Building ENERGY STAR® Qualified Homes and Incorporating Energy Efficiency and "Green" Building Practices into HOME-funded Affordable Housing

U.S. Department of Housing and Urban Development
Office of Community Planning and Development

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Prepared by

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U.S. Department of Housing and Urban Development
Office of Community Planning and Development

Table of Contents

Introduction

The U.S. Department of Housing and Urban Development (HUD) has established increased energy efficiency in affordable housing as a strategic priority.[1] This guidebook, *Building ENERGY STAR New Homes and Incorporating Energy Efficiency and Green Building Practices into HOME-Funded Affordable Housing*, is one of several HUD initiatives to promote HUD's goal of increasing energy efficiency in its affordable housing developments. This guide provides information and program tools to state and local housing agencies and communities to enhance the energy efficiency of HOME-funded affordable housing activities.

Improving energy efficiency in housing results in lower energy costs, improved building performance, lower maintenance costs, and enhanced financial stability. These are direct benefits to tenants, home owners, and property owners and managers. Cumulatively, these results also benefit the nation in reduced pollution and energy demand. Today, enhanced energy efficiency in housing is an achievable goal because of new technologies and advances in building practices that have evolved over the last decade. HUD urges its state and local partners to take advantage of these opportunities in their affordable housing ventures.

Purpose of the Guidebook

The primary purpose of this guidebook, *Building ENERGY STAR New Homes and Incorporating Energy Efficiency and Green Building Practices into HOME-Funded Affordable Housing*, is to provide technical and operational guidance to HOME participating jurisdictions (PJs), community housing development organizations (CHDOs), and subrecipients to help them develop ENERGY STAR qualified homes. This guidebook discusses the benefits of improved energy efficiency in housing; describes what the ENERGY STAR qualified home label means; describes what a PJ and its local development partners must do to meet the ENERGY STAR standards; and identifies other actions that PJ can take to improve building performance in affordable housing. Generally, PJs can achieve ENERGY STAR standards only with new construction activities; this guidebook also describes how to incorporate energy efficiency into rehabilitation activities and presents green building practices that may be incorporated into affordable housing activities.

Organization of the Guidebook

The guidebook is organized into five chapters:

- **Chapter 1, *ENERGY STAR and Energy Efficiency in Affordable Housing – Benefits to the Environment, Residents, Properties, State and Local Programs, and HUD*,** explains how and why increasing energy efficiency in affordable housing benefits residents, owners, PJs, and HUD. It also discusses HUD's actions to promote energy efficiency.

[1] This priority is described in the HUD Secretary's report to Congress, *Promoting Energy Efficiency at HUD in a Time of Change,* August, 2006. A copy of the report is available through HUD User, at http://www.huduser.org/publications/destech/energyefficiency.html.

- **Chapter 2**, ***ENERGY STAR Qualified Homes,*** describes the ENERGY STAR program with a focus on the ENERGY STAR for New Homes label. It discusses the standards and requirements of an ENERGY STAR qualified home label, identifies the key actors involved in the review process, explains the main elements of an ENERGY STAR qualified home, and identifies some technical and financial resources that can be leveraged to support ENERGY STAR qualified homes activities.
- **Chapter 3**, ***Incorporating ENERGY STAR into HOME-Funded Activities,*** discusses how to incorporate the standards for an ENERGY STAR qualified home into HOME-funded activities at the state or local level. It addresses the basic program-level actions necessary to achieve an ENERGY STAR label and how to document ENERGY STAR accomplishments in IDIS. It also presents good practices when implementing the ENERGY STAR for New Homes label in HOME-funded activities.
- **Chapter 4**, ***Energy Efficiency Measures for Moderate Rehabilitation and Other Affordable Housing Programs,*** explains how a PJ can incorporate energy efficiency measures into activities where an ENERGY STAR qualified home is not feasible: in moderate rehabilitation and new construction of multifamily housing over three stories. This chapter presents the Home Performance with ENERGY STAR program.
- **Chapter 5**, ***Incorporating Green Building Practices that Improve Housing Performance,*** introduces guidelines and design techniques for green building practices that reduce health risks in buildings and minimize their environmental impact. This chapter summarizes the benefits of these building practices, and identifies ways PJs can use these building practices in their affordable housing developments, including through site design, green building materials and construction methods, renewable energy, water conservation, healthy homes design, and operations and maintenance.

Who Benefits from Using this Guidebook?

This guidebook will benefit state and local PJs and their program partners (such as community housing development organizations, state recipients, and subrecipients) that are interested in helping low-income beneficiaries of their programs reduce housing energy costs; and improving the affordable housing stock that they develop. Program staff of these organizations who administer HOME Program activities will be able to use the information in this guide to initiate or improve their energy efficiency initiatives in their HOME-assisted housing. The guidebook offers information for communities experienced with incorporating energy efficiency measures, as well as for communities that have limited experience.

