the greatest steps DOE can take to reduce our nation's energy consumption. We see significant skills, activities, and progress across the broad scope of the Department's efforts and in its cooperation internally and with other elements of the US government. However, our investigation shows areas for improvement in certain program specifics, in how the overall building energy efficiency program is coordinated and communicated, and in outreach beyond the Department.

DOE is the only department that can take the lead on increasing building energy efficiency in the United States, and doing so must be a top priority. The Department has a clear understanding of how important this responsibility is and we are confident it will be successful. The findings in this report present recommendations for increased program emphasis and for better coordination within DOE, as well as with other government agencies and the private sector.

The Appendix that follows provides supporting information for the findings in this report. Appendices 9 and 10 are of particularly pertinent to our top recommendation of the establishment of the new OBEE. Appendix 9 explores the impact technological innovation is having on building energy efficiency and the tremendous savings that can be realized by increasing adoption of these technologies. Appendix 10 outlines the proposed roles and responsibilities of OBEE and tools available to the new office.

Appendix 1: *Terms of Reference for the Secretary of Energy Advisory Board Subcommittee on Building Energy Efficiency*

Purpose of the Subcommittee: Buildings use 40% of the nation's energy. DOE, in fulfilling its mission to improve building energy efficiency has a variety of activities. In the Office Energy Efficiency and Renewable Energy (EERE) building energy efficiency issues are, coordinated through the BTP. The primary focus of the BTP is to develop technologies, techniques, tools and programs that make buildings more energy efficient, productive, and affordable, recognizing that buildings are complex assemblies of components and integrated systems, interacting with complex human behavior, all of which must be understood to drive improved building performance. Activities range from basic building science development to component and systems technology maturation to demonstration projects and to deployment of various community-based programs. BTP also remains the primary touchstone for developing national buildings energy efficiency policies and ensuring that policy priorities reflect the market's technical capabilities. However, there are other offices with DOE (ARPA-E and the Office of Science) and other agencies that are involved in building energy efficiency issues.

Given the impact building energy reduction can have on U.S. energy consumption and greenhouse gas emission, it is important to review whether the buildings program is properly focused, executing and making progress against clear objectives, shaping clear and consistent policy, and is connected to cooperation opportunities and best practices of industry, federal, state, local and foreign governments.

Tasks: This SEAB subcommittee will:

(1) Review, comment and make recommendations on the overall set of current and planned DOE activities related to building energy efficiency as to the clarity of the overall objectives over time, the integration and coherence of the various programs and activities across EERE, ARPA-E, Office of Science and the various research constructs now in place (ERCs, the Hub, etc.), and the connection to the private sector.

(2) How can we accelerate the adoption of building efficiency? Comment on which activities are operating successfully and make recommendations for changes in processes and organization that the program employs in accomplishing its mission.

(3) Explore, comment and make recommendations regarding the coordination and cooperation between the EERE buildings program and the other capabilities and resources within DOE.

(4) Explore, comment and make recommendations regarding the coordination and cooperation between the DOE's buildings program and other government agencies (notably DOD, GSA, HUD and EPA) in areas such as technology development, demonstration and deployment, regulations, standards, and best practices.

(5) Assess the process and effectiveness of the building energy efficiency policy making processes. 1) technical capabilities in the market 2) align the national resources against energy priorities in a cost effective manner 3) developing appropriate technologies 4)addressing system integration challenges 5) providing necessary information to the market 6)setting appropriate standards 7) creating appropriate incentives 8) using the government buying power effectively, and 9) ensuring finance-ability.

(6) Explore, comment and make recommendations regarding the best practice sharing and cooperation opportunities between the DOE's buildings program and of city, states and other foreign governments from around the world.

Task Force membership:
Michael McQuade
Matthew Rogers
Art Rosenfeld
Maxine Savitz
Steve Westly (Chair)

Appendix 2: *Individuals providing input to the Subcommittee*

DOE Office of the Under Secretary
Colin McCormick, Senior Adviser for Research and Development

DOE Advanced Research Projects Agency-Energy (ARPA-E)
Professor Arun Majumdar, Director (former)
Ravi Prasher, Program Director
David Danielson, Program Director

DOE Office of Electricity Delivery and Energy Reliability (OE)
Patricia Hoffman, Assistant Secretary
Ben Steinberg, DOE-DOD MOU Partnership

DOE Office of Energy Efficiency and Renewable Energy (EERE)
Cathy Zoi, Assistant Secretary (former)
Dr. Henry Kelly, Principal Deputy Assistant Secretary (former)
Dr. Kathleen Hogan, Deputy Assistant Secretary for Energy Efficiency
Roland Risser, Building Technologies Program Manager
Dr. Timothy Unruh, Federal Energy Management Program Manager
George Hernandez, Building Technologies Program
Brian Holuj, Building Technologies Program
Arah Schuur, Building Technologies Program
Cody Taylor, Building Technologies Program
John Cymbalsky, Building Technologies Program
Dr. Robert Van Buskirk, Building Technologies Program

DOE Office of the Secretary
Stockton Williams, Senior Urban Policy Advisor (former)

DOE Energy Information Administration (EIA)
Howard Gruenspecht, Acting Administrator
Thomas Leckey, Office of Energy Consumption and Efficiency Statistics
Erin Boedecker, Office of Energy Consumption and Efficiency Analysis

DOE Office of Policy and International Affairs
David Sandalow, Assistant Secretary
Richard Duke, Deputy Assistant Secretary
Dr. Holmes Hummel, Senior Policy Advisor

DOE Office of Science
Dr. William Brinkman, Director

DOE Office of New Media
Cammie Croft, Director (former)

Department of Defense

Dr. Dorothy Robyn, Installations & Environment (former)
Dr. Jeff Marqusee, Installations & Environment
Joe Sikes, Installations & Environment
George Lea, Army Corps of Engineers

Department of Housing and Urban Development

Carole Galante, FHA
Shelley Poticha, Office of Sustainable Housing and Communities
Benjamin Metcalfe, Office of Multifamily Housing Programs

General Services Administration

Kevin Kampschroer, Office of Federal High-Performance Green Buildings
Ken Sandler, Office of Federal High-Performance Green Buildings

