

Building Technologies Program Overview

Introduction

Today's buildings consume more energy than any other sector of the U.S. economy, including transportation and industry. In 2006, it took approximately 39 quadrillion Btu (quads) of energy to service the 113 million households and 74.8 billion square feet of commercial floor space in the United States—almost 39% of total U.S. energy consumption.¹ And as the U.S. population grows and the economy shifts and expands, the demand for energy will only increase. The Energy Information Administration (EIA) estimates that energy consumption in buildings—primarily electricity and natural gas—will exceed 50 quads in the next two decades.²

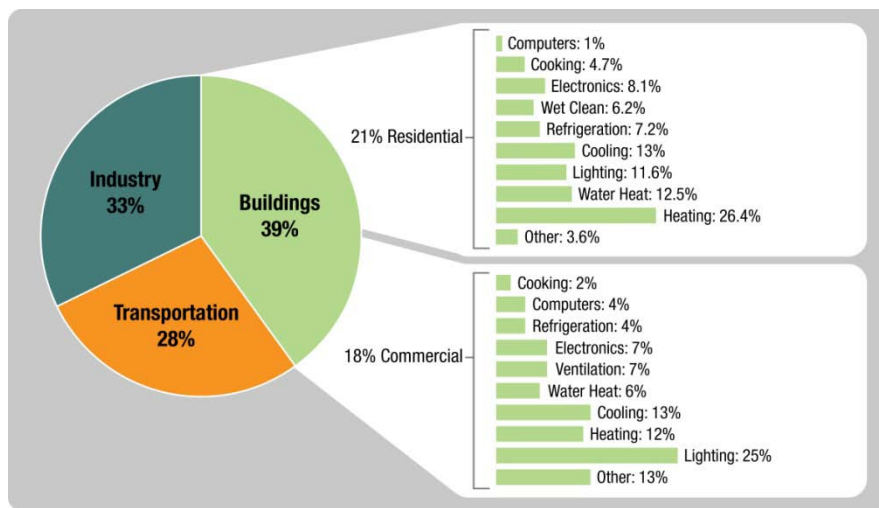


Figure 1. U.S. primary energy consumption, 2006³

Investment in energy efficiency research and development (R&D) within the buildings sector could significantly reduce energy consumption. But private-sector R&D has been minimal at best, largely because of the different types of firms that construct or operate buildings (e.g., manufacturers, designers, builders, subcontractors, and suppliers). Because their business goals and priorities are so varied, their abilities or incentives to build cost-effective, energy efficient buildings are limited.

As the lead federal agency responsible for increasing energy efficiency and reducing carbon emissions in the buildings sector, the Building Technologies Program (BTP) is working in collaboration with the private sector, funding research, development, and demonstration (RD&D) activities through public-private partnerships. In addition to helping industry partners develop the techniques and strategies for implementing today's

¹<http://buildingsdatabook.eren.doe.gov/ChapterView.aspx?chap=1#1>, accessed August 2009.

² http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/myp08overview_ch1.pdf, accessed August 2009.

³ Buildings Energy Data Book <http://buildingsdatabook.eren.doe.gov/>

energy efficient building technologies, the program funds high-risk, precompetitive research in the early phases of development. As activities progress from developing technology to validating technical goals, the government's cost share will diminish as private industries and institutions begin to take on the costs. BTP helps to bring technologies to the point where the private sector can successfully integrate them into buildings and the commercial market.

In addition to compensating for the obstacles to private-sector investment in building R&D, BTP plays a regulatory role in protecting consumers from products that utilize costly amounts of energy or harm the environment as a result of their use. The program establishes efficiency standards for energy-consuming equipment used in residential and commercial buildings under the authority of the Energy Policy and Conservation Act of 1975, as amended. Program representatives also assist in devising and promulgating building codes—targeting energy conservation—that fall under state and local jurisdiction.

