

The Building Technologies Office (BTO) supports research and development (R&D) and validation of cutting-edge energy technologies and practices that save American consumers and businesses money, improve building performance, reduce waste, and increase comfort and the quality of life.

Economic Highlights

BTO stimulates job growth and U.S economic competitiveness by developing and demonstrating next-generation energy-efficient technologies and building operational practices.

- In 2016, 2.2 million Americans were employed in energy efficiency, an increase of nearly 300,000 over 2015. Six in 10 work at construction firms installing or servicing energy-efficient products or performing related services.
- The manufacture, installation, and services tied to efficient building technologies supported by BTO research represents close to 80% of the total energy efficiency workforce.
- Advances in BTO-supported light-emitting diode (LED) lighting have added \$478 million to the domestic economy and created opportunities for U.S. global competitiveness.

BTO research studies and market-driven solutions result in energy and cost-saving improvements.

- Residential energy efficiency advances from BTO's Building America program have saved American households \$54 billion. For every \$1 spent, homeowners saved \$170 in contractor-installed, energy-saving technologies and building systems.
- BTO-led studies revealed that U.S. homeowners and businesses could save \$126 billion in energy costs between 2010 and 2040 through adoption of the latest building energy codes.

BTO leverages private-public partnerships to increase market adoption of next-generation energy-efficient technologies.

- Since 2013, BTO's Advanced Rooftop Unit Campaign has enabled 250 public and private sector organizations to upgrade 70,000 building units with high-efficiency replacements or advanced controls, saving \$108 million and 11 trillion British Thermal Units (BTUs) of energy.
- As of 2016, partners in BTO's Better Buildings Challenge saved \$1.9 billion from energy savings of 240 trillion BTUs. This voluntary public-private partnership accelerates investments in tools to assess building efficiency, savings opportunities, and financing options.

FY 2018 Priorities

FY 2018 Program Focus

- Early-stage R&D of next-generation transformative, energy-saving building technologies and systems.
- More efficient electricity and energy resources use in building systems and technologies, improving cyber security and resilience of buildings-to-grid interface, and establishing minimum energy efficiency standards.

Activity Highlights

- Heating, Ventilation, Air Conditioning, and Refrigeration (HVAC&R) R&D – Solid state cooling materials and non-vapor compression solutions, such as solid-state heating, cooling, and refrigeration.

- Solid-State Lighting (SSL) R&D – Critical challenges of semiconductor physics of LED and organic LED (OLED) technologies, such as emitter materials, high-efficiency wavelength conversion, and deposition and device fabrication processes.
- Commercial and Residential Building Integration R&D – Integrated component research into efficient building construction and retrofit design principals (e.g. Building America, Zero Energy, Home Energy Score, Evaluation, Measurement, and Validation).
- Buildings-to-Grid R&D – Cyber physical systems for buildings, such as advanced communication platforms and data management systems, digital sensing, monitoring, and controls.

FY 2018 Budget Request

Budget Authority (Dollars in Thousands)	FY 2018 Request
Building Energy R&D	29,500
Commercial Buildings Integration	5,500
Residential Buildings Integration	6,500
Equipment and Buildings Standards	26,000
Total, Buildings Technologies Office	67,500

BTO saves Americans money and improves the quality of life by researching and developing building equipment technologies and systems that reduce the energy used in buildings.

Major Accomplishments and Goals

BTO supports R&D for high-performance, cost-effective technologies used by multiple industries and consumers.

- BTO-sponsored SSL R&D helped improve the performance of white LED products from 20 lumens per watt (equivalent to a traditional incandescent bulb) to more than 160 lumens per watt in over 100 commercially available products.
- Utilization of advanced modeling and 3D printing aided in development of a new heat exchanger prototype that is lighter and more efficient, and can be manufactured faster. Heat exchangers are used across millions of product lines.
- Wide use of energy management and information systems (EMIS) in commercial buildings could save 1 Quad, equivalent to 10^{15} BTUs. BTO expertise assists partners representing 55 million square feet of space.
- BTO and industry implemented statutory efficiency standards and innovations that are expected to save consumers more than \$1 trillion by 2020. As a result, U.S. competitiveness in the appliance and equipment market is ensured as foreign-made products must comply with the same rules as domestic manufactured models.

BTO-supported R&D improves productivity, health, and comfort in American homes and buildings.

- BTO's long-term goal of reducing energy use intensity by 50% could have tangible economic impacts; between 2016 and 2030, consumers could save \$460 billion through –
 - Advanced HVAC R&D to establish the U.S. as a global leader in manufacturing next-generation HVAC systems and engage in new domestic and global markets.
 - Develop and optimize existing hardware and software infrastructure via connectivity and advanced automation for smart buildings to unlock energy and cost savings.
 - Foundational R&D to reduce the growing fraction of building energy usage from miscellaneous electrical loads.
 - Partnerships with industry developing and validating physics-based whole building modeling tools to support the design and operation of cost-effective, energy-efficient buildings.
 - Enable cost-effective design and construction of high-performance homes and commercial buildings that use 50% less energy compared to the average in 2010.

Success Stories

BTO's leadership in SSL ensures U.S. competitiveness in an increasingly popular and efficient technology.

- In the past decade highly BTO strategic investments helped make the U.S. the epicenter for LED and other SSL innovations.
- BTO-supported R&D has resulted in 270 patents and more than 220 commercially-available products, including SSL lamps, luminaires, LED components, power supplies, and manufacturing tools.
- In 2016, installation of common LED bulbs more than doubled, from 77 million to 202 million. In 2015, LED installations saved homeowners and businesses more than \$2.8 billion in energy costs.
- Despite rapid advances, more than 95% of SSL energy savings potential remains untapped.
- BTO R&D priorities include further efficiency and light system performance improvements through materials R&D and advancing understanding of semiconductor physics critical to LED and OLED advances.



HVAC consumes nearly 40% of energy used in buildings. BTO's early-stage HVAC&R work advances energy efficient consumer choices and promotes scientific leadership.

- BTO works to accelerate the development of next generation HVAC&R technologies.
- The U.S. could save 50% to 90% for HVAC&R technologies optimized for specific climates and applications. A BTO-sponsored cold-climate heat pump prototype has demonstrated 40% energy savings in field tests, without a cost-premium.
- Today's HVAC&R technologies are based on 100-year old vapor compression technologies. BTO-supported R&D has developed next-generation non-vapor compression technologies, including the prototype electrochemical compressor, which is a solid-state technology that uses water as the cooling fluid. Developed for use in water-heaters, it could save 25% more energy than other state-of-the-art models and be used in many other applications.
- In response to industry's request for the safe use of new refrigerants, BTO is working to support updated safety standards for widespread domestic use and international export by U.S. industry. BTO builds on past research for energy saving and cost-effectiveness of new refrigeration systems in southern U.S. climates and energy-efficient drop-in advanced refrigerants.