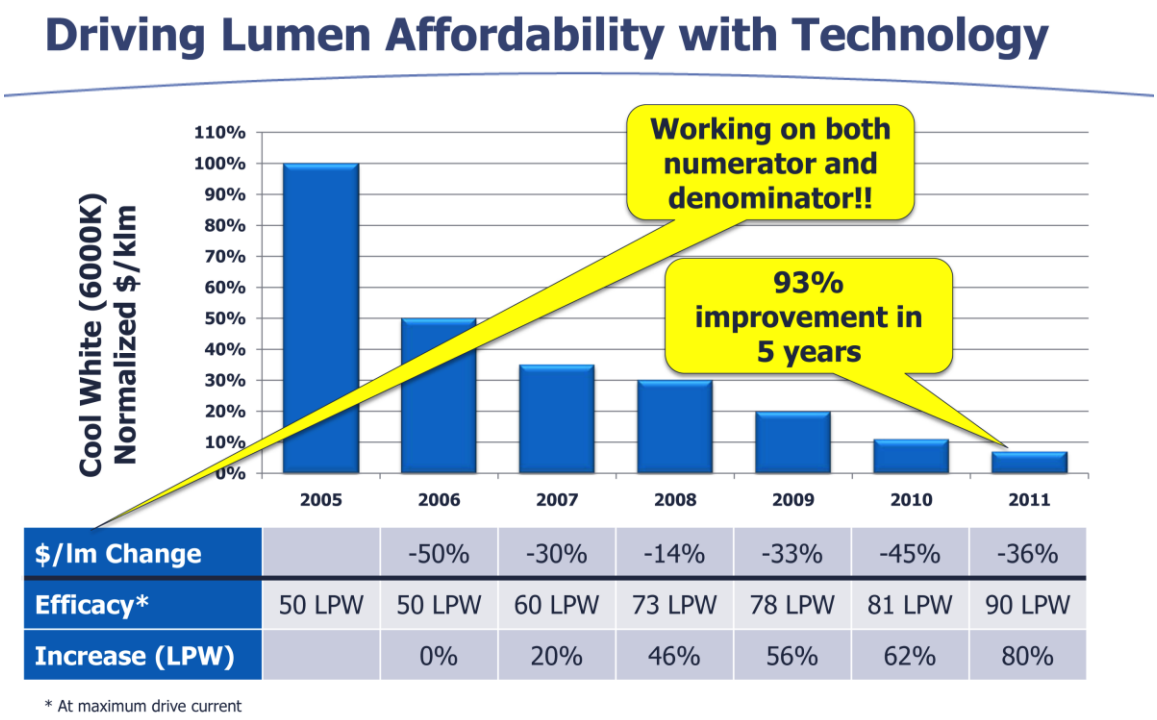
State and Local Government

Laurie Kerr, New York City Mayor's Office of Long Term Planning and Sustainability
Nancy Ryan, California Public Utilities Commission

Private Sector

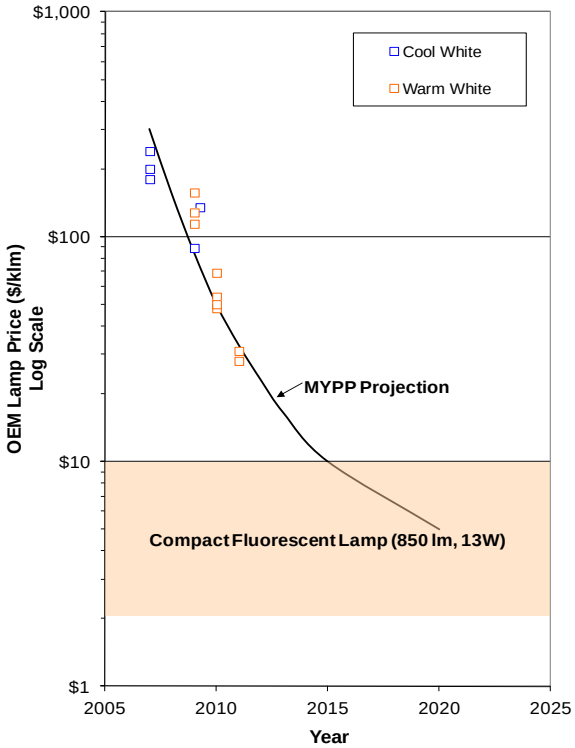
Aneesh Chopra, Former White House Chief Technology Officer
Jack Crawford, Velocity Venture Capital
Amy Davidsen, The Climate Group
Cisco DeVries, Renewable Funding
David Goldstein, Natural Resources Defense Council
Josh Green, Mohr Davidow
Jeff Lyng, OPower
Christina Page, Yahoo!
Steven Paolini, Lunera
Kent Peterson, PS2 and ASHRAE
Jon Sakoda, New Enterprise Associates
Terry Tamminen, Seventh Generation Advisers
Nell Triplett, Silicon Valley Leadership Group

Appendix 3: *Declining price of LED and CFL lights*



$/lm Change		-50%	-30%	-14%	-33%	-45%	-36%
Efficacy*	50 LPW	50 LPW	60 LPW	73 LPW	78 LPW	81 LPW	90 LPW
Increase (LPW)		0%	20%	46%	56%	62%	80%