About the HOME Model Program Guides

Building ENERGY STAR New Homes and Incorporating Energy Efficiency and Green Building Practices into HOME-Funded Affordable Housing is one of a number of HOME model program guides that HUD has issued to provide technical assistance to state and local PJs implementing the HOME Program. These model program guides cover a range of topics related to HOME Program administration and activities, and are available at no cost through Community Connections at 1-800-998-9999. For a complete list of all the model program guides, see the HOME Program's website, Model Program Guides, at http://www.hud.gov/offices/cpd/affordablehousing/library/modelguides/index.cfm.

Chapter 1: ENERGY STAR® and Energy Efficiency in Affordable Housing: Benefits to the Environment, Residents, Properties, PJs, and HUD

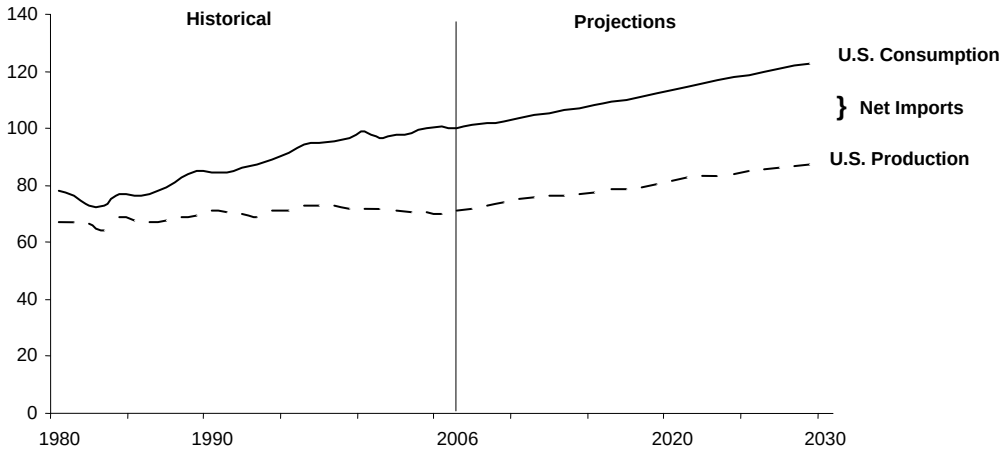
This chapter describes the growing trend toward the use of energy efficient products, design, and building techniques in the affordable housing industry. It explains why these changes are important and how they benefit residents, property owners, PJs, and HUD. The chapter concludes with a discussion of a number of HUD initiatives to promote energy efficiency in its affordable housing programs.

1.1. Energy Efficiency and Green Housing—A Growing Trend

In the United States, energy demand and costs are rising substantially and will continue to do so under current consumption patterns. According to the *Annual Energy Outlook 2008*, over the next 20 years, U.S. consumption of liquid fuels will increase by almost 15 percent, natural gas will increase by 20 percent, and coal will increase by almost 30 percent over current levels. Although the U.S. has made extraordinary technology advances in energy exploration and production, it produces 36 percent less petroleum today than it did in 1980. Additionally, the total U.S. primary energy consumption is projected to increase by about 23 percent by 2030 as the total U.S. energy production is projected to decrease by 22 percent. As energy demand grows and supply shrinks, Americans face an ever-increasing gap between its energy needs and available resources.[2]

[2] United States Department of Energy. Energy Information Administration. *Annual Energy Outlook 2008 with Projections to 2030*. December 2007. 12 February 2008. http://www.eia.doe.gov/oiaf/aeo/index.html.

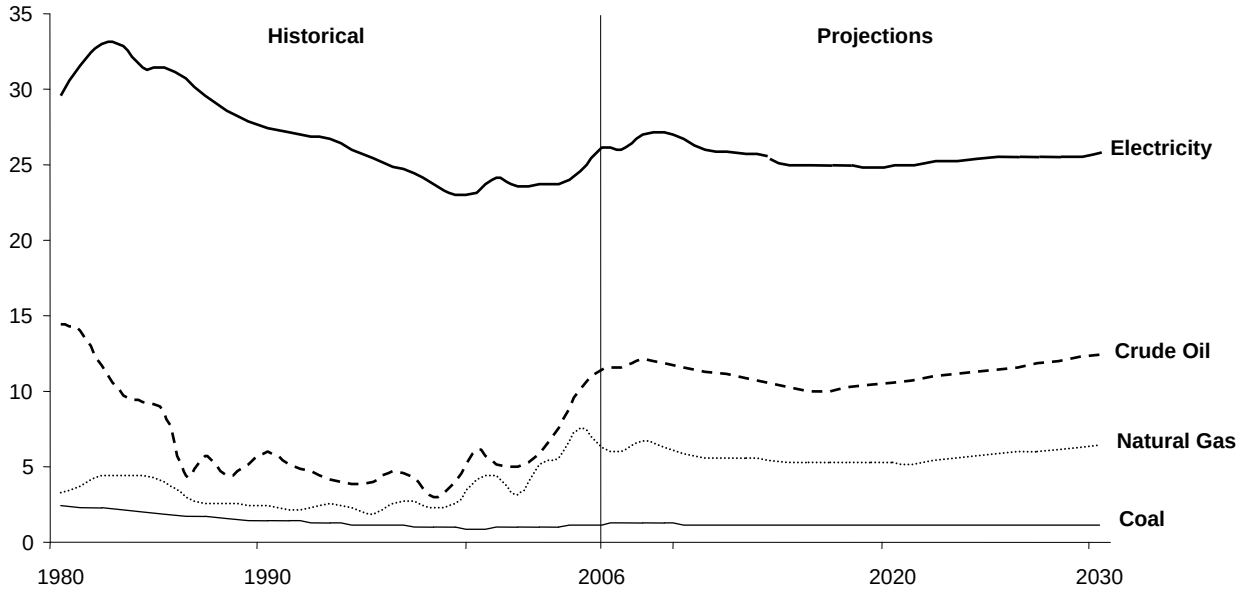
Figure 1-1. Total U.S. Energy Production and Consumption, 1980–2030 (quadrillion Btu)



