

## Building Technologies Program

### Funding Profile by Subprogram

#### Non-Comparable Structure

	(Dollars in Thousands)		
	FY 2011 Current <sup>a</sup>	FY 2012 Enacted	FY 2013 Request
Building Technologies Program			
Commercial Buildings Integration	37,308	31,913	61,079
Emerging Technologies	75,694	84,694	108,344
Equipment and Buildings Standards	35,000	58,302	98,250
Residential Buildings Integration	37,308	31,282	35,872
Technology Validation and Market Introduction	22,000	8,500	0
SBIR/STTR	0	4,513	6,455
Total, Building Technologies Program	207,310	219,204	310,000

#### Comparable Structure

	(Dollars in Thousands)		
	FY 2011 Current <sup>a</sup>	FY 2012 Enacted	FY 2013 Request
Building Technologies Program			
Innovations	13,300	10,894	17,567
Emerging Technologies	45,826	48,417	89,660
Systems Integration	91,184	88,578	98,068
Market Barriers	57,000	66,802	98,250
SBIR/STTR	0	4,513	6,455
Total, Building Technologies Program	207,310	219,204	310,000

#### Public Law Authorizations

P.L. 94 163, "Energy Policy and Conservation Act" (EPCA) (1975)  
P.L. 94 385, "Energy Conservation and Production Act" (ECPA) (1976)  
P.L. 95 91, "Department of Energy Organization Act" (1977)  
P.L. 95 618, "Energy Tax Act" (1978)  
P.L. 95 619, "National Energy Supply Policy Act" (NECPA) (1978)  
P.L. 95 620, "Power Plant and Industrial Fuel Use Act" (1978)  
P.L. 96 294, "Energy Security Act" (1980)  
P.L. 100 12, "National Appliance Energy Conservation Act" (1987)  
P.L. 100-357, "National Appliance Energy Conservation Amendments" (1988)  
P.L. 100 615, "Federal Energy Management Improvement Act" (1988)  
P.L. 102 486, "Energy Policy Act of 1992"  
P.L. 109-58, "Energy Policy Act of 2005"  
P.L. 110-140, "Energy Independence and Security Act of 2007"

#### Overview

In November 2009, the President set a national goal to reduce carbon emissions by 17 percent by 2020 and 83 percent by 2050, from a 2005 baseline. Energy efficiency is one of the most cost-effective and immediate steps to achieving the President's goals. The Department of Energy's goal is to catalyze the timely, material, and efficient transformation of the Nation's energy system and secure U.S. leadership in clean energy technologies.<sup>b</sup> The Building Technologies Program (BTP or Program) supports the DOE goal by addressing opportunities to produce more goods and services with less energy, by enabling improved energy efficiency in the buildings sector. The buildings sector currently accounts for approximately 40 percent of U.S. energy use and carbon emissions.<sup>c</sup>

Building energy efficiency in the U.S. provides an inexpensive energy resource that addresses national concerns involving energy affordability, reliability and

<sup>a</sup> SBIR/STTR funding transferred in FY 2011 \$3,190,000.

<sup>b</sup> [http://www.energy.gov/media/DOE\\_StrategicPlan\\_Draft.pdf](http://www.energy.gov/media/DOE_StrategicPlan_Draft.pdf)

<sup>c</sup> U.S. DOE Energy Efficiency and Renewable Energy, 2009 Buildings Energy Databook. November 2009: <http://buildingsdatabook.eren.doe.gov/Default.aspx>.

greenhouse gas (GHG) emissions. The Program reduces building energy consumption in the U.S. through the development and deployment of advanced, innovative technologies. Currently, buildings use over 70 percent of the electricity in the U.S., so a reduction in energy and electricity use has an added benefit of reducing demand within the electric power industry. New and advanced technologies developed through the Program and manufactured by domestic industry will build upon institutional building science and contribute to a transformation in the manner with which the U.S. currently uses energy, resulting in energy savings for Americans. These new products will help create jobs, spur economic growth, and continue America's role as a global innovator and exporter of high-tech products.

Based on the DOE's strategic goals and other policy and legislative drivers, the Program focuses specifically on improving the efficiency of new and existing residential and commercial buildings, through research and development on building systems as well as building components, through building integration demonstrations, and through market priming, equipment standards, and building code activities. In addition, the Program's progress depends upon the coordination of other EERE program efforts including: the Solar Technologies Program, which will accelerate the research and development (R&D) and large scale commercialization of distributed photovoltaic (PV) technology for buildings; the Weatherization and Intergovernmental Program (WIP), which will deploy energy retrofit technologies for low-income families and address local building efficiency needs; and the Federal Energy Management Program (FEMP), which will promote energy efficiency at Federal facilities.

The Program has set out to reduce building-related energy costs by reducing energy use by 50 percent by 2030. The State Energy Data System indicates residential and commercial energy expenditures totaled \$416 billion in 2010. If this BTP program goal is met, the net savings in the U.S. would be tens of billions of dollars per year by 2030, after accounting for both the energy savings and the capital investments required.

The Program pursues this goal, reducing building-related energy costs by reducing energy use by 50 percent by 2030, through three interwoven pathways (shown below in Figure 1). This figure shows how the Program's pathways for research and development (shaded boxes), combined with reducing market barriers and raised standards, can further enable the private market to subsequently seize the full potential available (outlined white box) for cost effectively reducing energy efficiency in buildings. It is important to note these pathways are highly complementary; increasing market pull builds on

R&D while standards builds on the increased market penetration. All three pathways are needed to optimize program impact.

Figure 1: Energy Savings Potential

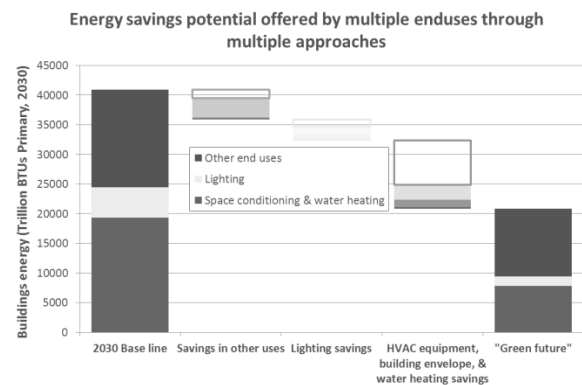


Figure 1 shows the market opportunity for buildings related energy savings and expected BTP benefits in three major end uses categories: heating, cooling and water heating; lighting; and other end uses.

### Strategy

The Program supports innovation, emerging technologies, systems integration, and reducing market barriers of advanced technologies to improve energy efficiency in America's buildings.

The primary barriers to improved building efficiency are technological (greater energy efficiency) and market-based (acceptable cost to purchase) in nature. The principal strategy of BTP is to support research, development, demonstration and deployment (RDD&D) of technologies that have the potential to achieve significant improvements in building efficiency. The Program also supports market-priming measures to ensure that these technologies overcome the barriers to widespread adoption, such as first cost, the various building trades' acceptance of new technology, and insufficient availability of consumer information. Widespread adoption of building efficiency technologies is critical to the success in meeting the Program's goals and includes both voluntary efforts such as Energy Star and the BetterBuildings Program (Residential and Commercial) as well as regulatory activities, such as, the Appliance Standards Program.

The Program strategy is divided into three interwoven pathways, each of which can result in lowering building energy use:

- Improve building components (solid state lighting, windows, heating ventilation and cooling, building envelope, sensors and controls), both performance and cost to manufacture/install, through ground-breaking research and development; and develop whole building energy simulation programs such as

Energy Plus that engineers, architects, and researchers can use to model energy and water use in buildings;

- Increase market pull from private industry through cooperation with stakeholders, improvement of building design and audit tools, and the creation of reliable efficiency benchmarks and databases to facilitate energy efficiency financing and to define efficiency's value-add to consumers (BetterBuildings Residential and Commercial, HUB, Energy Star); and
- Raise the standards for new energy consuming equipment and new buildings with continually updated equipment and model building codes based on cost effective, higher performing technology that has been successfully commercialized.

The Program faces a number of challenges, many of which are largely related to a market characterized by the general public's lack of certainty or knowledge in building technology and energy efficiency, high up-front product costs, limited workforce and product availability and overall fragmentation of the markets involved in energy efficiency technology. The Program's FY 2013 portfolio will achieve rapid gains in building energy efficiency through a balanced set of strategies. This includes expanded research on components and integrated systems that can dramatically increase energy efficiency and provide long-term cost savings, without sacrificing functionality or safety.

The Program will achieve its goals by working with its partners in industry, academia, the National Laboratories, the Office of Science, Advanced Research Projects Agency - Energy (ARPA-E), and other relevant stakeholders. The Program systematically identifies technology, market, informational, and financial and policy barriers to the development and commercialization of energy efficient building components and their incorporation into new and existing buildings.

The Program engages with the National Laboratories, industry, and academia via competitive solicitations, which are targeted at the Programs specific Research, Development, Demonstration and Deployment (RDD&D) goals described below. Reviews of projects and awards are conducted at least annually or in stepped phases of performance milestones, resulting in cancelling of projects, revisions and/or redirection as necessary to ensure an effective portfolio. Expert stakeholder and independent review panels assess the efficacy and quality of the processes used to solicit, review, recommend, monitor, and document proposal actions. Panels also assess the quality of the resulting portfolio, specifically the breadth and depth of portfolio elements

and the national and international standing of the elements.