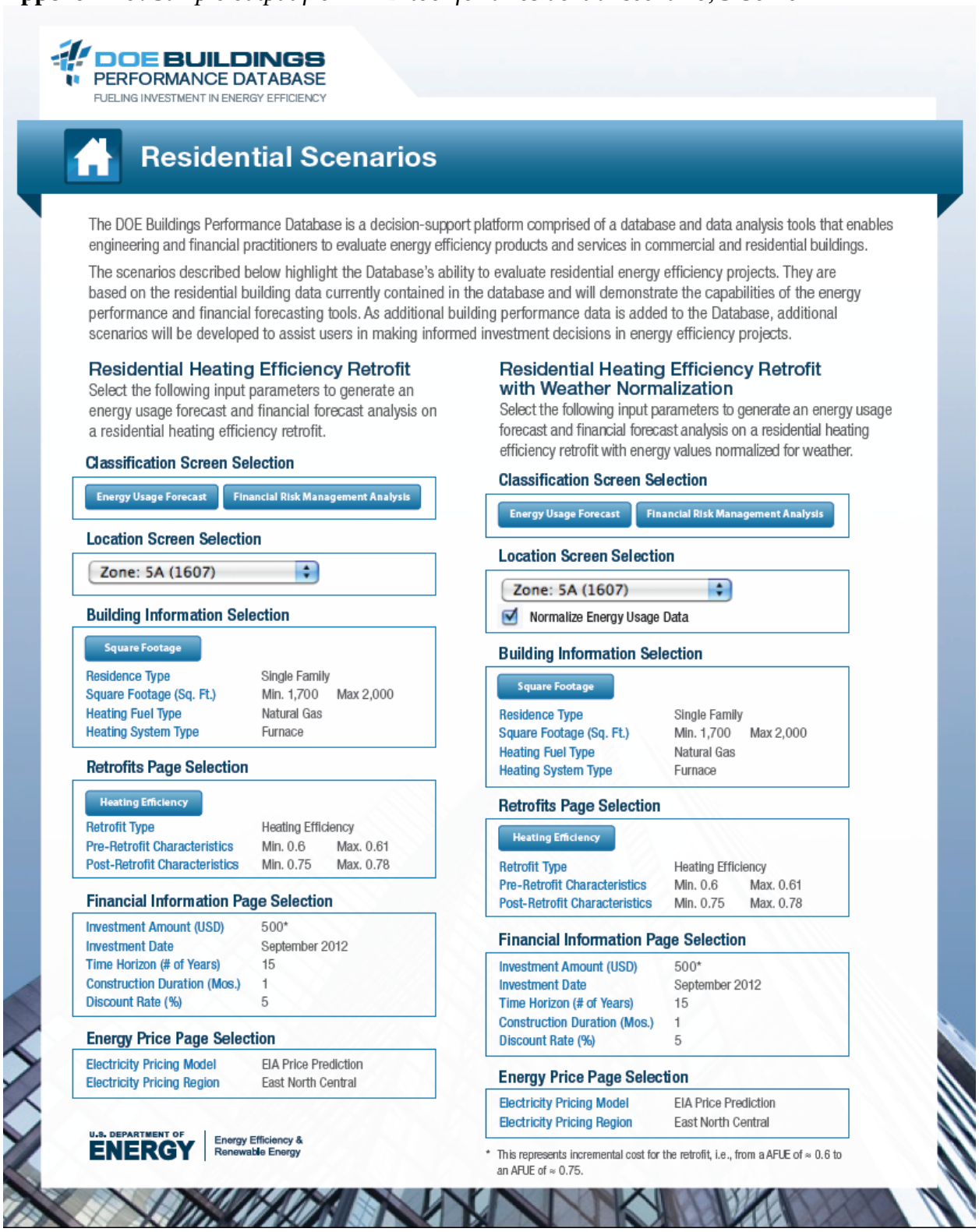
* At maximum drive current



Note: Assumes current prices for compact fluorescent price range (13W self-ballasted compact fluorescent; non-dimmable at bottom, and dimmable at top).

Sources: Cree Inc., DOE Solid-State Lighting Program

Appendix 4a: *Sample output from BPD tool for a residential scenario, 5-30-2012*



DOE BUILDINGS PERFORMANCE DATABASE
FUELING INVESTMENT IN ENERGY EFFICIENCY

Residential Scenarios

The DOE Buildings Performance Database is a decision-support platform comprised of a database and data analysis tools that enables engineering and financial practitioners to evaluate energy efficiency products and services in commercial and residential buildings.

The scenarios described below highlight the Database's ability to evaluate residential energy efficiency projects. They are based on the residential building data currently contained in the database and will demonstrate the capabilities of the energy performance and financial forecasting tools. As additional building performance data is added to the Database, additional scenarios will be developed to assist users in making informed investment decisions in energy efficiency projects.

Residential Heating Efficiency Retrofit

Select the following input parameters to generate an energy usage forecast and financial forecast analysis on a residential heating efficiency retrofit.

Classification Screen Selection

Energy Usage Forecast | Financial Risk Management Analysis

Location Screen Selection

Zone: 5A (1607)

Building Information Selection

Square Footage

Residence Type	Single Family	
Square Footage (Sq. Ft.)	Min. 1,700	Max 2,000
Heating Fuel Type	Natural Gas	
Heating System Type	Furnace	

Retrofits Page Selection

Heating Efficiency

Retrofit Type	Heating Efficiency	
Pre-Retrofit Characteristics	Min. 0.6	Max. 0.61
Post-Retrofit Characteristics	Min. 0.75	Max. 0.78

Financial Information Page Selection

Investment Amount (USD)	500*
Investment Date	September 2012
Time Horizon (# of Years)	15
Construction Duration (Mos.)	1
Discount Rate (%)	5

Energy Price Page Selection

Electricity Pricing Model	EIA Price Prediction
Electricity Pricing Region	East North Central

Residential Heating Efficiency Retrofit with Weather Normalization

Select the following input parameters to generate an energy usage forecast and financial forecast analysis on a residential heating efficiency retrofit with energy values normalized for weather.

Classification Screen Selection

Energy Usage Forecast | Financial Risk Management Analysis

Location Screen Selection

Zone: 5A (1607)

☑ Normalize Energy Usage Data

Building Information Selection

Square Footage

Residence Type	Single Family	
Square Footage (Sq. Ft.)	Min. 1,700	Max 2,000
Heating Fuel Type	Natural Gas	
Heating System Type	Furnace	

Retrofits Page Selection

Heating Efficiency

Retrofit Type	Heating Efficiency	
Pre-Retrofit Characteristics	Min. 0.6	Max. 0.61
Post-Retrofit Characteristics	Min. 0.75	Max. 0.78

Financial Information Page Selection

Investment Amount (USD)	500*
Investment Date	September 2012
Time Horizon (# of Years)	15
Construction Duration (Mos.)	1
Discount Rate (%)	5

Energy Price Page Selection

Electricity Pricing Model	EIA Price Prediction
Electricity Pricing Region	East North Central

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* This represents incremental cost for the retrofit, i.e., from a AFUE of ≈ 0.6 to an AFUE of ≈ 0.75.

Appendix 4a continued (see next page for enlargement)

DOE BUILDINGS PERFORMANCE DATABASE
FUELING INVESTMENT IN ENERGY EFFICIENCY

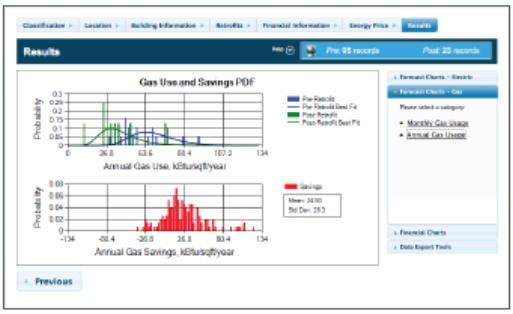
Results

After selecting the designated inputs, the Results tab displays a series of helpful charts based on your search parameters and building specifications. Here we examine Annual Gas Usage and Rate of Return Distribution results.

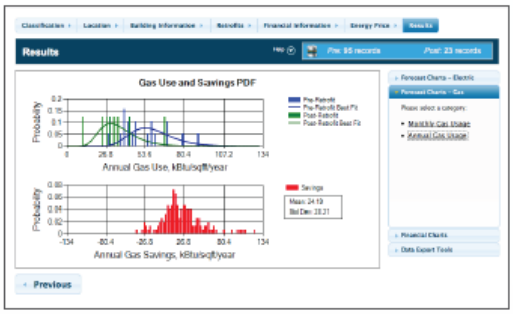
Energy Savings—Annual Gas Usage

The charts below represent the annual gas savings for each version of the heating retrofit. The top chart shows the probability distribution of the energy consumption for the pre-retrofit consumption (blue line) and post-retrofit consumption (green line). The bottom chart shows the net savings—a convolution of the pre- and post-consumption graphs. If there were more data points in the Database that comprise this retrofit scenario the graphs would be smoother.

