

Home Performance with ENERGY STAR: Accelerating Energy Efficiency Improvements in Existing Homes

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ABSTRACT

Home Performance with ENERGY STAR® (HPwES) is a program jointly managed by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) to significantly increase energy efficiency in existing homes. HPwES promotes whole-house improvements via home performance contracting, including comprehensive assessments **and** building-science based improvements where homeowners and the ENERGY STAR brand are protected by a robust quality assurance program. As of May 2008, HPwES programs are in twenty-three states. DOE is increasing both the **demand** for home performance contracting by: (1) exploring loan guarantees for homeowners to finance improvements and (2) working with Realtors to increase consumer awareness of benefits of home performance improvements; and the **supply** of qualified home performance contractors by (3) developing standards, field guides, and other tools for home performance contracting (4) encouraging national workforce development and (5) exploring HPwES contractor partnership pilots..

The goal of HPwES is to increase energy efficiency in the over 110 million existing homes—an increase of 25% represents 5.4 Quads and a potential annual energy bill savings of over \$62 billion. Some of the most cost-effective energy efficiency opportunities in America are improving existing homes' performance, but there are many barriers to widespread market penetration. DOE and EPA are working to increase market penetration of HPwES by increasing homeowners' awareness, enabling homeowners to finance improvements, and facilitating skilled contractor availability on a national scale. This paper discusses DOE's activities in the existing homes market to promote home performance and significantly increase the impact of HPwES.

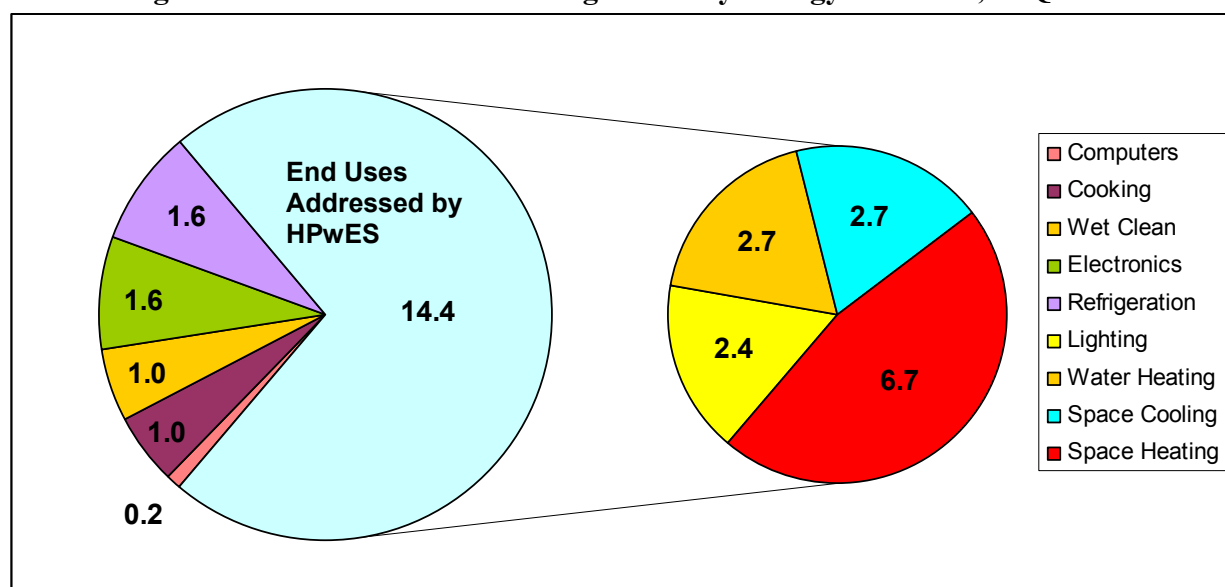
Overview

There are 113 million existing homes in the U.S., two-thirds of which are over twenty-five years old (BED 2007; JCHS 2007 U.S. Census Bureau 2006). Most homes were built before modern energy codes, which were established in 1983; however, states have adopted and adapted these codes to varying degrees. This means that the existing housing stock varies considerably with respect to the energy efficiency measures installed at the time of construction and subsequent remodeling, and that many homes have considerable potential for enhancing comfort, safety, and energy efficiency through comprehensive retrofits

Residential buildings consume 21.8 quadrillion Btu (Quads) a year, representing 22% of U.S. primary energy consumption (BED 2007). Existing homes represent a large source of untapped potential energy savings and Figure 1 shows the largest end uses: space heating and cooling, water heating, lighting, and refrigeration, which make up almost 66% of home energy

use. The average American homeowner spent nearly \$1,900 on energy bills in 2005, more than half of which went to space conditioning and water heating (BED 2007).