### Benefits

Residential and commercial buildings account for approximately 40 percent of the total U.S. energy consumed<sup>a</sup> and more than 70 percent of the electric energy consumed in the U.S. By helping to reduce this significant demand, the Program aligns with DOE's goal to provide clean, secure energy by developing reliable, affordable, and environmentally sound energy efficiency technologies, which significantly reduce the energy consumption of both new and existing residential and commercial buildings.

Figure 2: BTP Energy Efficiency Goals<sup>b</sup>

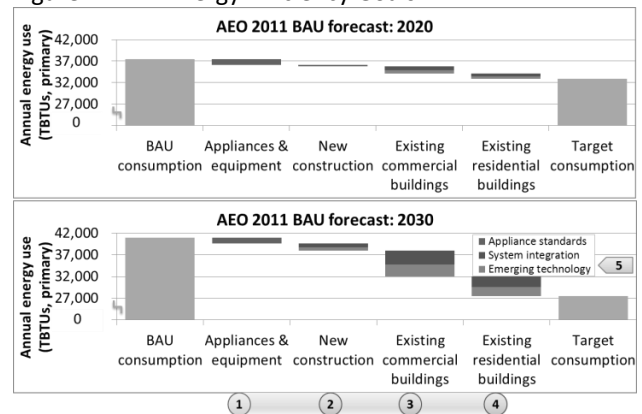


Figure 2 shows BTP's energy efficiency goals, expressed as a reduction in nationwide building energy use in 2020 and 2030 (Provided by the EIA's Annual Energy Outlook, 2010). Capturing these benefits requires applying all three interwoven pathways to pursue market opportunities aligned with five mid-term goals:

- **Appliance and Equipment:** Provide cost-effective energy savings through national appliance and equipment standards; issue 23 final rules by the end of FY2015; deliver 1,350 trillion BTUs annual savings by 2030;
- **New Construction:** Reduce the energy required to operate new residential and commercial buildings by 50 percent, at less than the cost of the energy saved. Prove existing technologies and practices and accelerate deployment through model building codes to deliver:
  - 350 trillion BTUs in annual savings by 2020;
  - 1,600 trillion BTUs in annual savings by 2030;
- **Existing Commercial Buildings:** Reduce the energy required to operate existing commercial buildings by

<sup>a</sup> Including the energy lost in the generation, transmission, and distribution of electricity delivered to residential and commercial buildings.

<sup>b</sup> BAU represents AEO 2010 forecast excluding "unspecified" commercial end uses. Goals 2-4 include impact of future standards.

40 percent, at less than the cost of the energy saved. Bring needed technologies and practices to market delivering:

- 1,600 trillion BTUs in annual savings by 2020;
- 6,000 trillion BTUs in annual savings by 2030;
- **Existing Residential Buildings:** Reduce the energy required to operate existing residential buildings by 50 percent at less than the cost of the energy saved. Bring needed technologies and practices to market delivering:
  - 1,250 trillion BTUs in annual savings by 2020;
  - 4,500 trillion BTUs in annual savings by 2030;and
- **Technology Development:** Bring to market technologies that save 70 percent of lighting, 60 percent of water heating, 40 percent of HVAC, and 20 percent of other appliances energy use at less than the cost of the energy saved.

All energy savings goals represent bottom-up calculations of estimated impacts derived from specific BTP activities. These calculations evaluate the technical energy savings potential, the cost effectiveness of consumer investment, and the speed of market up-take. For example our analysis suggests:

- Investing in research to develop light-emitting diodes, using labeling and testing to accelerate their market adoption, and evaluating the possibility of setting future standards for their performance can result in present value energy savings of over 1 quadrillion BTUs.
- The technical specification developed with manufacturers and consumers of commercial rooftop air-conditioning units will increase market adoption of advanced (SEER 17) units from under 1 percent per year to approximately 5 percent per year resulting in present value energy savings of over 1 quadrillion BTUs.

Current analysis efforts include an examination of over 500 diverse energy saving measures including technologies, voluntary agreements and specifications, building codes, appliance standards, behavior change, and other approaches to develop an effective portfolio of activities for BTP to pursue.

The Program generates the following benefits: The U.S. building sector is responsible for 38 percent of total U.S. carbon dioxide emissions.<sup>a</sup> The Program contributes to the reduction of GHG emissions by providing technologies that, when commercialized, will make the Nation's buildings more energy efficient. The efficiency gains from these advanced technologies not

<sup>a</sup> [BED] Building Energy Data Book, U.S. Department of Energy, 2010

only reduce the overall energy demand from buildings but also reduce consumption of electricity generated from fossil fuels. The use of energy efficient components and whole-building (systems integrated) design strategies will eventually permit low carbon buildings to become an everyday reality, while keeping the net costs of new components at or below the level of existing technologies.

Advanced efficiency technologies can directly reduce oil use in regions of the country that rely on home heating oil, making the residents of those homes less vulnerable to oil supply disruptions or price spikes. RDD&D activities focused on components such as advanced envelope and window technologies reduce heating loads in buildings, which reduces building energy use, and therefore reduces the utilization of source energy used in power plants.

Reduced energy use in buildings can be expected to reduce energy bills for American families and businesses. New technologies developed with the help of the Program and manufactured by the domestic industry will help create jobs, spur economic growth, and continue America's role as a global innovator and exporter of high-tech products. Efficient buildings have the added benefit of mitigating the need for the electric power industry to construct expensive new power plants.

#### **Key Accomplishments**

Examples of recent program accomplishments are below:

- Research Triangle Institute received an R&D 100 award for its development of photoluminescent nanofibers that can be used to produce an aesthetically pleasing light with better color rendering properties in Solid-State Lighting (SSL) applications.
- Work from Sandia National Laboratories has transitioned into a successful SSL R&D manufacturing project. Under Core Technologies Research, Sandia developed novel pyrometry tools to directly measure wafer growth temperature versus measurement of the ambient reactor temperatures. Under manufacturing R&D research, Sandia is teaming with Veeco Process Equipment, Inc., a major U.S. reactor manufacturer, to incorporate new technology into reactors designed for Light Emitting Diode (LED) growth.
- Philips Lumileds successfully demonstrated a neutral white LED with a light output of 950 lumens (lm), an efficacy of 115 lumens per Watt (LPW) at a current of 700 mA, correlated color temperature (CCT) of 3798 K, and a color rendering index (CRI) of 79. Achieving these specifications improves the quality of light, with better CCT and CRI making LEDs more durable, more pleasing to the eye, and more

efficient compared with similar non-LED lighting. The prototype was a 2x2 array of 2 mm<sup>2</sup> LEDs.

- By the end of FY 2011, the Program will have completed a large number of enhancements to EnergyPlus, its whole building energy simulation program. These enhancements include new models for ground source heat pumps, cooling fluids and mixtures, variable refrigerant flows, and radiant slabs, as well as an adaptive comfort model and expanded capabilities for control system specifications. FY 2012 modeling enhancement activities will focus on auto-sizing of components, solar shading, ice storage for cooling, multi-speed fans, multi-zone air-handling units, and increased outdoor-air ventilation options.
- DOE has aggressively pursued the commercialization of cost effective, highly insulating windows over the last several years through several R&D and market transformation strategies. In 2011, several window suppliers began offering cost effective R-5 windows. These windows reduce energy loads by approximately 40 percent compared to ENERGY STAR windows, with a less than \$2 to \$4 per square foot price premium over typical ENERGY STAR windows. Furthermore, a soon-to-be-completed windows project has devised an innovative automated manufacturing strategy to produce highly insulating windows in high volume and at low material and labor costs, thereby further increasing cost effectiveness.
- General Electric introduced an electric heat pump water heater (HPWH) into the market in 2011 that was a direct result of a partnership with Oak Ridge National Laboratory. Energy savings is approximately 50 percent as compared to standard electric storage models, reliability is high, and payback can be achieved in less than 4 years.
- Building America has expanded its program scope to include integration research on existing homes, identifying the most cost-effective measure packages to achieve 15 percent and 30 percent energy savings across 30 metropolitan areas within the 5 major climate zones. By bundling or integrating several energy efficiency technologies or improvements together into a home retrofit project, Building America scientists come to understand the level of increased energy savings possible by these technologies. For example, a team may bundle new air sealing, insulation, and duct sealing technologies into a retrofit project. From this project they learn how to install these systems more efficiently, how to reduce the total cost of the retrofit and how to mitigate any adverse effects such as moisture build-up or poor indoor air quality that may occur. By learning how to integrate these technologies into a

retrofit, it may be possible to safely achieve greater energy savings at lower costs. In addition, the National Laboratories have focused on achieving 50 percent energy savings in key climate zones for new and existing homes. By focusing on the 50 percent energy savings, the National Laboratories are developing cutting edge technology that may be required in the future to meet this ambitious energy target. Once demonstrated in the laboratories, this technology is then transferred to the market place through the Building America Program and other outreach activities. Building America teams and National Laboratories have also provided technical assistance to the deployment efforts under the BetterBuildings Neighborhood program and the Home Energy Score, ensuring a strong technical underpinning to these efforts.

