

# Building Technologies Program Results

## Introduction

The U.S. Department of Energy's (DOE) Building Technologies Program (BTP) works in partnership with the buildings industry, state and local governments, and manufacturers to develop technologies, techniques, and tools for making residential and commercial buildings more energy efficient, productive, and affordable. The long-term goal of the program is to help the nation achieve greater energy independence and a cleaner environment. To this end, BTP and its partners are establishing building codes and appliance standards, and developing marketable, cost-effective net-zero energy buildings technologies and practices that substantially reduce U.S. energy demand.

## Building America

With a strategic goal to develop and disseminate technologies and design approaches that lead to marketable net-zero energy homes (residential buildings that use 60% to 70% less energy than conventional homes) by 2020, BTP has created Best Practices handbooks and performed technology demonstration projects with its partners in all five of the nation's major climate zones—tailoring technologies and best practices to each region (see Figure 1).

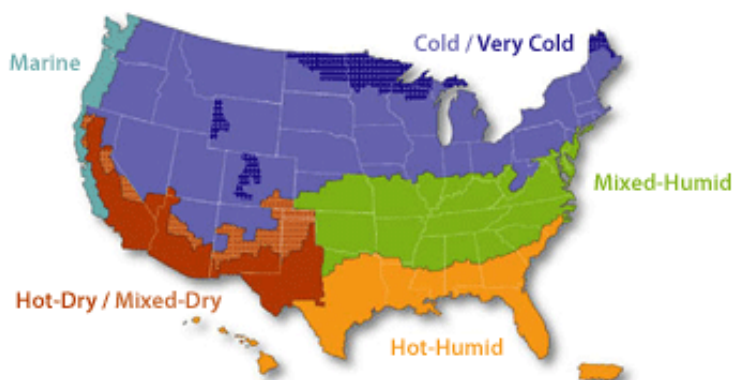


Figure 1. Building America Best Practices climate zones<sup>1</sup>

For example, Volume 3 of the *Building America Best Practices Series*<sup>2</sup> helps builders learn how to achieve 30% energy savings in space conditioning and water heating in cold and very cold climates, with guidance for every member of the builder's team—from the

<sup>1</sup> Source: [http://www1.eere.energy.gov/buildings/building\\_america/publications.html](http://www1.eere.energy.gov/buildings/building_america/publications.html), accessed August 2009.

<sup>2</sup> Pacific Northwest National Laboratory (PNNL) and Oak Ridge National Laboratory (ORNL). *Building America Best Practices Series, Volume 3: Builders and Buyers Handbook for Improving New Home Efficiency, Comfort, and Durability in the Cold and Very Cold Climates*. NREL/TP-550-38309. Golden, CO: National Renewable Energy Laboratory (NREL), August 2005. <http://www.nrel.gov/docs/fy05osti/38309.pdf>, accessed August 2009.

project manager to the site planner and designers, to the site supervisors, trades people, and marketers. Building America's research helped builder teams in Pittsburgh, Pennsylvania, design and construct new homes as part of a phased redevelopment of a 244-acre site. Although all the new homes in the development were built with energy efficiency in mind, one of the pilot homes achieved energy savings of 38% above the Building America benchmark, resulting in an annual energy cost savings of \$915<sup>3</sup>.

Four other volumes in the series offer similar guidance for builders and home buyers in hot-dry and mixed-dry climates, hot-humid climates, marine climates, and mixed-humid climates. In addition, the Best Practices series includes a volume on solar thermal and photovoltaic systems for homes,<sup>4</sup> with useful information for builders and home buyers throughout the United States.

BTP tracks the number of homes built that utilize technologies and strategies developed through Building America research to construct high quality, energy-efficient homes. As of September 2009, more than 41,000 homes have been built under the Building America program.

### **Building Energy Codes**

The **Building Energy Codes** program works with other government agencies, state and local jurisdictions, national code organizations, and industry to promote stronger building energy codes and help states adopt, implement, and enforce those codes. The program offers free software to simplify and clarify code compliance for residential and commercial buildings, See [www.energycodes.gov/compliance\\_tools.stm](http://www.energycodes.gov/compliance_tools.stm). The program also offers free training through webcasts, continuing education credits are available for some of the presentations. See [www.energycodes.gov/training/onlinetraining/videos.stm](http://www.energycodes.gov/training/onlinetraining/videos.stm).

### **Net-Zero Energy Commercial Building Initiative**

The **Net-Zero Energy Commercial Building Initiative (CBI)** focuses on improving the efficiency of new and existing commercial buildings. The goal for new construction is marketable, net-zero energy buildings by 2025.

Researchers at the national laboratories that support CBI have participated in many building projects as part of their on-going research and to understand the issues building owners face. One of the results of this effort is a report entitled [\*Lessons Learned from Case Studies of Six High-Performance Buildings\*](#)<sup>5</sup> that covers key findings in the areas of whole-building design process, lighting and daylighting, building envelope, mechanical systems, and more. Many more publications and research results are available at [www.commercialbuildings.energy.gov/publications.html](http://www.commercialbuildings.energy.gov/publications.html).