Figure 1. U.S. Residential Buildings Primary Energy End Uses, in Quads¹



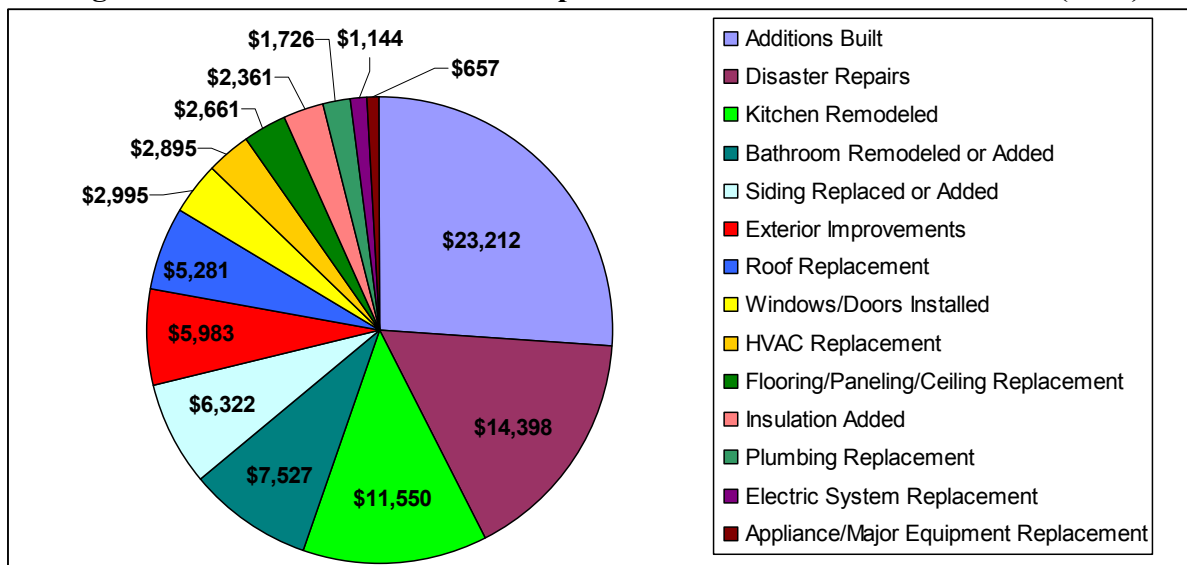
Source: BED 2007, Table 1.2.3

Only 9% of U.S. homes were built after 2000 (BED 2007),² so the energy consumption of households is largely determined by older existing homes and the renovations made to improve them. This represents a huge potential for energy efficiency improvements, and consumers are becoming increasingly interested in “green” or energy-efficient retrofits. Two-thirds of National Association of Home Builder (NAHB) survey respondents prioritize reduced energy costs when considering green remodeling, followed by health concerns at 55% and environmental benefits at 49% (NAHB 2007a). Americans spent \$215 billion in 2005 on renovations (BED 2007) and the 25% decrease in new housing starts in 2007 could shift home expenditures to the retrofits market (U.S. Census Bureau 2008). Additionally, remodeling expenditures are expected to grow by 44% between 2005 and 2015, and the remodeling industry is growing fastest in the professional installation segment at 46% (JCHS 2007). Homeowners spent \$136 billion on professional installations in 2005 (BED 2007) with most renovations in new additions, as shown in Figure 2. Approximately \$40 billion of these expenditures are in areas with specific potential for energy-related improvements (windows, insulation, HVAC, etc.); there is also a large market for green products, at \$500 billion annually (NAHB 2007b).

¹ The authors elected not to include the EIA adjustment factor, SEDS, of 1.02 Quads in 2005, used to account for discrepancies between data sources. SEDS represents buildings energy consumption that cannot be attributed to a particular end use.

² As of 2005.