- Commercial Building Energy Alliances (CBEAs) provide a mechanism for building owners and operators to collaborate on the common challenge of energy efficiency. Working groups face key challenges in their respective areas (retailers, commercial real estate companies, and hospitals), and benefit from information-sharing. Alliance members use their collective market share to enable high speed and scale market uptake of advanced technology and best practices. Working with CBEAs, high-performance specifications are developed to demonstrate capabilities and stimulate demand for advanced technologies identified as large opportunities for energy savings. For example, the US spends approximately 20 billion a year on commercial space cooling, with packaged rooftop climate control units accounting for nearly half of this. CBEAs developed a specification for high-efficiency rooftop units that reduces energy use by as much as 50 to 60 percent compared to the current ASHRAE 90.1-2010 standard. Similarly, nearly 8 percent of US lighting electricity use is consumed by outdoor area lighting. CBEAs have successfully completed five of these technology specifications in high-priority applications: high efficiency site parking lot lighting, high efficiency parking structure lighting, high efficiency roof top climate control units, high efficiency 2x2 recessed troffer lighting, and LED refrigeration case lighting.
- In FY 2011, DOE issued energy conservation standard final rules for clothes dryers, room air conditioners, residential refrigerators, residential furnaces, and central air conditioners and heat pumps. In the same fiscal year DOE issued test procedure final rules for walk-in coolers and freezers, battery chargers, external power supplies, fluorescent lamp ballasts, room air conditioners, clothes dryers, refrigerators, furnaces, and boilers. Altogether,

these final rules are expected to save consumers tens of billions of dollars off their utility bills through 2030.

- For Building Codes, in FY 2011, DOE issued the final determinations for the IECC 2009 (and 2006 and 2003), as well as ASHRAE 90.1-2007 and ASHRAE 90.1-2010 standards. DOE also developed and deployed compliance tools and pilot programs to assist states with establishing a compliance baseline, and achieved 30 percent efficiency improvement in national model energy building codes – using the 2006 IECC as the baseline for residential and ASHRAE 90.1 2004 as the baseline for commercial buildings.

#### **Strategic Plan and Performance Measure**

BTP program goals and mid-term objectives align with specific performance metrics. These measurable performance metrics are critical to determine overall progress to overcome major challenges and serve as steps to reach program goals. BTP faces a number of challenges related to program goals. These challenges are largely related to a current market characterized by the general public's lack of certainty or knowledge regarding building technologies and energy efficiency, high initial product costs, limited trained workforce and product availability, and overall fragmentation of the markets involved in energy efficiency technology. Performance metrics contribute to attaining mid-term objectives and ultimately to surmounting or lessening the barriers which hinder program goals to reduce U.S. energy use.

#### **Performance Measure Analysis**

The Program's case studies and handbooks will document means, methods, and technology solutions for commercial building owners to achieve savings in six building types. With FY 2013 funding the Program will further document solutions with building owners that

include overcoming implementation barriers; quantifying the opportunity, savings, and impacts; and documenting the technology solutions for six building types in all climate zones. Working through the Commercial Building Energy Alliances and the Better Building Challenge, uptake and impact of these solutions will be measured.

Under the BetterBuilding Neighborhood Program, DOE is working with utilities to receive pre-retrofit and post-retrofit utility bills for homes retrofitted under this grant program to gauge energy savings resulting from the retrofits. In addition, BTP is developing a database that will collect and store retrofit data associated with actual energy savings. This database will allow analysis of the magnitude of savings associated with types of improvements by climate region. Both efforts will help DOE improve its estimates of energy savings associated with retrofits. Also, the BetterBuilding neighborhood Program tracks the number of retrofits that occur with its grantees.

Many of the test procedure and standards rulemakings are legislatively mandated by the Energy Policy and Conservation Act. The number of proposals and final rules are determined by the typical rulemaking cycle, whose completion dates are specified by legislation. For ENERGY STAR, DOE estimated the number of proposals based on the Environmental Protection Agency's work plan for specification development. These activities assist in achieving this goal by improving the efficiency of new appliances and equipment, establishing test procedures to measure product efficiency, and verifying compliance with these test procedures and specified efficiency levels. The ENERGY STAR program also provides a complementary role to the research and demonstration activities of the Building Technologies Program.

**Comparable Explanation of Funding Changes**

(Dollars in Thousands)

		FY 2013 Request vs. FY 2012 Enacted
FY 2012 Enacted	FY 2013 Request	

**Building Technologies Program**

The Innovation Subprogram activities address the technological barriers to improved energy efficiency in buildings. The subprogram supports research of lighting; heating ventilation, air conditioning; building envelope and windows; and sensors and controls. Research will be expanded to develop improved OLED efficacies by as much as 65 percent as compared to baseline devices. New critical path innovations added this year will include researching low global warming potential (GWP) working fluids, alternative heating and cooling systems, heat exchanger technologies and theoretical investigations of light generation and extraction at molecular scales. Additional research will include projects to improve building systems operations with innovative sensors for temperature, humidity, air flow, motion/occupancy, light level, and carbon.

10,894      17,567      +6,673

The Emerging Technologies Subprogram is to move building technologies along the RDD&D continuum from lab testing to prototype validation. Emerging Technologies activities support the development of advanced lighting, building envelope, windows, space conditioning, water heating, solar thermal, and appliance technologies and analysis tools; The increase in the Emerging Technologies Subprogram will be focused on conducting new FOAs in the areas of HVAC; building envelope and windows; and sensors and controls. DOE will also initiate combined Building Integrated Photovoltaic (BIPV) (in conjunction with the Solar Energy Program) and Advanced Roofing Strategies activities to reduce total net energy roofing load by 35 to 75 percent, while increasing PV output due to lower operating temperatures. This Subprogram will also develop a technology roadmap for non- Solid State lighting technologies, to identify and begin prioritizing other opportunities to reduce lighting related energy use. We will also be working with the Advanced Manufacturing Office (AMO) to prioritize and fund (potentially co fund) projects to develop technologies and processes to reduce the manufacturing costs of more efficient products, and thus improve the speed of market uptake for these highly efficient products. The Building Energy Innovation Hub will begin work on scalable strategies for hosting validated high performance computational simulation, design, control, and optimization tools in an open computing environment which is readily and seamlessly accessible by architects, engineers, and other energy efficient retrofit (integrated design) process participants. Approximately 500 buildings in the Philadelphia region are expected to be identified as candidates for full spectrum energy retrofit based on high return-on-investment opportunities. Direct retrofit of 10-20 buildings utilizing Hub strategies and tools is planned.

48,417      89,660      +41,243

(Dollars in Thousands)

FY 2012 Enacted	FY 2013 Request	FY 2013 Request vs. FY 2012 Enacted
--------------------	--------------------	--

The Systems Integration Subprogram focuses on demonstrating and testing new technologies, both those developed by DOE as well as new technologies from academia and industry, and on accelerating the introduction of these highly efficient technologies and practices for new and existing residential and commercial buildings. Additional funding will be used to conduct demonstrations of commercial buildings retrofits (>30 percent of U.S. electricity demand) critical to achieving BTP's goal of reducing building related energy use by up to 50 percent cost effectively, as well as increasing deployment of the specifications and technical demonstrations of cost effective retrofits. Better Buildings Commercial will work on a competitive solicitation with Emerging Technologies with a focus on building envelope and windows, and one on sensors and controls with the intent to improve ongoing building energy use. Building America has expanded to include integration research on existing homes. It will continue to identify the most cost effective measure packages to achieve 15 percent energy savings and enable/demonstrate the cost effectiveness and reliability of systems required to meet the International Energy Conservation Code (IECC) 2012 code revision. In addition, the Building America Program as well as the National Laboratories will expand their research into achieving 50 percent energy efficiency savings over IECC 2009. These goals are targeted for completion for all climate zones by 2017. The additional funding will expedite this research, allowing for a more comprehensive study of the technologies to help achieve this 50 percent target.

88,578	98,068	+9,490
--------	--------	--------

Market Barriers Subprogram addresses market challenges or failures in the adoption of energy efficient technologies, through both market priming activities as well as regulatory activities, which identify cost-effective solutions for building equipment and new model construction energy codes. The funding increase in 2013 will allow DOE to increase the scope and effectiveness of its energy conservation standards by accelerating the test procedure and standards rulemakings that are currently scheduled, allowing for the increased use of DOE's existing authorities to establish standards for additional products that have large energy savings potentials. The increase in funding for the Equipment and Appliance standards program will be used to initiate approximately 6 new conservation standards rulemakings and the corresponding test procedure rulemakings. DOE remains committed to meeting all of its legislatively mandated deadlines for covered appliances and equipment and actively enforcing its existing standards to provide a level playing field for all manufacturers. DOE will prioritize the selection of the new standards by evaluating the benefits resulting from such adoption. DOE will also expand its activities in certification and enforcement in order to increase the effectiveness of existing energy conservation standards. Certification and enforcement improvements will include updates to existing certification and reporting requirements for manufacturers along with increases in the frequency and scope of product testing to verify compliance with DOE standards.

66,802	98,250	+31,448
--------	--------	---------

SBIR/STTR are calculated based on research and development funding allocations.

4,513	6,455	+1,942
-------	-------	--------

Total, Building Technologies

219,204	310,000	+90,796
---------	---------	---------



**Explanation of Changes**

The major changes to the Innovation Subprogram is expanding the research to include low global warming potential (GWP) working fluids, alternative heating and cooling systems, and heat exchanger technologies and theoretical investigations of light generation and extraction at molecular scales as well more focused R&D in sensors and controls. The increase in the Emerging Technologies Subprogram will be focused on conducting new FOAs in the area of HVAC; building envelope and windows (including BIPV), and sensors and controls. We will also partner with the AMO program on a FOA to reduce the manufacturing costs of the most energy efficient products, such as SSL. Increases in the Systems Integration Subprogram will focus on demonstrating and testing new technologies in retrofitting commercial and residential buildings. The Market Barrier Subprogram continues to increase the scope and effectiveness of its energy conservation standards and test procedures.