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<sup>3</sup> [http://apps1.eere.energy.gov/buildings/publications/pdfs/building\\_america/ba\\_bc\\_kacin\\_homes\\_cold.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ba_bc_kacin_homes_cold.pdf)

<sup>4</sup> PNNL and ORNL. *High-Performance Home Technologies: Solar Thermal & Photovoltaic Systems*. NREL/TP-550-41085. Golden, CO: NREL, June 2007.

[http://apps1.eere.energy.gov/buildings/publications/pdfs/building\\_america/41085.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/41085.pdf), accessed August 2009.

<sup>5</sup> <http://www.nrel.gov/docs/fy06osti/37542.pdf>

CBI has also successfully assembled many industry teams to help address energy use for retailers, hospitals, and commercial real estate owners. These Commercial Building Energy Alliances bring researchers together with industry representatives to identify and solve real-world issues that are impacting commercial building energy use. See [www.commercialbuildings.energy.gov/alliances.html](http://www.commercialbuildings.energy.gov/alliances.html).

Another industry effort, Commercial Building Partnerships, involves companies that have committed to certain energy reduction targets. See [http://www1.eere.energy.gov/buildings/commercial\\_initiative/building\\_partnerships.html](http://www1.eere.energy.gov/buildings/commercial_initiative/building_partnerships.html).

To help commercial buildings stakeholders improve building performance in relation to various factors such as energy, materials, and land use, BTP developed the **High Performance Buildings Database**.<sup>6</sup> The database is a unique central repository of in-depth information and data on high-performance, green building projects across the United States and abroad. It includes information on the energy use, environmental performance, design process, finances, and other aspects of each project. Members of the design and construction teams are listed, as are sources for additional information. In total, up to 12 screens of detailed information are provided for each project profile. Projects range in size from small single-family homes or tenant fit-outs within buildings to large commercial and institutional buildings and even entire campuses.

### **EnergySmart Schools**

Among the 112 projects in the Buildings Database are several that qualify as **EnergySmart Schools**. States and local agencies are planning to invest more than \$60 billion in the next three years to build or renovate schools. Through the EnergySmart Schools public/private partnership, BTP is helping the nation's K-12 schools realize significant improvements in energy efficiency and thousands of dollars in savings in their individual annual budgets.

Public schools nationwide spend more than \$8 billion per year on energy. BTP's goals are to upgrade new schools to 50% better than current energy codes and improve existing schools by 30% in the next three years—reducing annual K-12 energy costs by as much as \$2 billion.

To achieve these goals, the program provides decision makers and stakeholders with information and resources on financing and planning. BTP best practice guides on energy-efficient school construction and renovation are available and already being used by building industry professionals across the nation; and, similar BTP guidance is being resourced by facilities managers for operating and maintaining high-performance systems and equipment. For resources see [www.energysmartschools.gov/publications.html](http://www.energysmartschools.gov/publications.html).

As a result, several high-performance school buildings across the United States (from Maine to South Carolina) are providing healthier environments for students and teachers; educating students, teachers, and parents about energy-efficient technologies; saving

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<sup>6</sup> <http://eere.buildinggreen.com/mtxview.cfm?CFID=51317094&CFTOKEN=23682799>, accessed August 2009.

education budget dollars, and helping reduce greenhouse gas emissions by slowing the demand for new power generating plants. For example, the Poudre School District built a high-performance school in Fort Collins, Colorado, (see Figure 2) with no added design or construction costs. Completed on time and on a budget of \$38.5 million, Fort Collins' Fossil Ridge High School is comparable to a similarly sized, conventionally built school. The district collects energy usage and cost information monthly and compares it against the anticipated energy performance.

The new school is saving the district thousands of dollars per year in operating costs. As of 2007, energy savings of 60% were achieved at a construction cost of \$128 per square foot. The result is at least an \$85,000 reduction in annual energy costs (\$271,800 over three years) when compared to a similar high school in Fort Collins. Those dollars can be put directly back into the classroom. For more case studies see [www.energysmartschools.gov/case\\_studies.html](http://www.energysmartschools.gov/case_studies.html).



Credit: David Patterson, RB+B Architects, Inc.

**Figure 2. Fossil Ridge High School, an EnergySmart school in Fort Collins, Colorado<sup>7</sup>**

### **EnergySmart Hospitals**

The nation's 8,000 hospitals are among the most energy-intensive commercial buildings in the country, with more than 2.5 times the energy intensity and carbon dioxide (CO<sub>2</sub>) emissions of commercial office buildings. In 2007, hospitals spent more than \$5 billion on energy. Unlike many other commercial buildings, hospitals must remain fully operational 24 hours a day, seven days a week, and provide services during power outages, natural disasters, and other events that would force other facilities to close.