Figure 2. Mean U.S. Homeowner Expenditures on Professional Retrofits (2005)



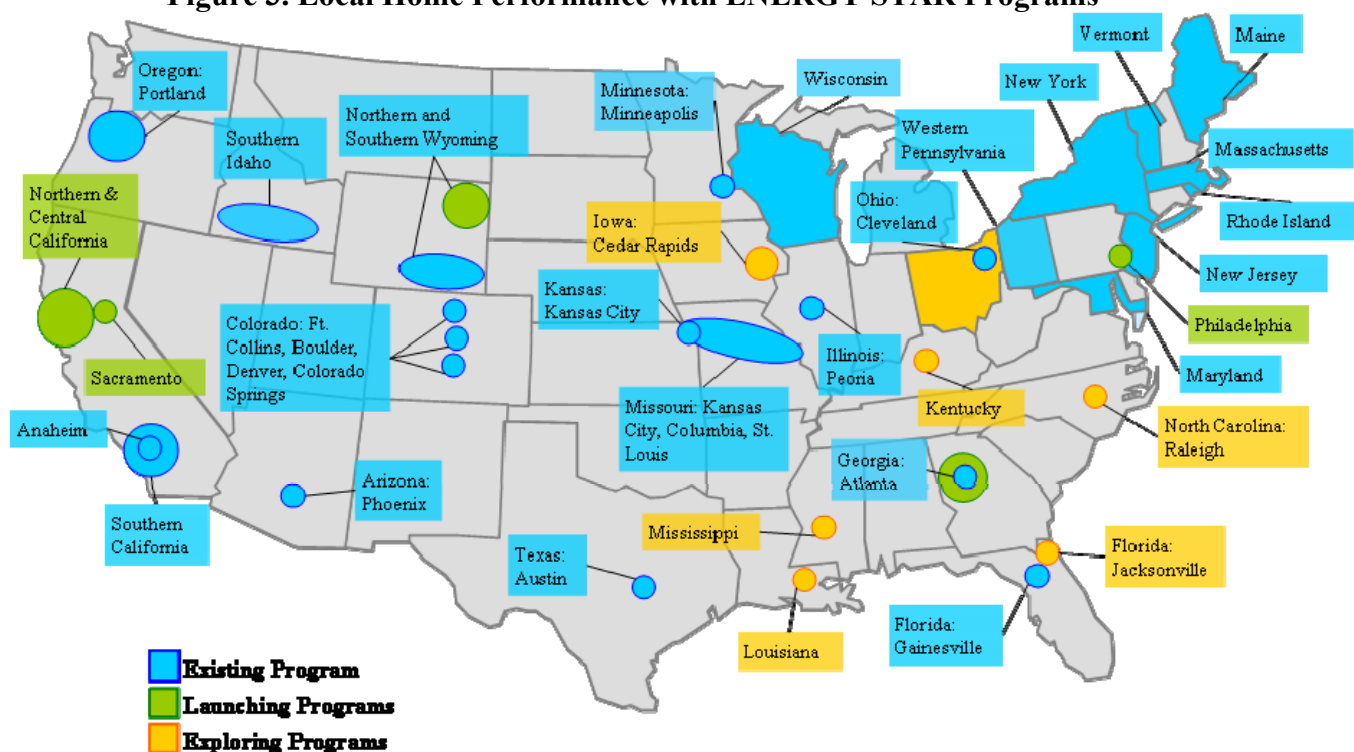
Source: 2007 *Buildings Energy Data Book*, Table 5.3.2

Demand for improved home comfort and decreased energy bills is growing; homeowners are facing rising energy prices and are becoming more concerned about indoor air quality as well as environmental issues. Increased state funding of energy efficiency programs has created rebates and other incentives that further increase consumer demand. On the contractor side, a steep decline in new home construction may result in many residential contractors becoming available and eager to work in the existing home market.

Home performance involves taking a whole-house approach to energy savings and comfort improvements. Contractors examine the entire house—not just individual components such as water heaters or windows—checking for duct leakages, poor sealing, combustion safety, and other potential areas of efficiency gains before making recommendations (Rogers, Edmunds & Knight, 2006). Common improvements suggested are sealing air leaks and ductwork, adding insulation, improving the heating-cooling system, and upgrading lighting (EPA and DOE). This approach allows contractors to maximize the effect of improvements while staying within the homeowner's budget.