**Funding Opportunity Announcement Background**

The Program posts current and past funding opportunities for all program areas, including research and development (R&D) for (old subprograms), systems integration, and market barriers projects at [http://www1.eere.energy.gov/buildings/financial\\_opportunities.html](http://www1.eere.energy.gov/buildings/financial_opportunities.html). Links to related opportunities from DOE

**Anticipated FOAs**

National Laboratories and other federal agencies are available. In carrying out its vision and mission, the Program conducts a broad portfolio of specific goal directed activities to transform America’s buildings sector by 2020, such that the efficiency of existing and new buildings has been significantly improved by 20 percent for commercial buildings and energy demand growth has been curbed through the development and deployment of conservation technologies, strategies, and practices. Improvements in energy efficiency are among the most cost effective and immediate steps toward achieving our national energy goals. Economy-wide efficiency can be achieved through the development of technologies, techniques and tools to create aggregated improvements in the U.S. building stock and make individual buildings more energy efficient, productive and affordable.

This open, competitive solicitation process is designed to meet the top technology needs identified by industry’s roadmaps and by program assessments. Funding opportunities encourage collaborative partnerships among industry, universities, National Laboratories, federal, state, and local governments and non-government agencies and advocacy groups. Solicitations, when available, include financial and technical assistance.

(Dollars in Thousands)

Fiscal Year	Technology Focus Area	Program Area of Focus	Projected Funding
FY 2012	Solid State Lighting Core Technologies – Round 8	Emerging Technologies	1,130
The objective of this opportunity is to conduct the applied research needed to fill technology gaps, provide enabling knowledge or data, and advance the technical knowledge base for Solid-State Lighting to be used for general illumination applications. Specific emphasis is given to achieving the performance and cost goals (including manufacturing related costs) stated in the annual Solid-State Lighting Research and Development: Multi-Year Program Plan (MYPP). The Energy Policy Act of 2005 (EPACT) directs the Secretary of Energy to support research, development, demonstration, and commercial application activities related to advanced SSL technologies. Under this authorization, this will be the 8th annual opportunity for Core Technology research. Breakout awards will be conducted with budget period decision points which include annual project peer review and evaluation with active go/no-go management. Successful awards will target relevant MYPP metrics such as internal quantum efficiency (IQE), external quantum efficiency (EQE), thermal stability, etc. It is anticipated that more than 30 applicants from academia, National Laboratories, small businesses, and other research institutions will apply.			
FY 2012	Solid-State Lighting U.S. Manufacturing – Round 3	Emerging Technologies	3,387
The objective of this opportunity is to achieve cost reduction of Solid-State Lighting for general illumination through improvements in manufacturing equipment, processes, or techniques. The goals are to reduce costs of SSL sources and luminaires; improve product consistency while maintaining high quality products; and encourage a significant role for domestic U.S. based manufacturing in this industry. Specific emphasis is given to achieving the performance and cost goals stated in the annual Solid-State Lighting Manufacturing Roadmap. EPACT directs the Secretary of Energy to support research, development, demonstration, and commercial application activities related to advanced SSL technologies. Under this authorization, this will be the 3rd annual opportunity for U.S. Manufacturing research. Breakout awards will be conducted with budget period decision points which include annual project peer review and evaluation with active go/no-go management. Successful awards will directly contribute to the 2015 goal of 110 lumens per dollar. It is anticipated that more than 30 applicants will apply.			

(Dollars in Thousands)

Fiscal Year	Technology Focus Area	Program Area of Focus	Projected Funding
FY 2012	Solid-State Lighting Product Development – Round 8	Emerging Technologies	1,693
<p>Project Description: The objective of this opportunity is to focus on the development or improvement of commercially viable Solid-State Lighting source, component, or integrated luminaire products. Technical activities are focused on a targeted market application with fully defined price, efficacy, and other parameters necessary for success of the proposed product. Specific emphasis is given to achieving the performance and cost goals (including manufacturing related costs) stated in the annual Solid-State Lighting Research and Development: Multi-Year Program Plan (MYPP). EPACT directs the Secretary of Energy to support research, development, demonstration, and commercial application activities related to advanced SSL technologies. Under this authorization, this will be the 8th annual opportunity for Product Development research. Breakout awards will be conducted with budget period decision points which include annual project peer review and evaluation with active go/no-go management. Successful awards will directly contribute to the 2015 goal of 154 lumens per watt. It is anticipated that more than 30 applicants will apply.</p>			
FY 2012	Heating Ventilation and Cooling	Emerging Technologies	1,600
<p>Competitive awards for HVAC, water heating, working fluids and appliance technologies that have high potential to provide 50 percent reduction in energy consumptions in 2020. These include but are not limited to researching low global warming potential (GWP) working fluids, Not-in-kind (NIK) technologies, heat exchanger technologies and advanced appliances. NIK technologies can replace or be integrated with conventional vapor compression technologies to provide 50 percent reduction in energy consumption with relevant environmental benefits. These different NIK technologies should be comparable or have better performance than state-of-art (SOA) vapor compression systems. Highly efficient heat exchangers developed by the Program are used not only in refrigeration, heating and air conditioning but also nearly every application that generates waste heat.</p>			
FY 2012	Advanced Building Envelope and Windows	Emerging Technologies	1,725
<p>Competitive awards for the Building Envelope and Windows sub-program for FY 2013 will support the goal for a reduction of 50 percent energy consumption in buildings by 2030. Additionally, these awards will be directed at projects within the innovation and emerging technology stages of commercialization that have also been identified as technologies with high potential impact. These may include but are not limited to: advanced materials for building technologies, highly insulating windows, dynamic windows, window films/attachments, thermal insulation, cool roofs and radiant barriers. Projects will address performance, cost and market goals to foster the acceleration of the technologies through the commercialization pipeline.</p>			
FY 2013	Solid-State Lighting Core Technologies – Round 9	Emerging Technologies	2,000
<p>The objective of this opportunity is to conduct the applied research needed to fill technology gaps, provide enabling knowledge or data, and advance the technical knowledge base for Solid-State Lighting to be used for general illumination applications. Specific emphasis is given to achieving the performance and cost goals (including manufacturing related costs) stated in the annual Solid-State Lighting Research and Development: Multi-Year Program Plan (MYPP). The Energy Policy Act of 2005 (EPACT) directs the Secretary of Energy to support research, development, demonstration, and commercial application activities related to advanced SSL technologies. Under this authorization, this will be the 9<sup>th</sup> annual opportunity for Core Technology research. Breakout awards will be conducted with budget period decision points which include annual project peer review and evaluation with active go/no-go management. Successful awards will target relevant MYPP metrics such as internal quantum efficiency (IQE), external quantum efficiency (EQE), thermal stability, etc. It is anticipated that more than 30 applicants from academia, National Laboratories, small businesses, and other research institutions will apply.</p>			
FY 2013	Solid-State Lighting U.S. Manufacturing – Round 4	Emerging Technologies	5,000
<p>The objective of this opportunity is to achieve cost reduction of Solid-State Lighting for general illumination through improvements in manufacturing equipment, processes, or techniques. The goals are to reduce costs of SSL sources and luminaires; improve product consistency while maintaining high quality products; and encourage a significant role for domestic U.S. based manufacturing in this industry. Specific emphasis is given to achieving the performance and cost goals stated in the annual Solid-State Lighting Manufacturing Roadmap. EPACT directs the Secretary of Energy to support research, development, demonstration, and commercial application activities related to advanced SSL technologies. Under this authorization, this will be the 4<sup>th</sup> annual opportunity for U.S. Manufacturing research. Breakout awards will be conducted with budget period decision points which include annual project peer review and evaluation with active go/no-go management. Successful awards will directly contribute to the 2015 goal of 110 lumens per dollar It is anticipated that more than 30 applicants will apply.</p>			

(Dollars in Thousands)