Energy Savings—Annual Gas Usage



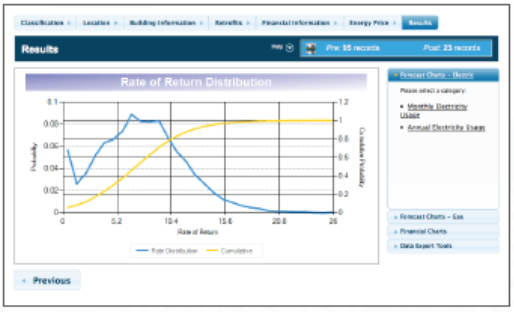
Energy Savings—Annual Gas Usage (Weather Normalization)



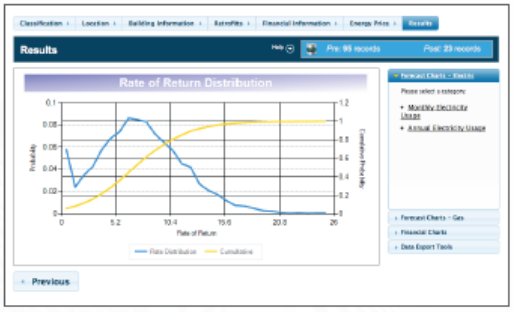
Rate of Return Distribution

The Rate of Return chart shows the distribution of the return form this retrofit based on the investment parameters and energy savings distribution. The blue line shows the probability that each rate of return will be achieved, while the yellow line is a cumulative return graph.

Rate of Return Distribution



Rate of Return Distribution (Weather Normalization)



For more information visit: www.buildingsperformance.net.

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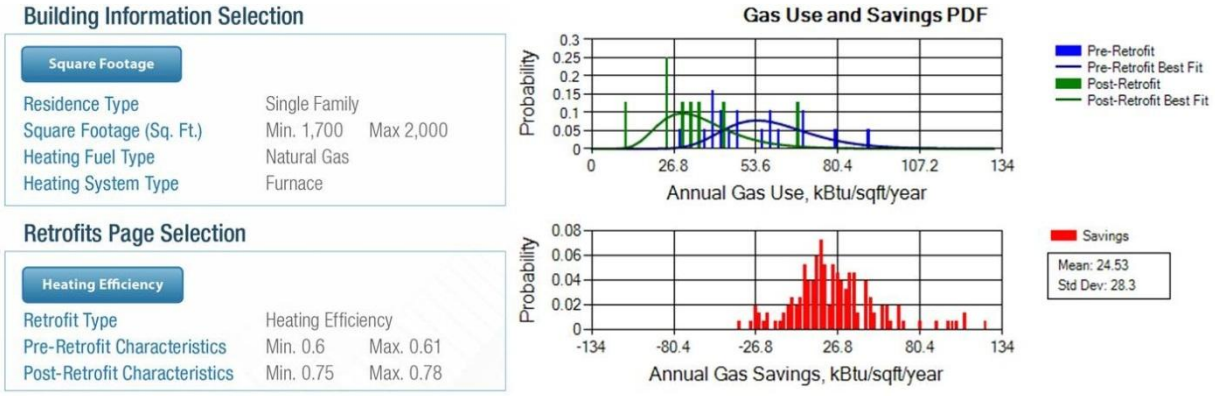
Appendix 4b: *Enlargement of charts generated for residential scenario*



Scenario 1: Residential Heating Retrofit, Dayton, OH area.
Pre-retrofit: 95 buildings, Post-retrofit: 23 buildings

Appendix 5a: *Sample output from BPD tool for a commercial scenario (see next page for enlargement)*

DOE BUILDINGS PERFORMANCE DATABASE
FUELING INVESTMENT IN ENERGY EFFICIENCY

Commercial Scenario

The DOE Buildings Performance Database is a decision-support platform comprised of a database and data analysis tools that enables engineering and financial practitioners to evaluate energy efficiency products and services in commercial and residential buildings.

The scenario described below highlight the Database's ability to evaluate a commercial energy efficiency project. It is based on the commercial building data currently contained in the database and will demonstrate the capabilities of the energy performance tool. As additional building performance data is added to the Database, additional scenarios will be developed to assist users in making informed investment decisions in energy efficiency projects.

Commercial Cooling Efficiency Retrofit

Select the following input parameters to generate an energy usage forecast analysis on a commercial air handler retrofit.

Classification Screen Selection

Energy Usage Forecast | Financial Risk Management Analysis

Location Screen Selection

Select an Item

- Zone: 1A (272)
- Zone: 2A (450)
- Zone: 3B (437)
- Zone: 4A (1474)
- Zone: 5B (198)

Building Information Selection

Square Footage

Facility Type	Multi-select All *Office* Types
Square Footage (Sq. Ft.)	Min. 90,000 Max 300,000
Cooling Fuel Type	Electricity
Cooling System Type	Chiller

Retrofits Page Selection

Air Handling

Retrofit Type	Air Handling
Pre-Retrofit Characteristics	CAV
Post-Retrofit Characteristics	VAV

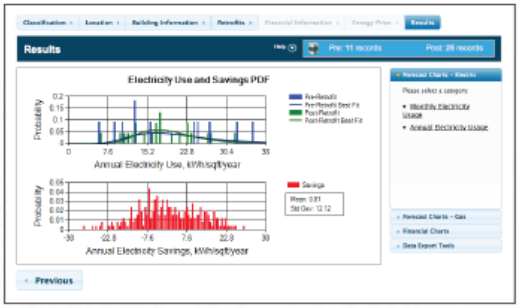
Results

After selecting the designated inputs, the Results tab displays a series of helpful charts based on your search parameters and building specifications. Here we examine the Annual Electricity Usage results.

Energy Savings—Annual Electricity Usage

The charts below represent the annual electricity savings for the air handling retrofit. The top chart shows the probability distribution of the energy consumption for the pre-retrofit consumption (blue line) and post-retrofit consumption (green line). The bottom chart shows the net savings—a convolution of the pre- and post-consumption graphs. If there were more data points in the Database that comprise this retrofit scenario the graphs would be smoother.

Energy Savings—Annual Electricity Usage



For more information visit: www.buildingsperformance.net.