HPwES is in a unique position to offer increasing a home's energy performance to the existing homes retrofits market for contractors as well as quality assurance for the homeowners who choose to improve their homes. Unlike other ENERGY STAR programs in which products are labeled, the HPwES logo is applicable to the services delivered by home performance contractors who participate in the local HPwES programs shown in Figure 3.

Figure 3. Local Home Performance with ENERGY STAR Programs



Source: Navigant Consulting, Inc.

The current program is implemented by these local sponsors (additional local sponsor information available on www.energystar.gov/homeperformance) such as utilities, state energy offices, and not-for-profits that recruit and train home improvement contractors. Qualified contractors conduct a comprehensive assessment using diagnostic equipment to check the heating and cooling systems, lighting, water heating, windows, insulation, flow of air into and out of the house, and a safety check of gas appliances. Based on this assessment, participating contractors offer solutions to fix comfort problems and address high energy bills; they then complete the needed renovations or work closely with other participating contractors. Unlike typical energy audit programs, the goal of HPwES is to ensure that *recommendations* result in actual *improvements* to a home's energy efficiency and comfort. Another key element of HPwES is that, when the project is complete, the contractor assesses the home again to document that specified improvements were properly installed and will achieve the estimated energy savings. Finally, all completed jobs are subject to quality assurance reviews by the independent third-party to ensure that improvements meet program standards, which assures homeowners of high-quality work.

Participating contractors have improved almost 40,000 homes between 2002 and 2007 through local HPwES programs as shown in Table 1. This represents approximately \$360 million³ in homeowner investment in energy improvements and an estimated \$45 million⁴ in accrued annual energy savings for homeowners.

³ Average investment in energy efficiency upgrades per home associated with Home Performance with ENERGY STAR program is estimated at \$9,000, therefore total estimated investment for 39,946 homes is approximately \$360 million in 2008 dollars (Navigant Consulting Inc.).

Table 1. HPwES Improved Homes

Year	Completed Installations	Program to Date
2002	531	531
2003	3,304	3,835
2004	4,825	8,660
2005	6,990	15,650
2006	12,649	28,299
2007	11,647	39,946
2008, projected	15,000	54,946

Source: EPA and DOE

To date, local program sponsors have launched HPwES activities in 23 states around the country, with more added every year. Federal involvement has focused on supporting implementation at the local and state levels by signing partnership agreements with utilities, state energy offices and not-for-profits. The increase in homes improved through locally-implemented HPwES has been considerable, and the program has been improved by the “lessons learned” from these locally-sponsored programs. Each year, interest in sponsoring local programs has grown and the Federal government intends to continue to support locally-sponsored programs in a variety of ways. In July 2007, in an effort to reach even more existing homes with home performance contracting services via HPwES, DOE convened an industry forum on HPwES. More than 100 participants from across the country, including representatives from 15 national companies, discussed exploring pilots for contractors to directly partner with HPwES that would be scalable to a national level. DOE and EPA are exploring developing the infrastructure to support a National Delivery Model for HPwES by collaborating with national companies that have contractor networks and organizations that can deliver quality assurance. These major manufacturers and retailers, and their associated contracting networks, could increase the availability of home performance contracting services to many more homeowners across the country, resulting in further homeowner savings and reduced energy consumption.

Benefits of Improving Existing Homes via HPwES

Home energy costs for U.S. households were \$1,899 in 2005 (BED 2007) and they are projected to increase to nearly \$2,200 in 2008 (ASE). The increase in energy costs enhances the program’s economic benefits by increasing the value of savings. For some homes, energy savings can be as much as 40% of pre-installation energy use installing commercially available technologies. However, savings depend on homeowner investment, and are typically 20% to 30% (Rogers, Edmunds & Knight, 2006). A 2007 analysis reported that homes improved via Austin Energy’s HPwES program achieved an average cooling savings of 25% - 35% (Belzer, Mosey, Plympton & Dagher 2007).

Savings also vary by climate region, as shown in Table 2, and coordinating both electricity and natural gas savings measures results in greater overall homeowner benefit (EPA and DOE).