Fiscal Year	Technology Focus Area	Program Area of Focus	Projected Funding
FY 2013	Solid-State Lighting Product Development – Round 9	Emerging Technologies	3,000
<p>Project Description: The objective of this opportunity is to focus on the development or improvement of commercially viable Solid-State Lighting source, component, or integrated luminaire products. Technical activities are focused on a targeted market application with fully defined price, efficacy, and other parameters necessary for success of the proposed product. Specific emphasis is given to achieving the performance and cost goals (including manufacturing related costs) stated in the annual Solid-State Lighting Research and Development: Multi-Year Program Plan (MYPP). EFACT directs the Secretary of Energy to support research, development, demonstration, and commercial application activities related to advanced SSL technologies. Under this authorization, this will be the 9<sup>th</sup> annual opportunity for Product Development research. Breakout awards will be conducted with budget period decision points which include annual project peer review and evaluation with active go/no-go management. Successful awards will directly contribute to the 2015 goal of 154 lumens per watt. It is anticipated that more than 30 applicants will apply.</p>			
FY 2013	Heating Ventilation and Cooling	Emerging Technologies	9,285
<p>Competitive awards for HVAC, water heating, working fluids and appliance technologies that have high potential to provide 50 percent reduction in energy consumptions in 2020. These include but not limited to researching low global warming potential (GWP) working fluids, Not-in-kind (NIK) technologies, heat exchanger technologies and advanced appliances. NIK technologies can replace or be integrated with conventional vapor compression technologies to provide 50 percent reduction in energy consumption with relevant environmental benefits. These different NIK technologies should be comparable to or have better performance than state-of-art (SOA) vapor compression systems. Highly efficient heat exchangers developed by the Program are used not only in refrigeration, heating and air conditioning but also nearly every application that generates waste heat.</p>			
FY 2013	Advanced Building Envelope and Windows	Emerging Technologies/Systems Integration	10,000
<p>Competitive awards for the Building Envelope and Windows sub-program for FY 2013 will support the goal for a reduction of 50 percent energy consumption in buildings by 2030 in conjunction with Better Buildings Challenge. Additionally, these awards will be directed at projects within the innovation and emerging technology stages of commercialization that have also been identified as technologies with high potential impact. These may include but are not limited to: advanced materials for building technologies, highly insulating windows, dynamic windows, window films/attachments, thermal insulation, cool roofs and radiant barriers. Projects will address performance, cost and market goals to foster the acceleration of the technologies through the commercialization pipeline.</p>			
FY 2013	Sensors and Controls	Emerging Technologies	5,000
<p>Competitive awards in the area of Sensors and Controls will support the development of technologies that have the potential to provide energy savings in buildings through advanced sensing and controls solutions. More specifically, awards will be directed at projects within the emerging technology stage of commercialization with topics such as the development of enhanced sensor networks and/or a superior controls platform to optimize building energy performance.</p>			
FY 2013	Manufacturing	Emerging Technologies	5,000
<p>We will be working with the Advanced Manufacturing Office (AMO) to develop competitive awards and targeted technology development focused on reducing the manufacturing costs for some of the most energy efficient products. This technology and process development is very important in reducing consumer costs for these products, and thus increases the speed of market adoption. R&amp;D on these pre-commercial manufacturing technologies and processes will be selected based upon market opportunity of the products impacted by these improvements, as well as the technical opportunity to reduce the overall manufacturing costs for an industry sector(s), and will likely include SSL as one of the areas of focus.</p>			

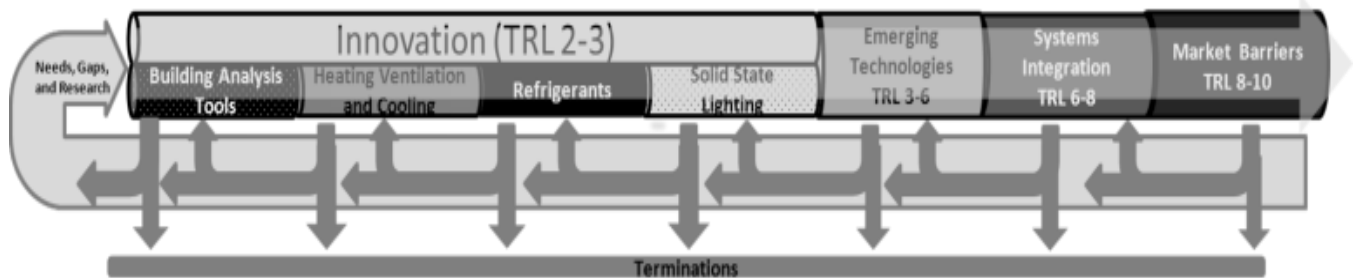
## Innovations

### Comparable Funding Profile by Subprogram

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Innovations	13,300	10,894	17,567
SBIR/STTR	0	351	550
<b>Total, Innovations</b>	<b>13,300</b>	<b>11,245</b>	<b>18,117</b>

#### Sequence



#### Description

The role of the Innovation subprogram is to move building technologies along the RDD&D continuum, including Technology Readiness Levels (TRL) levels 2-3, from basic research to establishing proof of concept. The Innovation subprogram activities address the technological barriers to improved energy efficiency in buildings. The subprogram supports research of lighting, heating, ventilation and cooling (HVAC) and sensors and controls. The Innovation activities accelerate research of highly efficient technologies and practices for both new and existing residential and commercial buildings. In moving technologies along the Technology Readiness Level pathway, the Building Program coordinates with the Office of Science and ARPA-E.

#### Key Technology and Focus Areas

The Innovations Subprogram focuses on examining and displaying proof of concept for potential energy efficient technologies. It relies on applied research to prove these concepts, and the Program is expecting to explore a number of technology areas in FY 2013. These include new concepts in lighting and heating/ventilation and cooling (HVAC), two of the largest energy using areas in today's buildings.

Solid State Lighting (SSL). The objective of lighting innovation efforts is to conduct the applied research needed to fill technology gaps, provide enabling knowledge or data, and advance the technical knowledge base for Solid-State Lighting (SSL) to be used for general illumination applications. Specific emphasis will be given to achieving the performance and cost goals stated in the annual Solid-State Lighting Research and Development Multi-Year Program Plan (MYPP).

Example areas of study include theoretical investigations of light generation and extraction at molecular scales; material properties of substrates, encapsulants, or polymers; software tools that capture scientific principles to expedite the decision process of design; modeling of heat transfer principles to estimate temperature profiles within a semiconductor reactor; and mapping of scientific principles that explain the interactions of dopants and hosts or metal alloys to create light of a specified spectrum. Goals for Core Technology Research are specific to the approaches proposed and relate to those metrics defined in the annual MYPP. A specific goal for FY 2013 is to demonstrate violet/blue laboratory semipolar LED devices with internal quantum efficiencies that exceed 80 percent at 150A/cm<sup>2</sup> and 100°C.

With regard to SSL, DOE desires to ensure that technologies resulting from Core Technology Research are readily available for product developers to license and also to encourage U. S. manufacture of such technologies. Therefore, recipients of core technology research have been granted an Exceptional Circumstances Determination under the Bayh-Dole Act. Under the Determination, all entities at any tier retaining patent rights to inventions made under resulting awards will be subject to a requirement to offer to each member of the Next Generation Lighting Industry Alliance (NGLIA) the first option to enter into a non-exclusive license upon terms that are reasonable under the circumstances, including royalties, for these inventions.

The NGLIA is a competitively selected industry group which was established by EPACT. It is anticipated that technology will advance from core technology research into the SSL product development research through this mechanism.

Space Conditioning and Refrigeration. The long-term goal for the Space Conditioning and Refrigeration Innovations activity is to research and gain the engineering proficiency to determine cost effective advanced Space Conditioning and Refrigeration technologies that have the potential to provide 50 percent reduction in energy consumptions by 2020. These technologies include researching low global warming potential (GWP) working fluids, Not-in-Kind (NIK) technologies, and heat exchanger technologies.

Current air conditioners, refrigerators, and heat pumps utilize compression cycle technology with high-GWP working fluids. Refrigerants and blowing agents are used in wide variety of appliances, air conditioning, and refrigeration equipment. New findings and policy developments regarding climate change are putting new pressures on the HFC alternatives, because of their high-GWP values (e.g., 1430 for HFC- 134a, 2088 for HFC- 410a). As a result of the need to find suitable alternatives for higher global warming refrigerants, a family of new low-GWP refrigerant molecules have been identified, most notably HFO-1234yf & HFO-1234ze. NIK technologies can replace, or be integrated with, conventional vapor compression technologies to provide 50 percent reduction in energy consumption with relevant environmental benefits.

The lower GWP effort will be to assess the overall environmental impacts for alternative refrigerants using a life cycle climate performance (LCCP) model based on such factors as leak rates and energy consumption. Candidate refrigerants will be modeled, tested, and evaluated to achieve alternatives with high energy efficiencies at minimal risk, cost, and changes to equipment.

Sensors and Controls. The Program is actively engaged in commercial building sensor and controls research to improve management effectiveness of building environments to achieve comfort, cost reductions,

security, and reliability in commercial and residential buildings. Sensors and Controls activities include:

- Improving buildings systems operations with innovative sensors for temperature, humidity, air flow, and motion/occupancy, light level, and carbon dioxide including fault detection and diagnostics for HVAC commercial units, self-correcting and self-configuring HVAC controls to compensate for faults in the system, and developing micro sensor units to accommodate multiple and varied sensor heads.
- Utilizing new energy harvesting/ storage technology to reduce the costs of purchase, installation, and maintenance of sensors and controls through an SBIR topic for new approaches.
- Developing and testing wireless, RFID, and other network relay and retransmission approaches to meet security, data integrity and validation, control system, and operator requirements, and evaluating commercial control goals and paradigms for effectiveness in actionably reducing energy use.
- Developing a more granular strategy for the Program to identify targets of opportunity for new technology projects, with other companies and organizations participating through an industry workshop.

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

#### **Benefits**

Innovation activities will identify and provide proof of concept for new, highly efficient technologies and practices for both new and existing residential and commercial buildings. Innovation activities support the Program's goals through R&D of advanced lighting, space conditioning, sensors and controls. Without advanced components and subsystems, such as the SSL technologies developed by these activities, the goal of maximizing cost effective energy efficiency in buildings will not be met.