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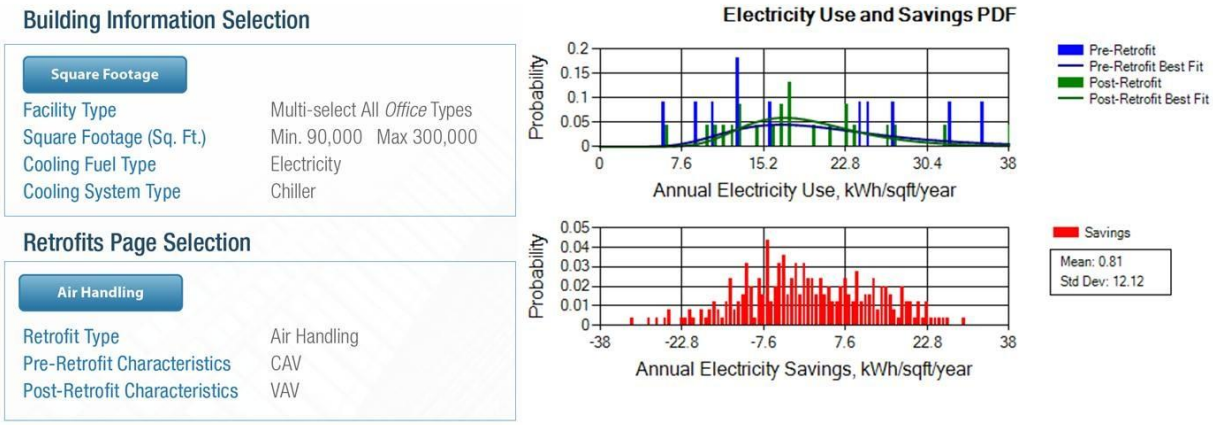
Appendix 5b: *Enlargement of charts generated for commercial scenario*



Scenario 2: Commercial Office building Air Distribution Retrofit
Pre-retrofit: 11 buildings, Post-retrofit: 25 buildings
Note: This example is meant to be illustrative of the method, and should not be taken as a representative result because the sample is very small.

Appendix 6: *Memo from Roland Risser on the RTU Challenge*

MEMORANDUM FOR THE SECRETARY OF ENERGY ADVISORY BOARD
SUBCOMMITTEE ON BUILDING ENERGY EFFICIENCY

TO STEVE WESTLY
CHAIR
SECRETARY OF ENERGY ADVISORY BOARD
SUBCOMMITTEE ON BUILDING ENERGY EFFICIENCY

FROM ROLAND J. RISSER via Penny Weaver, 6-15-2012
PROGRAM MANAGER
ENERGY EFFICIENCY AND RENEWABLE ENERGY

SUBJECT INFORMATION: The Rooftop Unit (RTU) Challenge - Performance Criteria for 10-ton Capacity Commercial Air Conditioners

OPPORTUNITY: Commercial buildings currently account for 18 percent of U.S. energy use. Data from the Commercial Building Energy Consumption Survey (CBECS) indicates that approximately 40% of commercial floor space is served by package air conditioning units. Nationwide, if all 10-20 ton RTUs currently installed were replaced with units that meet the RTU Challenge, businesses could annually save approximately 16.7TWh and $1.9B. This memorandum is only for information. No action is required.

BACKGROUND:

- In February 2011, DOE joined with industry partners to release a new design specification for 10-ton capacity commercial air conditioners, also known as rooftop units. The new specification resulted from DOE's efforts, working in coordination with the private sector, to spur the market introduction of energy efficient equipment. Commercial buildings present significant opportunities for energy and financial savings that can help American companies be more competitive on a global scale.
- On May 24, DOE announced that five manufacturers – Daiken McQuay, Carrier, Rheem, Lennox, and 7AC Technologies – are participating in the RTU Challenge and have until April 1, 2013 to get a complete product evaluated by DOE against the specification. DOE also announced that Daikin McQuay already submitted a candidate product, the Rebel rooftop unit system, which fulfilled the specification and therefore met the RTU Challenge.
- The RTU Challenge specification was developed by DOE's Commercial Building Energy Alliances (CBEA), which are a voluntary partnership between DOE and commercial building owners and operators seeking to improve the energy and operational efficiency of their buildings. The RTU Challenge demonstrates how the federal government has responded to the market and fostered a unique working relationship between the government and the private sector. Participating organizations represent a significant portion of the commercial building footprint

in their respective sectors, which include retailers, hotels, hospitals and institutions of higher education.

- Fourteen CBEA members – Target, Walmart, Lowe's, Yum! Brands, Grubb & Ellis, Gundersen Lutheran, Publix, Macy's, McDonald's, Edens & Avant, InterContinental Hotels Group, Cleveland Clinic, The Home Depot, and Costco – have declared that they will strongly consider purchasing units that meet the RTU Challenge and are consistent with their cost-effectiveness criteria and procurement timeframes. By demonstrating their commitment to high efficiency RTUs, these potential buyers urged manufacturers to participate in the Challenge and produce equipment that meets the specification.
- The minimum Integrated Energy Efficiency Rating (IEER) was set at 18, which will reduce energy consumption up to 50 percent compared to the current ASHRAE 90.1-2010 standard, depending on location and application. In addition, the units must include direct digital controls and operational fault detection.
- DOE National Laboratories evaluate RTU Challenge units, develop tools and guidance to assist building owners in evaluating the life cycle cost of these units relative to typical equipment and facilitate demonstrations in CBEA and federal facilities.

RECOMMENDATION: The success of this program is being expanded to catalyze the market introduction of other advanced technologies and products that improve the energy and operational efficiency of businesses. These types of challenges help prove that energy efficiency is a good business practice that benefits manufacturers, industry partners and American consumers.

Appendix 7: *Information on the BTP RTU Challenge*

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BUILDING TECHNOLOGIES PROGRAM

DOE and Private-Sector Partners Introduce a New Money-Saving Specification for Commercial Air Conditioners

In January 2011, the U.S. Department of Energy (DOE) joined industry partners to release a design specification for 10-ton capacity commercial air conditioners, also known as rooftop units (RTUs). The specification resulted from DOE coordination with an array of building owners and operators aiming to catalyze the market introduction of cost-effective, energy-saving RTUs.

RTUs built according to the specification are expected to reduce energy use by as much as 50 percent compared to the current ASHRAE 90.1 standard, depending on location and facility type. Nationwide, if all 10-20 ton commercial units were replaced with units built to this specification, businesses would save about $1 billion each year in energy costs.

Members of DOE's Commercial Building Energy Alliances (CBEAs) are highly engaged throughout this project and are a key to its success. The CBEAs, composed of leading building owners and operators throughout the United States, receive technical support from DOE and its national laboratories on a broad range of projects intended to spur market adoption of energy-savings tools, technologies, and best practices that can make buildings more efficient, productive, and affordable.

The DOE RTU design specification strongly signals suppliers on commercial buyer support for rooftop air conditioning units manufactured in compliance with innovative, energy-efficient specifications.

The CBEAs are leveraging the expertise and purchasing power of their membership—representing broad swaths of the retail, commercial real estate, higher education, and healthcare sectors—to demonstrate market demand for high-performance RTUs.

Benefits for All Stakeholders

The development of buyer-driven, high-performance RTUs will result in big wins for both building owners and manufacturers, as the former save energy and money, and the latter receive a strong market signal for a common set of advanced equipment requirements across major potential purchasers. Participants also support the nation's progress toward energy independence and enhance their own reputations as responsible environmental stewards.