⁴ Annual estimated energy cost per single family home in 2001: \$1,868 (\$2005, BED 2007) 25 percent savings represents \$460 per home in 2005 dollars. Total accrued energy savings for the 39,946 homes improved over the six year period is estimated at \$45.3 million in 2005 dollars (Navigant Consulting Inc.).

Table 2. Potential per Home Energy Savings by Climate Zone

	Northeast	Midwest	South	West
Electricity (kWh)	1400	1700	4600	1400
Natural Gas (Therms)	400	400	200	200

Source: DOE/EPA programmatic document “Home Performance with ENERGY STAR- A cost-effective strategy for improving efficiency in existing homes”.

In addition to base load decreases, HPwES also results in peak load reductions as many recommended improvements address heating and cooling, contributors to seasonal peak energy usage. Average savings per home are approximately 1.6 kW in the summer and 0.9 kW in the winter (EPA and DOE).

The energy savings from improving existing homes benefit the environment in addition to homeowner savings. Reducing home energy use through HPwES in almost 40,000 homes over six years is the equivalent of saving over 445 thousand barrels of crude oil. Home Performance has also reduced carbon emissions by 74 thousand tons carbon equivalent. This achieves the same effect as combusting about 1 million fewer gallons of gasoline per year.

HPwES also stimulates local economy through job creation. The program provides the means for remodelers, HVAC installers, insulation installers, and home energy raters to diversify their businesses, which gives them the flexibility to adapt to market changes. The program also allows for many approaches and successful business models. Contractors who expand to offer home performance contracting report success in terms of higher closing rates, expanded jobs, and higher margins (Rogers, Edmunds & Knight, 2006). Current remodeling trends indicate specialty contractors experience stronger revenue growth and stable jobs (JCHS 2007).

HPwES Strategies

Although both homeowners and contractors are becoming interested in a whole-house approach to existing homes retrofits, home performance has not yet received broad market recognition. DOE is working to accelerate the market adoption of HPwES by (1) exploring use DOE loan guarantees for financing for home performance improvements (2) working with Realtors to increase consumer understanding of home performance improvements (3) developing resources for home performance contractors (4) exploring national workforce development and (5) exploring pilots for HPwES contractor partnerships.

Home Performance Improvement Financing in Conjunction with DOE Loan Guarantees

Homeowners are facing rising energy costs in houses in need of comfort and indoor air quality improvements; however, many are unable to finance these upgrades. High first costs prevent many homeowners from following through with the recommended whole-house improvements from a HPwES assessment. Additionally, equipment replacements are often purchased when the equipment fails, and the homeowner’s highest priority is to have working equipment and often does not seek out a more comprehensive, energy efficient option (which is often a higher first cost option) to replace the failed equipment (for example, HVAC equipment) (Thorne 2003). The first cost barrier may be overcome by offering homeowners attractive financing options. Some loan guarantees can be used by HPwES programs to offer financing to homeowners, removing one of the barriers to implementing home performance.

The mission of DOE's Loan Guarantee Program Office (LGPO) is to originate, guarantee, and monitor loans for clean energy projects, as authorized under Title XVII of the Energy Policy Act of 2005 (EPAcT). Projects supported by loan guarantees will help the U.S. reach the goal of increasing affordable, reliable, secure, and clean sources of energy by encouraging early use of new or significantly improved technologies in energy projects. EPAcT allows for the LGPO to invite applications for innovative technologies that employ (among others) energy-efficient building technologies. These technologies can include improved air sealing, insulation, lighting, window, and HVAC technologies and most importantly, house-as-a-system assessment.

The EPAcT 2005 loan guarantee authority requires the technologies that are eligible for financing to be innovative and, because of the higher than normal risk with new and innovative technologies, unlikely to qualify for conventional financing. Since technologies typically used within HPwES are commercially available, the home performance technologies themselves do not meet EPAcT criteria but the deep energy savings and whole-house approach allows DOE to utilize loan guarantees for home performance loans. Because the Federal government is guaranteeing the loans, the financing rate of the loans are typically reduced by 1 - 2 percentage points. Loan guarantees will likely provide easier access to financing and lower interest rates, facilitating homeowner completion of whole house improvements, resulting in deep energy savings.