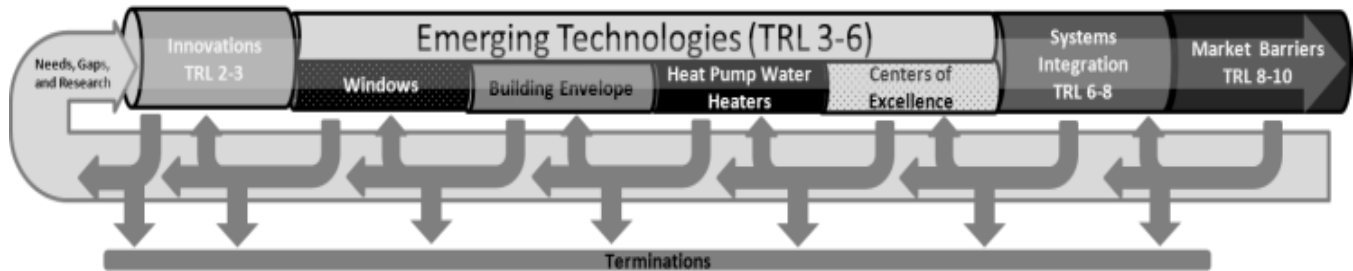
## Emerging Technologies

### Comparable Funding Profile by Subprogram

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Emerging Technologies	45,826	48,417	89,660
SBIR/STTR	0	1,500	2,856
<b>Total, Emerging Technologies</b>	<b>45,826</b>	<b>49,917</b>	<b>92,516</b>

#### Sequence



#### Description

The role of this Emerging Technologies Subprogram is to move building technologies along the RDD&D continuum, including TRL levels 4-6, from lab testing to prototype validation. Emerging Technologies activities support the development of advanced lighting, building envelope, windows, space conditioning, water heating, and appliance technologies and analysis tools; and accelerate the introduction of highly efficient technologies and practices for both new and existing residential and commercial buildings.

#### Key Technology and Focus Areas

The Emerging Technologies Subprogram is able to take those concepts proven in innovations and develop working prototypes through collaborative efforts with the national laboratories, universities and manufacturers. The Program is expecting to explore a number of new technology areas in FY 2013. These include new prototypes in lighting, HVAC, building envelope, water heating, and analysis tools.

Solid State Lighting. Emerging Technologies will conduct laboratory performance testing on SSL prototypes to evaluate product utility, market, health, and safety issues. Feedback from the owner/operator and technical data gathered from testing will be used to improve prototype designs. Further design modifications and re-testing will be performed as needed. Along with the technical aspects of product development, the Program will complete market and fiscal studies to ensure a successful transition from product development to demonstration and commercialization. To be positioned for success, new products must exhibit cost and/or performance advantages over commercially available technologies. New and continuing areas of study include substrate development, semiconductor material, phosphor development, LED

**Energy Efficiency and Renewable Energy/  
Building Technologies/Emerging Technologies**

package architecture, novel luminaires, low-cost electrodes, panel out coupling, and panel reliability.

Heating, Ventilation, and Cooling. The Program is also developing a CO2 Heat Pump Water Heater (HPWH) with an Energy Factor greater than 2.0 for residential applications. This HPWH activity will improve the energy efficiency and the use of low GWP refrigerants. Also this water heater will employ innovative techniques to adapt a mature water heating technology to the U.S. market requirements (specifications, cost, and performance targets). In 2008 residential water heating accounted for 3.03 Quads of primary energy<sup>a</sup>, of which 1.52 Quads are from electric water heaters. When fully deployed, the CO2 HPWH may provide up to 0.8 Quads of primary annual energy savings, equivalent to 47 million tons of CO2 emission reductions<sup>b</sup>, without the need for HFC refrigerants with much higher GWP.

A more efficient window air conditioner unit is also being pursued. Minimum efficiency levels for window air conditioners are currently set at 9.7 to 9.8 EER for the most popular product classes. A window air conditioner with an Energy Efficiency Ratio (EER) of 13 would result in a 25 percent energy savings. In addition, because of the low first cost of window air conditioners, typically in the \$300 to \$500 range, research will focus on cost effective improvements. In the U. S., there are approximately 57 million installed window air conditioning units with an estimated annual energy consumption of 0.33 quads. Since the first cost of an Energy Star unit (10 percent above NAECA standard efficiency levels) is generally the same as a

<sup>a</sup> 2010 building energy data book Table 2.1.5

<sup>b</sup> 2010 building energy data book Table 1.4.8

standard-efficiency model, window air conditioners provide an excellent opportunity for energy savings.

BTP will work with the Advanced Manufacturing Office (AMO) to develop competitive awards and targeted technology development focused on reducing the manufacturing costs for some of the most energy efficient products. This technology and process development is very important in reducing consumer costs for these products, and thus increases the speed of market adoption. R&D on these pre-commercial manufacturing technologies and processes will be selected based upon market opportunity of the products impacted by these improvements, as well as the technical opportunity to reduce the overall manufacturing costs for an industry sector(s), and will likely include SSL as one of the areas of focus.

A high efficiency Cold Climate Heat Pump (CCHP) that minimizes, or even eliminates, the need for backup strip heating is being explored. Resistive heating is limited to a 1.0 energy performance factor while multi-stage heat pump heaters can provide higher energy efficiency, i.e. significant energy savings over current technologies (> 70 percent compared to strip heating). The Program is also pursuing the development and market introduction of an air-source integrated heat pump (AS-IHP) suitable for new or existing residences with the technical potential to reduce annual HVAC, dehumidification, and water heating energy consumption by 50 percent. Analyses and testing at Oak Ridge National Laboratory (ORNL) indicate that this technology can approach the 50 percent energy savings goal over a range of climates for HVAC/WH in an energy efficient residential building when compared to a similar home operating with a baseline system consisting of current minimum efficiency HVAC and water-heating equipment. In FY 2012, the Program validated seasonal (heat/cool) predictions with field data in support of its market introduction and completed the engineering developmental stage for this effort and product demonstration is anticipated by late FY 2013.

Advanced Building Envelope and Windows. Additionally, with the building envelope technologies, the long-term goal is to enable dynamic annual performance of attics and walls equivalent to greater than R-40 performance with no increase in 30 year life cycle cost by 2015. The Program is developing advanced envelope materials in response to needs identified by the Systems Integration subprogram. The Program will conduct large scale whole house, full scale applications for insulation with phase change materials that offer thermal mass effects to dramatically reduce peak loading. In FY 2013, studies will be continued along with work on new ASTM test standards to provide a metric to market dynamic insulation systems.

Also, with window technology, there exists the potential to develop R-10<sup>a</sup> windows and reduce the incremental cost to \$3 per square foot by 2020 (the current industry average for R-10 windows is \$13 per square foot). Funds will support further applied R&D and market transformation activities to overcome technical, manufacturing and market barriers, thereby making highly insulating windows more cost competitive and enhance market penetration. For example, one such project will explore further development of vacuum insulated glass at low cost. The Program will also work on cost effective R-10 highly insulating windows with conventional low cost multi-pane designs, as well as higher risk, high performance vacuum glazing.

Building Energy Modeling. In FY 2013, the Program will continue to focus on developing enhanced modeling capabilities for whole buildings. The FY 2013 focus is expected to be on fully-general system control, district heating and cooling systems, and improved modeling of ducts, pipes, and plenums. These support the Program's goals of providing design and engineering practitioners with tools — Building Energy Modeling (BEM), in this specific instance — that allow them to build high-performance buildings and building systems. In FY 2013, the Program will focus on enhancing the credibility and robustness of building energy modeling, as well as reducing phase I modeling effort for existing buildings via automated model acquisition. The goals, respectively, are to increase confidence in building energy modeling and to facilitate the use of BEM in deep retrofit projects.

Commercial Building Energy Alliances. Emerging Technologies is also focused on commercial partnerships that seek out innovative and new technologies that might be unrepresented in the industry for direct deployment to CBEA and create market action via recruiting partners for demonstration projects who exhibit a commitment to energy targets, implementation schedules, building commissioning, performance evaluations and collaboration with other CBP partners. This effort will also work with partners and project teams to develop energy efficiency technology package and technical assistance services.

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

#### **Benefits**

Emerging Technologies activities will accelerate the introduction of highly efficient technologies and practices for both new and existing residential and commercial

---

<sup>a</sup> A measure of the capacity of a material, such as insulation, to impede heat flow, with increasing values indicating a greater capacity. A typical wall has an R-value of R-19 while the current off the shelf double paned window has an R-value of 2.

buildings. Emerging Technologies activities support BTP goals through R&D of advanced lighting, building envelope, windows, space conditioning, water heating, and analysis tools. Without advanced components and subsystems, such as the SSL technologies developed by these activities, the BTP goal of developing and deploying technologies, tools and codes and standards to achieve 50 percent building energy savings at half the cost of energy from new generating facilities by 2030 will not be met.

When fully deployed, the CO<sub>2</sub> HPWH may provide up to 0.8 Quads of primary annual energy savings, equivalent to 47 million tons of CO<sub>2</sub> emission reductions (2010 building energy data book Table 1.4.8), without the need for HFC refrigerants with much higher GWP.

Cumulative energy savings potential of 2.5 quads for the period 2010 – 2035 are estimated for a 13 EER window air conditioner compared to typical new units with an EER of 9.8. One quad is roughly equivalent to 1% of annual energy use in the U.S.