Program Mission, Goals, and Objectives

To support national goals of greater energy independence and a cleaner environment, BTP embraces its mission to develop technologies, techniques, and tools for making residential and commercial buildings more energy efficient, productive, and affordable. BTP researchers carry out the program's mission by working to improve the energy efficiency of individual building components, equipment, and integrated whole-building systems. In addition, they explore ways to integrate renewable energy systems into building design and operation and to accelerate the adoption of these technologies and practices.

BTP's long-term strategic goal is to create technologies and design approaches that lead to marketable zero energy homes (ZEHs) by 2020 and zero-energy commercial buildings (ZEBs) by 2025. A net-zero-energy building requires significantly less energy because of efficiency gains (60% to 70% less than a conventional building), with the balance of energy requirements supplied by renewable technologies. These efficiency gains also find application in buildings currently being constructed, resulting in immediate energy savings.

Approaches to Achieving Energy Efficiency Goals

The program takes a three-pronged approach, described in the sections that follow and illustrated in Figure 2. The overall goal is to propel the buildings sector toward more energy efficient buildings that also incorporate renewable power technologies.

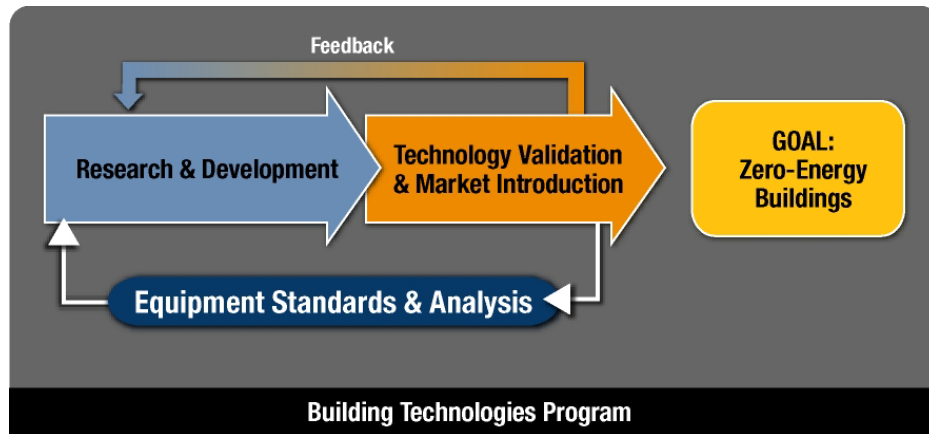


Figure 2. How the three areas work together toward the zero-energy goals⁵

Research and Development

BTP’s residential buildings R&D efforts focus on improving the efficiency of the approximately 1.5 to 2 million new homes built each year in the United States, as well as the more than 100 million homes that already exist. The program has two major residential building R&D targets: (1) developing climate-specific and cost-effective technology packages that achieve an average 40% reduction in whole house energy use by 2010, and (2) developing technologies and solutions that lead to a 70% reduction in energy use in new homes by 2020.

On the commercial buildings front, BTP researchers are exploring energy savings opportunities in new and existing commercial buildings. In collaboration with industry, BTP will develop, document, and disseminate technology packages to help builders reduce energy use by 30% in new, small- to medium-sized commercial buildings by 2010. Program researchers are also developing a set of initial technology options as a basis for achieving a 50% energy use reduction in commercial buildings.

Finally, BTP researchers are working to accelerate the development and integration of technologies for new and advanced lighting, building envelopes, windows, space conditioning, water heating, and appliances.

Equipment Standards, Guidelines, and Analyses

BTP’s standards subprogram conducts activities in three specific areas: test procedures, mandatory energy conservation standards, and labeling.

To improve the efficiency of appliances and equipment, program researchers conduct analyses and develop national standards that are technologically feasible and economically justified. Such codes, standards, and guidelines can increase the minimum efficiency levels of integrated building systems and save significant amounts of energy. By 2010, BTP will issue several formal proposals for enhanced product standards and test procedures.