As a public signal of their support, participating CBEA members jointly announced that they would strongly consider purchasing units that:

- Comply with the specification
- Are consistent with CBEA cost-effectiveness criteria
- Align with CBEA procurement time frames.

A Holistic Approach for Enabling Market Adoption

To help drive deployment of these best-in-class rooftop units, DOE national laboratories have developed a lifecycle cost calculator tool for potential purchasers to compare RTUs, as well as robust testing requirements to ensure that the specification is met.

Commercial Building Initiative

To date, two manufacturers, McQuay International and Carrier Corporation, have submitted entries. Verification testing of their units against the specification is expected to get underway by mid-2012. DOE will then facilitate the demonstration of a specification-compliant unit in a CBEA-member building to capture performance data in actual operating conditions.

Based on this experience, how-to guidance for installing, commissioning, metering and operating the RTU will be disseminated so that others can successfully replicate this project. The aim of this holistic approach is to significantly lower many of the hurdles facing early adopters of new products, and therefore spur much more aggressive market adoption than would otherwise occur.

What is in the Specification?

The specification covers hardware, performance, and controls, including information detailing basic RTU elements and various equipment options intended to help ensure that the unit operates at top energy and operational performance levels throughout its service life.

Primary Features of the Specification

- High-performance Integrated Energy Efficiency Rating (IEER) of 18
- Direct digital controls
- Operational fault detection

How to Participate

For the CBEAs to encourage manufacturers to develop high-performance RTUs, widespread building owner support for the specification is key. Many CBEA members have already signaled their support through the "signatures" of their corporate logos on the DOE announcement, which indicates their strong interest in potentially purchasing products that comply with the specification. The CBEAs encourage all members and manufacturers of entire RTU systems (rather than individual component suppliers) to take advantage of this unique opportunity. For more information on how to join either the CBEAs or to submit a candidate RTU, please visit http://www1.eere.energy.gov/buildings/alliances/rooftop_specification.html.

A diverse and growing list of CBEA members support the specification.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

Appendix 8: *January 26, 2012 email from Kathleen Hogan and Roland Risser to Maxine Savitz*

BTP Program Goal
As you know, the goal you referenced (reduce energy consumption in buildings by 50% for 5c/kWh) is the overall goal for the Buildings Technologies Program (BTP). I should note while the rigorous analytics used to develop the 50% savings for 5 cents/kWh have not changed significantly, since September we have further refined the goal to state:

Support the development and deployment of technologies, systems, and market solutions to save $2.2 trillion in energy-related costs by reducing energy use by 50% by 2030:

- $6.1 trillion savings corresponding to the present value of 50% of building related energy expenditures
- Investment of $3.9 trillion in energy saving technologies
- Direct program activity will provide half of this benefit (10 quads/year in 2030)

It is worth noting that the same analytics and research used to develop this goal and required program design were also leveraged by the QTR.

BTP's Policy & Regulatory Options
BTP will employ a variety of policy and regulatory options in pursuit of this goal. For example, appliance standards are a critical component of this plan; they are planning to issue 10 final rules by the end of this fiscal year in addition to 12 new appliance test procedures. The Appliance Standards Program coordinates with EPA on test procedures for ENERGY STAR products.

Another major policy mechanism they will employ is building codes and standards. The program is working on developing new and more efficient codes and standards at the same time as providing technical assistance to states that wish to codify and enforce them. For this work, through legislative mandate, the program coordinates with HUD on manufactured housing codes and standards.

SEE Action
SEE Action is another avenue through which we are pursuing policy development, but in the state and local realm as opposed to the federal level (in fact, because SEE Action is not a FACA, they cannot officially advise the federal government on policy). We have been pleased with SEE Action's progress. As you know, SEE Action is modeled after the successful National Action Plan for Energy Efficiency and includes a network of over 200 leaders from state and local governments, associations, businesses, non-government organizations, and their partners working toward a goal of achieving all cost-effective

energy efficiency by 2020. The Network is led by state and local governments, and facilitated by DOE and EPA. Through its 8 Working Groups, SEE Action has been working over the past year to advance best practice recommendations for energy efficiency policy and program development and implementation where some of the largest opportunities exist. To this point, these Working Groups have developed over 25 knowledge resources to educate and inform decision makers, and approximately 20 more are under development now. In the next phase of SEE Action, the Working Groups will reach out to decision makers to share the knowledge resources and offer support where requested as state and local leaders take action.

Cooperation with HUD on weatherization and other activities

Joint weatherization goal

In regard to the housing retrofits, we just revised our High Priority Performance Goal with HUD. While the original goal was to weatherize 1.1 million homes, the agencies together are now committing to weatherize 1.2 million homes between FY10 and FY13; DOE is responsible for 1 million of those. As of the fourth quarter of FY11 (our most recent numbers), DOE completed more than 778,000 homes, which is more than 10 percent ahead of our projected pace to meet our target. HUD is also ahead of schedule with nearly 162,000 homes weatherized in the same time period.

Memorandums of Understanding

In terms of other coordination with HUD, we have two ongoing memorandums of understanding (MOUs). The first was a culmination of a May 6, 2009 announcement by Vice President Biden on “An Opportunity for Agencies to Collaborate and Help Working Families Weatherize Their Homes in Multi-Unit Buildings”. This resulted in a Memorandum of Understanding (MOU) signed by Sec Chu and Sec Donovan of HUD at the May 6th Cabinet Meeting. Through this MOU, both Secretaries committed to lowering the administrative hurdles to coordinating the efforts of DOE's Weatherization Assistance Program (WAP) and HUD programs for assisted housing.

Subsequently, DOE published a final rule in the Federal Register on January 25, 2010, amending 10 CFR Part 440.22 - Eligible Dwelling Units (75 Fed Reg 3847). Under this rule, if a public housing, assisted multi-family or Low Income Housing Tax Credit (LIHTC) property is identified by HUD and included on one of three published lists, it is deemed to meet certain eligibility criteria. On March 1, 2010, DOE posted the first lists of properties supplied by HUD and these lists are updated regularly.

DOE and HUD have been working closely to expedite weatherization and home energy retrofits of existing HUD multifamily properties. As of September 30, 2011, the WAP had weatherized 125,000 multifamily units through the Recovery Act alone.

The second MOU was signed on January 13, 2010 that listed many areas of cooperation that the agencies could explore for "building energy programs and energy efficient mortgages" (including the PowerSaver loan program mentioned below). Last summer, our main point of contact at HUD came over to DOE on a detail and was working to better integrate DOE's and HUD's mutual interests. Unfortunately, he left DOE in December for the private sector. Representatives from HUD continue to work with DOE on these areas of cooperation at meetings and conferences.