Increasing Consumer Education by Working with Real Estate Agents

Almost 5 million existing single-family homes were sold in 2007 (NAR 2008); therefore, targeting homebuyers can be an effective way to educate a sizeable portion of residential homeowners. During a potential home purchase, homebuyers are often in a "data gathering" mode because of the large financial investment, and they are looking for detailed information on home financing, features, etc. They are most likely to make major home improvements at the time of purchase or shortly thereafter (JCHS 2006), so this is a point when homeowners may be receptive to improving their home's performance.

An effective way to reach homebuyers is through their real estate agent. According to the National Association of REALTORS® (NAR), 90% of homebuyers rely on the direction and advice of a real estate agent when they purchase homes, and 84% of home sellers (about 5.4 million) used the assistance of agents in 2006 (NAR 2007).

Equipped with knowledge about the factors that affect home energy consumption, ways their clients can save money, and strategies to market homes with improved performance, real estate agents can ensure energy efficiency is a priority for buyers. According to NAR, 46% of all buyers think that energy efficiency is very important when searching for a home, while another 46% think that energy efficiency is at least somewhat important (NAR 2007). As residential energy costs continue to increase, a home's energy performance will retain importance. Some states passed or have pending legislation that encourages home energy consumption disclosure at the time of sale.

In early 2007, DOE launched its Real Estate Initiative and partnered with NAR to assist in member outreach and education, increasing homeowner knowledge on home energy use. The partnership facilitates real estate roundtables, surveys, and focus groups designed to gain a better understanding of real estate agents' attitudes about energy efficiency and what resources they need to effectively introduce it into their business practice. Feedback will be used to ensure that

jointly crafted resources are effectively designed to serve real estate agents. NAR and DOE will draft energy efficiency brochures for real estate agents and their clients and determine the best distribution mechanism to increase their reach. The Real Estate Initiative continues to explore avenues for educating real estate agents and Realtors so the industry can educate homebuyers and sellers about the benefits of home performance.

DOE also seeks to change the market infrastructure by persuading the hundreds of multiple listing services (MLS) around the country to provide energy efficiency data on homes for sale to agents and the public. NAR reports that 77% of buyers used the Internet in a home search in 2005, and 80% went on to hire a real estate agent (NAR 2005). MLS data is the source for the public internet listings used by home buyers; therefore, changing this data to reflect energy features will create more public awareness and demand for energy efficient home features while also providing a tool for real estate professionals. As MLS add data fields that capture energy-efficient features, home sellers, home buyers, and their agents will begin to use the data in their marketing and search efforts.

Resources for Home Performance Contractors

Successful home performance programs require a knowledgeable and effective workforce of home performance contractors. Developing this skilled workforce requires contractor training, home performance improvement standards and certifications, and field guides that help the contractor implement the standards. DOE has previously supported work in all these areas and is currently teaming with the Building Performance Institute (BPI) to review and update its standards and certifications, as well as to develop field guides.

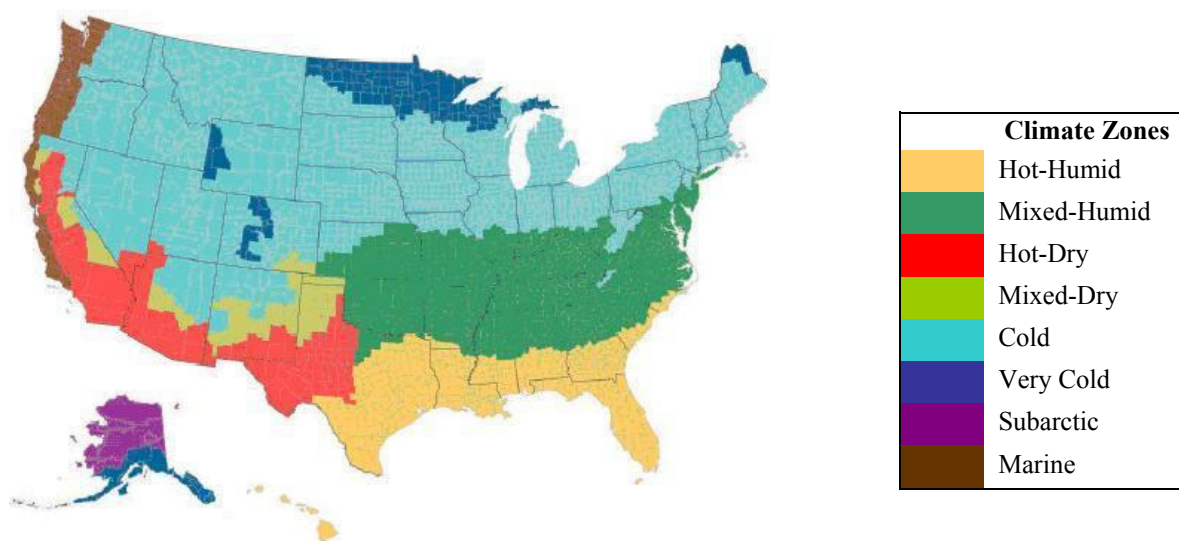
As of May 2008, BPI standards and certifications are used by home performance contractors in eight locally-sponsored HPwES programs and BPI accreditation is used in three programs and under consideration in an additional three.⁵ To ensure that these standards are as up-to-date and comprehensive as possible, BPI has instituted an annual review process and convened a new Standards Technical Committee (STC). The review process begins with a public review and proposal period. To develop new draft standards, the STC will review existing BPI standards, proposals for new standards, and proposed changes to standards. All changes suggested by the STC will be posted on the BPI website public comment page by July 31 of each year. Comments will be considered and addressed, and new standards will be released each December. This process will ensure that the standards and certifications continue to evolve as building science expands and new test procedures are developed.