⁵ http://www1.eere.energy.gov/buildings/program_areas.html, accessed August 2009.

Technology Validation and Market Introduction

BTP administers several programs designed to accelerate the adoption of energy efficient and renewable energy technologies, including EnergySmart Schools, EnergySmart Hospitals, Building Energy Codes, and the Solar Decathlon.

BTP's **EnergySmart Hospitals** and **EnergySmart Schools** programs are helping health care and educational institutions put funds previously spent on energy into patient care and school improvements. The nation's 8,000 hospitals are among our most complex, diverse, and energy-intensive facilities, spending more than \$5 billion a year on energy and producing approximately 30 pounds of carbon dioxide (CO₂) emissions per square foot.⁶ Clearly, there's much room for improvement in hospital energy use. And schools spend more on energy than any other expense except personnel. High-performance, energy efficient schools can lower a school district's operating costs by as much as 30%, without sacrificing educational quality.⁷

In support of the Energy Conservation and Production Act, Section 304, BTP's Building Energy Codes segment offers technical and financial assistance to states to update and implement their energy codes and boost the construction of more energy efficient buildings.

BTP also sponsors the Solar Decathlon, a high-profile university competition held biannually on the National Mall in Washington, D.C. The competition showcases highly efficient building technologies, ZEHs, and almost all forms of renewable energy. BTP invests in innovations highlighted during the competition, ranging from energy efficient, whole-building design approaches, through advanced window and building envelope technologies, to heating and cooling equipment, appliances, and lights.

In addition, BTP partners with the Environmental Protection Agency on ENERGY STAR[®] activities to remove technical, financial, and institutional barriers to the widespread awareness, availability, and purchase of highly efficient appliances, compact fluorescent lighting (CFL) products, windows, and other new or advanced products. For example, BTP has targeted increasing the market share of ENERGY STAR windows to 65% by 2010 and maintaining the 28% market share for ENERGY STAR appliances.

BTP Research Team and Partners

For **residential buildings**, BTP sponsors **Building America**, an industry-driven research program aimed at accelerating the development and adoption of ZEH technologies in new and existing homes. Building America research teams, made up of key members of the building industry involved in the production of advanced residential buildings, conduct systems engineering research to develop technologies and strategies to construct homes—on a community scale—that use 40% to 100% less source energy. The teams include:

⁶ <http://www1.eere.energy.gov/buildings/energysmarthospitals/>, accessed August 2009.

⁷ <http://www1.eere.energy.gov/buildings/energysmartschools/>, accessed August 2009.

- The **Building America Industrialized Housing Partnership (BAIHP)** collaborates with factory builders, affordable housing providers, and other builder partners primarily in the Southeast and the Northwest.
- The **Building Industry Research Alliance (BIRA)**, which operates primarily on the West Coast, consists of more than 80 industry partners representing a wide variety of builders, architects, manufacturers, state energy offices, utilities, and representatives from all aspects of the new residential homebuilding industry.
- The **Building Science Consortium (BSC)** members are helping in the construction of energy and resource efficient homes and communities that sustain affordable, high-quality living environments.
- The **Consortium for Advanced Residential Buildings (CARB)** works with scores of professionals throughout the homebuilding industry to design, engineer, and test affordable high-performance homes.
- **Integrated Building and Construction Solutions (IBACOS)** partners with innovative builders and developers to deliver homes that are more energy-efficient, safe, healthy, durable, comfortable, and environmentally responsible.
- The **National Association of Home Builders Research Center (NAHBRC)**, a subsidiary of the National Association of Home Builders, promotes innovation in housing technology to improve the durability, affordability, and environmental performance of homes and building products.