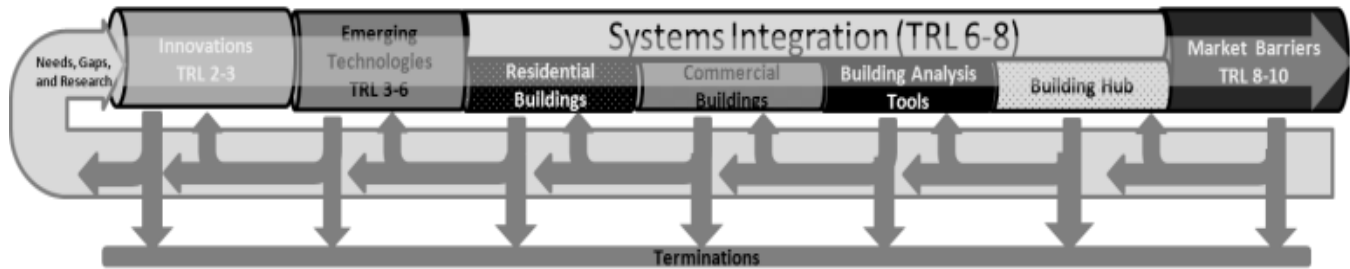
## Systems Integration

### Comparable Funding Profile by Subprogram

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Systems Integration	91,184	88,578	98,068
SBIR/STTR	0	2,662	3,049
<b>Total, Systems Integration</b>	<b>91,184</b>	<b>91,240</b>	<b>101,117</b>

#### Sequence



#### Description

The Systems Integration Subprogram serves as the proving ground for emerging energy efficiency technologies and practices, many of which are developed in prior years by the Emerging Technology Subprogram. This subprogram moves the various technologies along the TRL continuum, where each activity is focused on demonstrating that a technology (or suite of technologies) will work in its final form and under expected conditions. It also includes demonstrations of actual system prototypes as an input into the final stage.

#### Key Technology and Focus Areas

The Systems Integration subprogram focuses on demonstrating and testing new technologies, both those developed by DOE as well as new technologies from academia and industry. Each technology is demonstrated and tested in “real world” settings to understand how they perform.

#### COMMERCIAL

**Better Buildings Challenge.** A priority is the implementation of innovative approaches to retrofits and the attraction of industry investment in commercial buildings through the Better Buildings Challenge. The Program is supporting the implementation of the Better Buildings Challenge to deploy successful models that increase investment in commercial building energy efficiency and improve this efficiency by at least 20 percent by 2020. It is also participating in a joint research effort with Emerging Technologies to develop advanced envelope and window technologies for commercial building retrofits.

**Superior Energy Performance and Global Superior Energy Performance.** To support the robust challenge to corporations to continuously maintain energy improvements they have achieved in their properties in the commercial and industrial sectors, DOE will accelerate the introduction of the Superior Energy Performance program (SEP), the national program being implemented in alignment with the GSEP initiative. GSEP was announced internationally as part of the Clean Energy Ministerial and will coordinate national level certification programs. These voluntary programs will require commercial facilities to implement energy management systems such as the ISO 50001 energy management standard and related measurement and verification protocols. To deploy the program, region-focused and specialty-focused extension centers will develop energy management systems tools and resources and certification materials to use nationally and share internationally in support of the GSEP. Once companies take up the challenge to make and maintain energy efficiency improvements, corporations’ acceptance and action on the challenge will then create demand within the commercial retrofit marketplace.

**Commercial Building Energy Alliances.** The Program will also work with industry via technical support to stimulate demand for and deployment of more efficient commercial building technologies through Commercial Building Energy Alliance (CBEA) membership. Activities include:

- Deploying energy-saving technologies in partnership with industry members via CBEA high-efficiency technology specifications (Commercial Roof Top Units (RTU), Lighting, Refrigeration, etc.)

- Disseminating sector-specific technical information and guidance to assist industry members in improving the efficiency of their existing building portfolios
- Demonstrating cost-effective new construction and retrofit techniques to achieve deep energy savings (30-50 percent above code)
- Demonstrating the impact of energy management and continuous improvement encouraged by SEP program

Systems Integration is also establishing a reliable/reputable national commercial building disclosure method and associated asset and operational ratings. Activities include:

- Development and validation of a low cost building asset rating method with a required minimal amount of data collection
- Development and validation of an operational rating that can be directly tied to asset rating
- Development of a standard database design for state and local governments to use in holding the building energy information they receive as a result of disclosure ordinances

In FY 2013, BTP will also continue to invest in research and deployment activities in the areas of building operations, maintenance, commissioning, and auditing. The Commercial Buildings Program will extend its work with NIST's commercial building extension program with universities. This partnership will allow university students and professors to work within their communities to grow the auditing, operations, and commissioning activities with local businesses. It also provides a national network for easily disseminating information and data regarding commercial building retro-commissioning and retrofits. In FY 2013, CBI will fund 8 extension programs with universities and community colleges.

#### RESIDENTIAL

Building America Program. For Residential technologies and systems, the Program relies on the Building America Program to conduct energy efficiency technology evaluations. Building America is an industry-driven research program designed to accelerate the development and adoption of advanced building energy systems for existing and new homes. Building America research teams work with all segments of the residential building industry to develop, analyze, and implement strategies that achieve significant energy savings. Building America addresses residential building system integration R&D through private/public research partnerships focused on accelerated development of cost-effective and reliable market-driven solutions that

benefit consumers by reducing utility bills by 30-50 percent. Building America has expanded to include integration research on existing homes; has identified the most cost effective measure packages to achieve 15 percent energy savings; and enabled/demonstrated cost effectiveness and reliability of systems required to meet the International Energy Conservation Code (IECC) 2012 code revision. Building America industry teams will focus on system research required to achieve the 30 percent source energy savings on a community scale nationwide, relative to current code IECC 2009 for new construction and pre-retrofit conditions for existing homes. Building America will also support accomplishment of BTP goals by accelerating the development of 50 percent energy savings solutions to be integrated into test homes in future years.

BetterBuildings Neighborhood Program. The BetterBuildings Neighborhood Program is using \$508 million of ARRA and FY 2010 appropriation to fund 41 state and local governments to test innovative models for energy efficiency retrofit program delivery that overcome market barriers to consumer-driven energy efficiency. The Program is developing self-sustaining markets through outreach and sharing of successful and replicable business models for delivering low cost retrofits. DOE will integrate Home Performance with ENERGY STAR as well as State Energy Efficiency Action Project (SEE Action) into the BetterBuildings Neighborhood Program. BTP will continue to evaluate BetterBuildings Neighborhood Program grantee business models and assist them in successfully transitioning their grant-funded programs into sustainable models capable of delivering home energy efficiency upgrades to consumers.

Home Energy Score. The Home Energy Score was developed to help homeowners easily and affordably compare their homes' energy performance with other homes in the same area, similar to a vehicle's mile-per-gallon rating. It was established in response to a 2009 request from the Vice President and White House Council on Environmental Quality, and in November 2010, after a year of homeowner and expert research and development, the U.S. Department of Energy (DOE) launched pilot tests. To ensure the effectiveness of the new scoring method, DOE is partnering with utilities, non-profit organizations, and state and local governments across the country to test the program through summer 2011.

DOE completed a set of successful pilots for the Home Energy Score in the summer and fall of 2011. The tests indicated homeowner preference for the tool, ease of use by the home auditor, and results that agreed with comparable but more expensive auditing tools. The results also allowed BTP to make improvements in the

presentation of the results to homeowners, and to improve several internal calculations for more accurate results. Upon completion of the pilot phase in which between 1,000 and 2,000 homes will have been scored, DOE hopes to complete 10,000 scores in 2013. DOE aims to complete 10,000 scores in 2013 by working with home energy raters, building performance contractors, home inspectors and other home improvement professionals who have demonstrated competence in the use of the tool. It is through this network of qualified technicians that BTP plans to meet this goal of 10,000 score in 2013. BTP will roll out the Home Energy Score to this network in 2012.

Building Innovation Hub. The Building Innovation Hub identifies and assesses relevant technologies for integrated building systems, subsystems, components, sensors, controls, and diagnostics necessary for scalable retrofit solutions that can meet the stringent economic demands of the whole-building retrofit market with the expectation of substantial market penetration capabilities.

- Assessment of the value of measured indoor environment characteristics including lighting levels and spectral distribution, air quality (particle counts and humidity ratios), and sensible temperatures relative to occupant satisfaction.
- Assessment of the value of energy efficient building retrofits addressing factors such as occupant health, safety and security, community well-being, and worker productivity, creativity and innovation, as well as reduced energy consumption.

Building Energy Modeling. Building energy modeling (BEM) is one method to demonstrate to consumers the potential benefits of energy efficiency technology. The Program is focused on reducing the cost of BEM, thus enhancing its business case and encouraging its productive use in a greater number of projects, for both new construction and deep retrofits. The current too-high cost components of BEM are data gathering and entry, and model calibration. Slow execution speed is also a detriment in some scenarios, e.g., value engineering. We are addressing the data issues with

data schemas that connect BEM to Computer Aided Design (CAD) tools and other simulation engines and databases of simulation-ready component data. The pre-computed performance maps —and some of innovation/emerging technology work undertaken in FY 2012 to utilize them — will address calibration.

BEM is a key tool in designing buildings and building retrofits with aggressive energy targets. Buildings are complex systems whose total performance is due as much to interactions between sub-systems as it is to the individual performance of these sub-systems. The complete building system cannot be understood and optimized without detailed simulation. The classic example is the combined use of (natural) day lighting with dimming controls on the electric lights. The combined effects include reductions in lighting electricity use and heat gain from lights, but also increased heat gain through larger windows and more open spaces.