Programs from the QTR
As for the specific programs you mentioned about HUD from the QTR:
- Sustainable Communities Program: This program is a partnership among HUD, DOT and EPA. We did, however, have a staffer that attended their meetings and provided advice (including serving as grant reviewer). HUD personnel also helped to review our Weatherization Innovation Pilot Program. As it wasn't an official DOE program, the funding cut doesn't impact our programs directly.
- PowerSaver: The PowerSaver program is administered by the Federal Housing Administration and provides loans for energy upgrades to homes (up to $25k). It is currently in its pilot phase. As you can see, Sec Chu joined Sec Donovan in announcing the financial partners in April of last year. DOE helped to identify those upgrades eligible under the program. DOE had provided some technical advice on the residential energy efficiency market to HUD and also connected this loan program with some of our Better Buildings Neighborhood Program grantees.
- Building Codes: As mentioned above, DOE is legislatively mandated to coordinate with HUD on building codes for manufactured housing (for which a rulemaking process is currently underway).

DOE staff are active participants in the interagency Healthy Homes Work Group. Core agencies include HUD, HHS, EPA, CDC, NIST, and DOL in addition to DOE. DOE staff have worked closely with EPA and HUD personnel on a number of crosscutting efforts on both residential energy efficiency as well as healthy homes.

Benchmarking & Workforce Training
In regard to your question about the chart on slide 13 (about alternative financing, benchmarking, and workforce training), we have several actions ongoing that include coordination with the interagency.

Benchmarking
For benchmarking in the commercial sector, we coordinate often with other federal agencies, state and local officials, and the private sector. EPA directs the federal

government's primary public-facing benchmarking tool: ENERGY STAR Portfolio Manager. DOE has contributed to the funding improvements to this tool over the last year. For the commercial asset rating tool (more on this below), our staff has regular calls with EPA to discuss ideas, technical methods, and the best way to link the asset rating tool to Portfolio Manager. We also coordinate with EPA, HUD, Fannie Mae and other state, local, and private entities on multifamily benchmarking.

One of our main efforts in commercial benchmarking has been the development of a tool called the Standard Energy Efficiency Data (SEED) Platform that building portfolio owners/managers, state and local agencies, and others can use to begin collecting building energy performance data in a format compatible with the national database; this should help make it easier to use the buildings performance database and associated tools to understand their data in the context of other datasets. (Note that this work will be presented and discussed on Monday.) This project has been done hand-in-hand with EPA in particular because the data will interact with Portfolio Manager. We've also had many conversations with state and local officials as they will be a prime user once it's completed.

SEE Action has worked on identifying model policies to distribute to stakeholders; benchmarking and disclosure were identified as priorities in the commercial buildings working group.

Our development of workforce training activities and standards has included some coordination with DOL, EPA, HUD, and other Federal Agencies through the "Recovery through Retrofit" interagency process. We also have ongoing coordination with GSA and FEMP on the Federal Buildings Personnel Training Act (in fact, we have an interagency meeting scheduled on January 26).

Workforce Guidelines
For workforce guidelines, one of our primary efforts from within WAP is developing the Guidelines for Home Energy Professionals. This project is laying the foundation for high quality energy upgrades in America's homes. The two major pillars of the Guidelines project are quality work and qualified workers. The project fills a need within the industry for nationally accepted and standardized specifications for work performed on homes. The project also addresses the need for third party verification of training programs and puts in place a certification structure to accurately assess worker qualifications. When complete, the Guidelines for Home Energy Professionals will form a comprehensive set of tools for quality assurance in the Weatherization and Home Performance industry.

WAP staff has met with DOL regarding the Guidelines for Home Energy Professionals project on two separate occasions. These meetings took the form of information sharing sessions primarily aimed at making DOL staff aware of the guidelines for training and certification that are being developed by the WAP. DOL currently does not require recipients of grant funds to adhere to any third-party verification process in order to receive funding. They did indicate that this is something that could be considered in the future and that they appreciated being made aware of the WAP resources.

In addition to the Guidelines for Home Energy Professionals project, WAP also has the following resources for workforce training:

- 39 Weatherization Training Centers located in 29 states
- The WAP Standardized Training Curriculum
- The National Weatherization Training Platform (online)
- Third party accreditation of training programs and certification of instructors through the Interstate Renewable Energy Council
- Standard Work Specifications for Single Family, Manufactured Housing, and Multifamily Energy Upgrades

EPA was a key partner on the development of the Single Family Standard Work Specifications (SWS) and HUD and EPA have been key collaborators on the Multifamily and Manufactured Housing SWS's.

WAP also worked with DOL's Wage Determination Bureau to establish weatherization worker job classifications for all 3,056 counties in the country.

As for alternative financing, aside from the information above, I'm afraid I don't have much information to share. Our financing group in the Weatherization and Intergovernmental Programs office has no outstanding MOUs or official agreements with other agencies.

Asset Rating Program

Finally, you had inquired about the state of the Asset Rating Program. DOE's asset rating work is on schedule. We held a stakeholder workshop in December and have been working to develop the software tool and program infrastructure. We are on track to begin piloting the commercial building energy asset rating program in the spring. We are not branding the program at this point, and are thus trying to avoid an official title until sometime in the future when we move out of pilot phase. We have not yet committed to a "full launch" of the program; we may instead move into a second pilot to address lessons learned before full roll out.

The asset rating tool will both give buildings a rating for their physical infrastructure (how efficient are the building's various systems) and identify potential opportunities for improving energy performance.

FEMP's Interagency Activities

In addition to your questions, I thought I'd also include some of the interagency coordination activities performed by FEMP. FEMP is working with GSA and the Army on efforts to achieve deep energy retrofits that are consistent with the 50% aspirational goal, which should be possible on many buildings undergoing substantial renovation. We are also encouraging the use of on-site renewables to further reduce consumption of conventional energy resources. In addition, FEMP is working with GSA to have energy service companies (ESCOs) perform deep retrofits on over two dozen GSA buildings.

On Dec 2, 2011, as part of DOE's Better Buildings Initiative, President Obama committed Federal agencies to undertake $2 billion in energy efficiency building improvements using performance based contracts. Performance Based Contracts are financial vehicles through which Energy Service Companies and utilities pay for the upfront costs of retrofit activities in exchange for a long-term contract paid from the energy savings. FEMP has been designated as the lead entity in that effort and in January launched an interagency coordination process to achieve these energy savings. FEMP will fulfill most of this effort using its Indefinite Delivery, Indefinite Quantity contract with 16 Energy Service Companies. In this role, FEMP will be assisting 25 agencies.

Appendix 9: *The role of building energy efficiency technology*

The pace of technological innovation in the building efficiency space is accelerating. The onus is no longer squarely on the consumer to consciously use less energy – new technologies significantly reduces the amount of energy building products use and automate actions that used to be manual. In this section, we highlight two areas where technological improvements are making large differences – LED lighting and building energy management software – but advancements are happening across the industry.