For **commercial buildings**, BTP's Net-Zero Energy **Commercial Building Initiative (CBI)** is aggressively working to improve the performance and decrease the energy consumption of commercial buildings. To help set research priorities and offer advice based on real-world implementation, industry representatives are heavily involved in the initiative through two activities, **Commercial Building Partnerships (CBP)** and **Commercial Building Energy Alliances (CBEAs)**. The CBPs are companies and organizations selected by BTP representatives to conduct cost-shared research, development, and deployment of advanced buildings technologies. The CBPs are charged with constructing buildings that achieve savings of 50% or retrofitting buildings to achieve 30% savings above the ASHRAE/IESNA Standard 90.1-2004.⁸

The CBEAs are a more informal group of organizations that play key roles in transforming the energy efficiency of commercial buildings. These alliances, including the **Retailer Energy Alliance**, **Commercial Real Estate Energy Alliance**, and **Hospital Energy Alliance**, serve as a compelling voice on the collective demand for highly efficient commercial buildings products and services.

⁸ http://www.energycodes.gov/training/pdfs/ashrae_90_1_2004.pdf, accessed August 2009.

BTP Activities and Accomplishments

BTP has made great strides in speeding the market adoption of today's proven energy efficient technologies and researching new technologies that are reducing costs and increasing the performance of the nation's buildings. Homes being built today using the best practices developed through BTP's Building America research program are capable of decreasing the energy used in comparable new homes by as much as 40%. Compact fluorescent lamps (CFLs) have captured more than 20% of the lighting market, thanks in large part to ENERGY STAR promotions. Additional success stories follow:

- The program's EnergyPlus software allows commercial building designers to calculate the savings potential of a wide range of energy options and combinations. The software was recognized with an R&D 100 Award as one of the 100 most technologically significant new products of 2003. Since 2001, more than 66,000 copies have been downloaded.
- In 2004, the program's solid state lighting researchers also garnered an R&D 100 Award for the development of a new process for growing gallium nitride on an etched sapphire substrate. The process, called cantilever epitaxy, promises to make brighter and more efficient green, blue, and white light-emitting diodes (LEDs).
- During the past 12 years, BTP has established technical compliance criteria for achieving the ENERGY STAR labels on washing machines, dishwashers, refrigerators, room air conditioners, freezers, windows, doors and skylights, solid state lighting luminaries, and domestic hot water heaters in addition to CFLs.
- BTP is enlisting the homebuilding industry to construct more energy efficient homes through the Builders Challenge initiative. The Builders Challenge offers information and strategies to help move the residential market toward the net-zero energy goals.
- Through an aggressive EnergySmart Hospitals program that combines conservation, efficiency, and renewable energy, Gundersen Lutheran Health System—a nonprofit serving the tri-state region of western Wisconsin, northeastern Iowa, and southeastern Minnesota—is realizing its goals of reducing baseline energy costs by 20% by the end of 2009 and achieving 100% energy neutrality by 2014.
- As part of the EnergySmart Schools program, Fossil Ridge High School in Fort Collins, Colorado, was able to reduce its energy costs by \$153,000 without added costs for design or construction.
- After a tornado destroyed or damaged 95% of the homes and businesses in Greensburg, Kansas, on May 4, 2007, the city is rebuilding as a model green community with the help of BTP and other DOE personnel. The city's master rebuilding plan includes reducing energy use in buildings; seeking LEED Platinum ratings for new city building projects; and incorporating biodiesel, solar, and wind power systems into its community systems.
- The ENERGY STAR Operation Change Out military challenge, a joint effort between DOE and the U.S. Department of Defense, is the first national energy

efficiency campaign focused on the military. The challenge encourages every serviceman and woman to save energy and money and protect the environment by replacing their inefficient, incandescent light bulbs with ENERGY STAR qualified bulbs. From the campaign's launch on Earth Day in 2008 through early June 2009, 151 bases had signed up, collectively changing out nearly 848,800 light bulbs. Over the lifetime of the bulbs, these change-outs are estimated to save more than 239 million kilowatt-hours, cut nearly \$25.4 million in energy costs, and prevent nearly 382 million pounds of CO₂ emissions.