⁵ According to the Program Sponsor Partnership Agreement for HPwES, April 3, 2008: "Partners may authorize an independent entity to review reports, initiate customer feedback, follow-up on problems, perform on-site inspections, and document actions. For example, if BPI accreditation is a local program requirement for contractor participation, BPI could perform these functions." According to the BPI Accreditation Policies and Procedures, Manual, www.bpi.org, accessed May 3, 2008, "BPI Accredited organizations agree to employ BPI Certified Professionals in sufficient quantity and designation at each location for the scope of the business operation." Currently, Anaheim Public Utilities, Austin Energy, Energy Trust of Oregon, Long Island Power Authority (LIPA), Maryland Energy Administration, New Jersey Board of Public Utilities (NJBP), New York State Energy and Research Development Authority (NYSERDA), and West Pennsylvania Power Sustainable Energy Fund HPwES programs require BPI certification for their participating home performance contractors and LIPA, NYSERDA and NJBP HPwES programs require BPI accreditation. Anaheim, Austin, and Oregon are introducing BPI accreditation into their programs.

In conjunction with this effort, BPI is working with the Residential Energy Services Network (RESNET) to develop a new standard and certification—the Home Performance Analyst (HPA), which will combine the requirements of the BPI Building Analyst certification and the RESNET Rater certification. This will result in a nationwide standard for building performance contractors that ensures a uniform knowledge base and will enable contractors to improve homes in any climate according to building science principles and best practices. In developing this standard, BPI is following the process required by the American National Standards Institute (ANSI) and is proceeding with ANSI approval.

In parallel with this effort, DOE is supporting the development of field guides that will align with the BPI certifications as well as a field guide for “Photovoltaics”. These field guides will help contractors implement BPI standards and will address the diagnosis of common problems found in specific regions and for specific equipment types. The guides will include not only home performance analysis, but also implementation of solutions to the problems found. Separate field guides will be created for each of the five temperature and humidity climate regions developed by the DOE’s Building America Program as shown in Figure 4. This organization will mirror that of the Energy & Environmental Building Association’s (EEBA) Builders Guides⁶ for new homes that was developed with DOE support.

Figure 4. Building America Climate Zones for HPwES Field Guides.



Source: DOE, Building America

In addition, DOE has supported the development of the Delta-Q blower door and duct testing tool at the Lawrence Berkeley National Laboratory (LBNL). This tool greatly reduces the time needed to test a home for air infiltration and duct leakage. It uses a ramping procedure (increasing and decreasing fan speed and pressure) and a computer analysis to determine the amount of air leakage and duct leakage to the outside. It is also possible to identify approximately where the duct leaks are located. The system does not require sealing supply or

⁶ The EEBA Builders Guides address ventilation, moisture control, and energy efficiency in new homes and there are solutions guides for four climates: Cold, Mixed-humid, Hot Humid, Hot/Mixed-dry.

return air vents in the house so setup time is greatly reduced. The test procedure is codified at ASTM E1554 and it is being revised to incorporate the new ramping procedure.