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<sup>7</sup> Source: [http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess\\_fossil-ridge\\_cs.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_fossil-ridge_cs.pdf), accessed August 2009.

BTP's **EnergySmart Hospitals** initiative offers hospitals design strategies, advanced energy design guides, technology assessments, case studies, training sessions, and an interactive Web site to help decision makers increase the energy efficiency of their facilities. The BTP goal is to improve energy efficiency in existing hospitals by 20% and to help develop new hospitals that are 30% more efficient than current building standards—all while maintaining quality patient care and healthy healing and work environments.

At the heart of the EnergySmart Hospital initiative is the Hospital Energy Alliance (HEA), a coalition of leading hospitals and national associations (see sidebar) gathered to evaluate and promote energy efficient technologies and processes that will reduce the energy consumption and operating costs of healthcare facilities. A 2007 American Hospital Association survey reported that hospitals planned to allocate 49% of their 2008 capital budgets for new construction or facility modernization. The current capital crisis has forced many hospitals to postpone or cancel construction or renovation plans. But with the EnergySmart Hospital initiative and the HEA, hospital leaders now have the opportunity to re-evaluate facilities plans and ensure that they are taking full advantage of energy efficiency and renewable energy strategies.

#### **Hospital Energy Alliance Steering Committee**

- Catholic Healthcare West
- Department of Veterans Affairs
- Gundersen Lutheran Health System
- Kaiser Permanente
- New York-Presbyterian Hospital
- Providence Health & Services
- Texas Medical Center/TECO
- TRICARE Management Activity
- University of Pittsburgh Medical Center
- American Society for Healthcare Engineering (ASHE)
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- Global Health and Safety Initiative
- Hospital Corporation of America
- Illuminating Engineering Society of North America (IES)

Source: <http://www.eere.energy.gov/buildings/hospital/>, accessed August 2009.

#### **Solar Decathlon**

The U.S. Department of Energy **Solar Decathlon** has grown into a highly anticipated housing design competition that draws thousands of people to the National Mall in Washington, D.C. The year of 2009 marked the fourth year for the Solar Decathlon, a hugely successful program that engages students, universities, the building industry, and the general public. See [http://www.solardecathlon.org/future\\_benefits.cfm](http://www.solardecathlon.org/future_benefits.cfm) to learn more about the benefits of this program.

#### **Solid State Lighting**

The Solid State Lighting program is actively involved with the industry to promote the use and accelerate advancement of this technology that has the potential to significantly save energy and enhance the quality of our building environments. Visit [www.ssl.energy.gov](http://www.ssl.energy.gov) to learn more and see the extensive research available on this technology.

#### **Awards and Accomplishments**

A number of BTP activities have been recognized as outstanding achievements by the scientific community and the buildings industry.

**EnergyPlus:** This simulation software program allows commercial building designers to calculate the savings potential of various combinations of heating, cooling, lighting, ventilating, and other energy flows, as well as water, in buildings. Since 2001, more than 66,000 copies of the software have been downloaded from the BTP Web site. The software program has also been the recipient of several awards, including the following:



- A 2003 R&D 100 Award, as one of the 100 most technologically significant new products of the year
- A 2004 Award for Excellence in Technology Transfer from Lawrence Berkeley National Laboratory
- A 2002 Award for Excellence in Technology Transfer from the Federal Laboratory Consortium
- An IT Quality Award for Technical Excellence, one of the U.S. Department of Energy Chief Information Officer Annual Awards presented in March 2002

**R&D Awards:** *R&D Magazine* annually gives awards to the top 100 industrial innovations worldwide. In 2004, BTP-directed research for a new process of growing gallium nitride on an etched sapphire substrate, called cantilever epitaxy, received an R&D 100 award. The technology will improve solid state lighting by making brighter green, blue, and white light emitting diodes (LEDs). In 2009, BTP-funded researchers developed a new generation of phase change material for innovative dynamic insulation, receiving another R&D 100 Award. If the dynamic insulation were installed in only 10% of U.S. homes, energy savings between 0.2 and 0.5 quads per year could potentially be realized.

**ENERGY STAR®:** In addition to these prestigious awards, BTP's accomplishments with the ENERGY STAR program cannot be overlooked. Inefficient appliances consume nearly \$14 billion per year in energy costs in the United States. BTP is supporting two ENERGY STAR appliance recycling campaigns—encouraging consumers to find out just how much energy is used and money is spent to power late-model refrigerators, freezers, and washing machines, as well as how to properly recycle inefficient models. The program also offers guidelines for selecting ENERGY STAR-rated replacement models.



BTP is also a driving force behind ENERGY STAR Operation Change-Out, the first energy efficiency campaign focused on the U.S. military. The program encourages every serviceman and woman to replace their inefficient incandescent light bulbs with ENERGY STAR-qualified bulbs, saving energy, money, and protecting the environment. From the campaign launch on Earth Day 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 the emissions of nearly 382 million pounds of carbon dioxide.