DOE has an important role to play supporting the development and adoption of these technologies and has done a good job supporting the development of new HVAC, window, and server technologies. We strongly endorse the findings of the SEAB Technology Transition Subcommittee report, which found that government support can occur in four stages:

> *(1) Creation of new ideas (basic research and exploratory development), (2) development of new technical ideas to a process development scale that defines system operation (advanced engineering) and validates feasibility, (3) system demonstration that creates a practical option for the private sector by establishing the technical performance, cost, and environmental effects of supply or demand side technology, and (4) deployment assistance or regulatory mandates to encourage the adoption of new energy technologies at a faster pace than would occur without government involvement because of (a) the absence of policies that internalize external costs, e.g. GHG emissions, (b) imperfect information, or (c) imperfect market conditions.*[20]

LED lights represent an entirely new approach to lighting, rather than a reimagining of incandescents and fluorescents. Costs are decreasing significantly (see Appendix 3), which has been matched by a drop in the price of lighting controls. Simultaneous installation of LEDs with lighting controls can dramatically reduce lighting-related energy use.

An opportunity exists for DOE to help jumpstart a relatively new industry. LEDs have already achieved the first two stages described above, but by installing LED lights in government buildings, DOE can become a showcase for the efficacy and practicality of this technology. James Brodrick, the lighting program manager in BTP, deserves praise for leading an R&D joint effort with industry that led to significant technological advances and for helping to establish solid-state lighting centers at the University of California Santa Barbara and University of California Davis.

The prospect of incorporating more efficient lighting with "smart" lighting controls, smart thermostats and building management software unlocks new ways to achieve greater efficiency, especially in commercial and industrial buildings. The industry is

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[20] Department of Energy. Secretary of Energy Advisory Board. Interim Report of Technology Transition Task Force to the Secretary of Energy Advisory Board. July 2011. <http://energy.gov/downloads/doetechnologytffinal-junpdf>.

booming due to emissions reductions laws and the leadership of elected officials like Mayor Bloomberg in New York City, who has signed legislation to require building energy efficiency software. Because of shortened payback period (often less than 24 months), it is an economical way for building owners to realize substantial energy savings without significant financial risk. DOE can promote the best practices of cities like New York to encourage other cities and states to follow suit.

Breakthroughs are not just happening on the hardware side. Behavioral energy efficiency initiatives combined with prompt feedback and some social media reinforcement are beginning to bear fruit, delivering larger and more sustainable results than the market initially expected.

The level of innovation in the building energy efficiency sector creates an enormous opportunity to link various technologies across platforms. DOE should do all it can to make sure this happens as quickly as possible. This includes working more assertively with DOD and GSA to explore all avenues for getting the Federal government to use these types of technologies and showcasing the results.

Appendix 10: *The role of the Office of Building Energy Efficiency*

Building energy efficiency needs to be a priority at DOE, and currently it is not enough of one. To remedy this, our primary recommendation is for the Secretary to establish a new, comprehensive buildings program that stretches from science to stakeholder engagement and includes a buildings policy. The new OBEE, under the leadership of a strong senior director, will have numerous available tools to increase adoption of energy efficiency technologies:

1. Work with GSA to use the Federal government's purchasing power to adopt more building energy efficiency solutions and to set an example by making investment decisions based on the lifecycle costs of products rather than upfront costs alone.
2. Make data available to states so they can adopt the most effective building efficiency standards possible.
3. Work with the Loan Programs Office to identify technologies that will most rapidly gain consumer adoption and achieve the greatest energy savings.
4. Identify key areas of building energy efficiency research not currently being addressed by DOE, NIST, or DARPA.
5. Improve technology transfer from National Labs to the private sector.
6. Place greater emphasis on program plans, portfolio management, and milestones to run programs more effectively and professionally.
7. Coordinate other Federal agency activities in building energy efficiency (e.g. clearinghouse for RFPs encouraging building energy efficiency).
8. Create a database of best practices and develop a system to distribute information to state and local governments. Coordinate closely with the International Energy Agency (IEA) and other governments to promote best practices like the successful Collaborative Labeling and Standards Program (CLASP).[21]
9. Use the Internet, and social media in particular (e.g. Facebook and Twitter), as a low-cost communications tool to raise awareness of DOE's current building energy efficiency programs.
10. Social science behavioral studies.

[21] This coordination should not pre-empt existing collaborations between IEA and other DOE offices, such as EERE, OE, Policy & International, etc.

Glossary

ACEEE	American Council for an Energy Efficient Economy
AHRI	American Heating and Refrigeration Institute
API	Application Programming Interface
ARPA-E	Advanced Research Projects Agency-Energy
ASHRAE	American Society of Heating, Refrigeration, and Air-conditioning Engineers
BPD	Buildings Performance Database
BTU	British Thermal Units
BTP	Building Technologies Program
CBEA	Commercial Building Energy Alliance
CBECS	Commercial Buildings Energy Consumption Surveys
CEQ	Council on Environmental Quality
CFL	Compact fluorescent lamps
CLASP	Collaborative Labeling and Standards Program
DARPA	Defense Advanced Research Projects Agency
DOD	Department of Defense
DOE	Department of Energy
EER	Energy Efficiency Ratio
EERE	Office of Energy Efficiency and Renewable Energy
EFRC	Energy Frontier Research Center
EIA	Energy Information Agency
EPA	Environmental Protection Agency
EPACT 1992	Energy Policy Act of 1992
EPSA	Energy Policy and Systems Analysis Office
ESCO	Energy Service Company
ESPC	Energy Saving Performance Contract
ESTPC	Environmental Security Trust and Certification Program
FEMP	Federal Energy Management Program
FHA	Federal Housing Authority
FHFA	Federal Housing Finance Agency
FY	Fiscal Year
GSA	General Services Administration
HUD	Department of Housing and Urban Development
HVAC	Heating, ventilation, and air conditioning
IEA	International Energy Agency
IEER	Integral Energy Efficiency Ratio
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design
MOU	Memorandum of Understanding
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
OBEE	Office of Building Energy Efficiency
OE	Office of Electricity Delivery and Energy Reliability
OMB	Office of Management and Budget

PACE	Property Assessed Clean Energy financing
PCAST	President's Council of Advisors on Science and Technology
PI	Policy and International Office
PII	Personally indentifiable information
QTR	Quadrennial Technology Review
R&D	Research and Development
RECS	Residential Energy Consumption Surveys
RFP	Request for Proposal
RTU	Rooftop Unit
SBIR/STTR	Small Business Innovation Research and Small Business Technology Transfer
SEAB	Secretary of Energy Advisory Board
SEE Action	State and Local Energy Efficiency Action Network
SEED	Standard Energy Efficiency Data platform
SPIDERS	Smart Power Infrastructure Demonstration for Energy, Reliability, and Security
TWh	Terrawatt hours