Training Additional Home Performance Contractors through Workforce Development

To improve a significant number of American existing homes each year, thousands of trained and qualified home performance contractors are needed across the country. These home performance contractors may be HVAC contractors, insulation installers, remodelers or others already working in the home improvement field, that want to add home performance contracting to their businesses. In addition, interested individuals and companies could invest in home performance contracting training to join the home improvement field. As a result of the wide variety of potential home performance contractors, HPwES is exploring several venues for workforce development for home performance contractors.

To understand the fundamentals of home performance contracting, an education in basic building science to develop an understanding of the whole-house approach to design, building, and remodeling is essential. For the past three years, DOE has worked with the National Association of Universities and Land Grant Colleges (NASULGC) to develop appropriate building science courses on several levels. The initial activity focused on creating a Building Science 101 course for architects and engineers. This course will also be offered by some schools in a slightly different form as a general science course. Work is also underway to develop courses that are being offered through community colleges, the NAHB Institute, trade schools, and other organizations to builders and trades. DOE has begun discussions with the Agriculture Extension Service to train the Extension Service agents to provide outreach to homeowners. Finally, the Extension Service has recently launched a web-based information tool called E-Extension. DOE is exploring the possibility of using E-Extension as an outlet for information and training.

Current home improvement contractors and building professionals may need to expand their knowledge base through additional training. Although they may be experienced in practical building techniques, home improvement contractors may require additional skills to transition to home performance contracting. DOE has worked with a variety of stakeholders over the past five years to increase the number of contractors who are improving the energy performance of existing homes. DOE, working with Oak Ridge National Laboratory, Southface Energy Institute, and the NAHB Research Center, has developed training modules for remodelers on improving the energy efficiency of homes. The eight modules in the series are marketing, building science, house-as-a-system, kitchens, bathrooms, room additions, space conversions, and mechanical systems. Each training module is in a presentation format and includes a teacher's guide and a student workbook. The complete course is available online on the Toolbase.org website at www.toolbase.org/Design-Construction-Guides/Remodeling/energy-efficient-remodeling.

As a result of the large workforce required to support HPwES program growth, DOE hosted a summit on workforce development for home performance contractors in July 2008 in Washington, DC. The goals of the summit include developing a roadmap for several strategies to increase the amount of training available nationally for people who are interested in becoming home performance contractors. DOE planned to convene the various stakeholders in the training and program implementation communities who either facilitate training or provide training to candidate home performance contractors. The results of the summit are posted on www.affordablecomfort.org.

Exploring HPwES Contractor Pilots

To increase the number of contractors who can improve the energy performance of homes under the auspices of the HPwES program, DOE and EPA are exploring pilots in one to three metropolitan areas that do not have traditional program sponsors—a utility, state energy office or non-profit organization. DOE and EPA are collaborating with national companies that have contractor networks to assess the opportunities for their contractors to become home performance contractors. In addition, DOE and EPA are working with local and state governments and utilities to collaborate on consumer education and potentially utility incentives for home performance contracting jobs.

Conclusion

American existing homes have been described as “the last frontier of energy efficiency” in our economy. The majority of American homes are in need of home performance improvements that can reduce energy bills, increase comfort and help mitigate climate change. HPwES can improve a significant percentage of these homes each year, saving homeowners money and creating jobs for contractors. As the existing homes market has not been sufficiently addressed, there is a great need for accelerating Home Performance with ENERGY STAR to increase the number of homes improved each year.

Often, homeowners are not aware of the benefits of home performance contracting, so they do not know to seek a whole-house approach when addressing comfort problems and annually increasing energy bills. Realtors are in a good position to educate homeowners and once qualified contractors have made recommendations, loan guarantees can help homeowners finance comprehensive improvements. In order to make comprehensive home energy improvements, contractors must be trained and certified to ensure homeowner trust and satisfaction. Through standards, certifications, field guides, and improved assessment tools, the HPwES program is facilitating a skilled workforce of contractors, while increasing their availability through workforce development.

Through HPwES, American homes will be more comfortable with improved indoor air quality, and local and national economies will be stimulated due to the increase in available dollars not spent on wasted energy.

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