Calculating the net effect on cooling and heating loads requires quantitatively balancing these concerns while taking building program requirements and local weather conditions into account. For a given building, detailed energy simulation is the only reasonable way of doing this — physical experimentation is prohibitively expensive.

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

#### **Benefits**

The Program's Systems Integration activities will validate energy efficient technologies and solutions that improve the performance of residential and commercial buildings. These activities and outputs lead directly to decreased energy use in homes and businesses, contributing to the Department's goal of transforming our energy systems, reducing carbon emissions, contributing to the Administration's goal to reduce energy related greenhouse gas emissions by 17 percent by 2020, and lower energy bills.

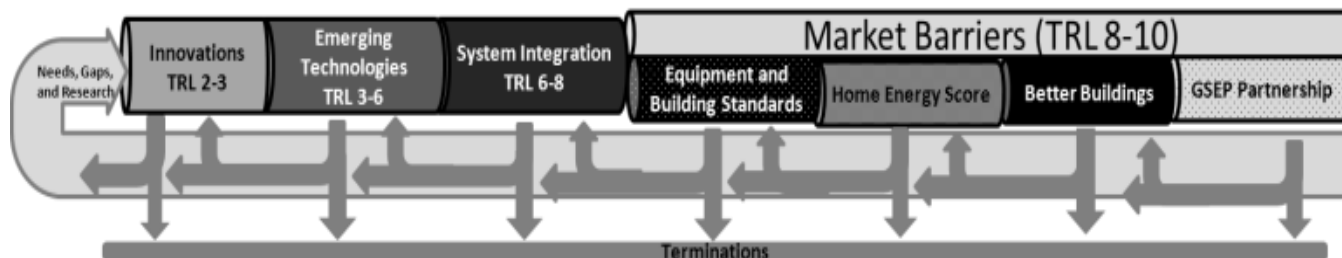
## Market Barriers

### Comparable Funding Profile by Subprogram

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Market Barriers	57,000	66,802	98,250
SBIR/STTR	0	0	0
<b>Total, Market Barriers</b>	<b>57,000</b>	<b>66,802</b>	<b>98,250</b>

#### Sequence



#### Description

The Program's activities under Market Barriers address market failures in the adoption of energy efficient technologies, through both market priming activities as well as regulatory activities, which identify cost-effective solutions for building equipment and new model construction energy codes. Appliance standards, accelerated development and adoption of new model building codes, building labels, and other methods will accelerate adoption of new efficiency technologies.

#### Key Technology and Focus Areas

The Program's Market Barrier activities focus on providing information to the market to facilitate the adoption of energy efficient technologies while also saving consumer's energy and dollars through regulatory activities such as Federal energy efficient equipment standards and energy efficiency model building codes.

Equipment Standards. Equipment standards and analysis activities lead to improved efficiency of appliances and equipment by conducting analyses and developing standards that are technologically feasible and economically justified. Since minimum standards effectively eliminate non-efficient products from the market place, equipment standards contributes to the goal by ensuring energy efficient technologies are purchased, installed and operated. In FY 2013 DOE will continue to take all necessary and feasible steps to finalize legally required efficiency standards consistent with all applicable judicial and statutory deadlines. DOE will build upon prior year activities by accelerating or initiating new energy conservation standards, test procedures, and labeling rulemakings for certain types of consumer products and commercial equipment. Several

of the new products for which DOE has identified rulemaking opportunities include commercial fans, blowers, and pumps, as well as certain types of consumer electronic equipment. With the funding increase, DOE expects to have the ability to conduct 6 additional energy conservation standards rulings, which could potentially save consumers \$100 billion on their energy bills over 30 years. DOE will pursue these new rulemakings following a well-defined schedule and plan that allows sufficient time for comprehensive review. .

Building Codes. For Building Codes, in FY 2011 DOE issued the final determinations for the IECC 2009 (and 2006 and 2003), as well as ASHRAE 90.1-2007 and ASHRAE 90.1 2010. DOE also developed and deployed compliance tools and pilot programs to assist states with establishing a compliance baseline, and achieved 30 percent improvement in national model energy building codes using the 2006 IECC as the baseline for residential and ASHRAE 90.1 2004 as the baseline for commercial building. In FY 2012, DOE will provide technical assistance to States to adopt, update, implement, and enforce their energy codes to meet the 2009 IECC and Standard 90.1-2010; issue the final determination for the 2012 IECC, the Notice of Proposed Rulemaking (NPR) for Manufactured Housing Standard, and the final rule for Sustainable Design and Fossil Fuel; and initiate analyses and support for upgrading the next generation of IECC and ASHRAE 90.1 codes and standards with an increased emphasis on cost-effectively achieving 50 percent energy savings over the baseline. For FY 2013, DOE will build upon prior year activities to achieve the 50 percent upgrade of the IECC and ASHRAE 90.1 and provide significant technical assistance to states for code adoption and compliance.

Better Buildings Challenge. The Program’s market barrier activities support the implementation of the Better Buildings Challenge to deploy successful models that increase investment in commercial building energy efficiency and improve this efficiency by at least 20 percent by 2020.

Energy upgrades performed in the commercial building market are currently impacted by a variety of barriers including lack of public awareness, lack of successful models, lack of private sector investment, and lack of overall knowledge of proper specifications or resulting impacts. The BetterBuildings Challenge addresses a multitude of barriers by deploying successful cost-effective retrofits and market-tested implementation models that make energy performance and assessments more transparent and understandable, demonstrate integrated building systems, and promote public and private sector commitments to energy efficiency investments. Through research and development, technical assistance, resources, and grants, the Program supports the implementation of the BetterBuildings Challenge: to deploy successful models of public–private partnerships to increase investment in commercial building energy efficiency and to assist building owners and private sector investors in identifying cost effective options for integrated energy upgrades.

The Program’s Market Barrier activities also include the Building Performance Database and the Energy Performance and Disclosure Platform, two tools to provide greater ability for investors and building owners to predict and insure energy savings from retrofit projects.

Building Innovation Hub. The Buildings Innovation Hub is focused on developing tools for integrated design; integrated technologies and systems; policy, markets, and behavior; and commercialization and deployment. These areas address the vision established by DOE to advance “highly promising areas of energy science and engineering from the early stage of research to the point where the technology can be handed off to the private sector.” The Hub, located at the Philadelphia Navy Yard, will function as a living laboratory for collaborative development and demonstration of new system integrated and operational technologies, policies, business models, and process integration methods spanning design, construction, commissioning and operation. Activities include:

- Document quantified improvement in occupant health and safety and worker productivity, as well as reduced energy consumption in retrofitted buildings.
- Begin to assist building component and system manufacturers in Greater Philadelphia to produce cost-effective and optimized whole building systems

for installation in retrofitted buildings by building type.

- Identify existing and proposed public policies and practices at local, state, and national government levels influencing integrated energy efficient retrofit of average size commercial and multi-family residential buildings in Greater Philadelphia.
- Work with building owners, educational institutions, labor, workforce investment boards, and others to meet the demand for building operators with the skills needed to operate buildings with sophisticated controls, HVAC and lighting management systems.

Solar Decathlon. The Solar Decathlon is an award-winning program that challenges collegiate teams to design, build, and operate solar-powered houses that are cost-effective, energy-efficient, and attractive. The winner of the competition is the team that best blends optimal energy production and maximum efficiency with affordability, consumer appeal, and design excellence. The first Solar Decathlon was held in 2002; the competition has since occurred biennially in 2005, 2007, and 2009. The FY 2011 event was held on the National Mall’s West Potomac Park in Washington, D.C. September 22 through October 2, 2011. The overall goal of the Solar Decathlon is to raise public awareness about affordable clean-energy products that are available today to save money and reduce energy use. The Program accomplishes this goal by holding a fair and safe competition, supported by effective industry and association partnerships, and disseminating key messages to the public.

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

### **Benefits**

Equipment Standards and Analysis activities lead to improved efficiency of appliances and equipment by conducting analyses and developing standards that are technologically feasible and economically justified. In 2013, the Program will complete 7 final rules. Test procedures and energy conservation standards developed by this subprogram correlate directly to energy policy objectives, such as increasing energy savings, reducing peak electricity demand, and reducing carbon emissions. According to a study commissioned by DOE and prepared by Lawrence Berkeley National Laboratory, a typical household saved approximately

\$175 in utility bills per year due to the standards promulgated by DOE.<sup>a</sup>

Building Energy Codes activities include submitting code proposals, supporting the upgrading of model building energy codes, and providing technical and financial assistance to States to update, implement, and enforce their energy codes to meet or exceed model codes in support of Section 304 of ECPA. It also promulgates standards for manufactured housing as required by Section 413 of EISA. These activities and outputs increase the energy performance of newly constructed homes and commercial buildings, assist consumers in reducing energy bills, and contribute to job creation in the construction industry.

Solar Decathlon is a high-profile university competition that promotes public awareness of highly efficient building technologies and energy efficient homes using solar energy. The competition fosters innovation and encourages incorporation of new building technologies and design practices into engineering and architecture university curricula.

---

<sup>a</sup> Lawrence Berkeley National Laboratory, Energy and Economic Impacts of U.S. Federal Energy and Water Conservation Standards Adopted from 1987 through 2010, Publication forthcoming.