Source: Energy Information Administration, Annual Energy Outlook with Projections to 2030

This gap causes energy prices to become more volatile and the cost of living to increase. According to the *Annual Energy Outlook 2008*, electricity prices are projected to rise through 2009 and then decline for the next decade before again rising slowly. Crude oil, natural gas, and coal follow this same trend.

Figure 1-2. U.S. Energy Prices, 1980–2030 (2006 dollars per million Btu)



Source: Energy Information Administration, Annual Energy Outlook 2008 with Projections to 2030.

As energy prices and the cost of living increase, American households will need to spend an increasing percentage of their incomes on utility bills. By 2009, it is expected that electricity and natural gas utility costs will have increased by at least 25 percent over the 2004 costs.[3] With energy becoming such a significant cost, it is becoming increasingly important to use energy efficiency measures in housing, to reduce energy usage, and therefore utility bills.

The building industry has increased its use of energy efficiency measures and green building designs in the last ten years because of growing concerns about the financial, environmental, and health impacts of using fossil fuels and non-renewable sources of energy. Green building design criteria typically includes energy efficiency, renewable energy, water management and conservation, environmental remediation, materials beneficial to the environment, and healthy living materials. As new energy sources have been further developed (such as solar, wind, and other sustainable forms of energy), residential building designers and suppliers have developed methods to reduce the amount of fossil fuel energy that appliances and building systems traditionally use.

In response to these trends, there are growing opportunities for state and local agencies to advance residential and commercial energy efficiency, through incentive programs to encourage voluntary use of energy efficient measures as well as through revised and updated building requirements. With these changes, more residential housing developers are able to adopt energy efficiency and green building techniques in their projects.

1.2. Why Promote Efficiency and Green Building Techniques in Affordable Housing?

Rising energy costs hit low- and moderate-income households especially hard, often forcing them to make tough choices between paying their utility costs or other household needs. In 2005, the average American family with an after-tax income of $52,069 spent nearly nine percent of its budget on energy, according to *Energy Cost Impacts on American Families, 1997-2007*. The 61 million families—the majority of U.S. households—that earn less than $50,000, however, devoted nearly 20 percent of their after-tax income to energy. The 25 percent of households that earn between $10,000 and $30,000 paid 20 percent and more of their estimated after-tax income on energy.

Many working households must accommodate increases in energy by cutting back on expenditures to meet other needs. Several studies demonstrate a link between a family's inability to pay its home energy bills and consequences such as homelessness, malnutrition, heart disease, and heat stroke. Some studies have even linked the inability to pay utility bills to the disintegration of families. There are reports of children who were removed from their homes because of loss of heat or electricity, senior homeowners who were forced to sell their homes because they could not keep up with their energy bills, and families who have needed to move frequently, because they are unable to pay their energy bills. This frequent moving disrupts children's educational development.[4]

To address the impacts of rising energy costs on low-income households, both national and local efforts are focusing on the reduction of energy use and cost by building more energy efficient, affordable housing.

Figure 1-3 illustrates the home energy affordability gap, which is a measure that shows the amount by which home energy bills exceed what is considered affordable. The table shows the national dollar average as well as data from the states with the highest and lowest gap that show the burden or percentage of income families would pay for all home energy costs. For example, the table shows that in Vermont, households that are below 50% of the federal poverty line spend 78.9% of their gross income on all home energy costs.

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[3] United States Energy Information Administration, U.S. Data Projections. Short Term Energy Outlook tables for residential energy usage. http://www.eia.doe.gov/oiaf/forecasting.html. March 20, 2008.

[4] Trisko, Eugene. "Energy Cost Impacts on American Families, 1997-2007." *Balanced Energy*. May 2007. http://www.balancedenergy.org/docs/ABEC%20Media%20Room%20Docs/ABEC%20Energy%20Costs%201997%20to%202007%20507-2.pdf. 12 December 2007.

Figure 1-3: 2006 Home Energy Affordability Gap

The Home Energy Affordability gap is the average dollar amount by which actual home energy bills exceeded affordable home energy bills for households below 185 percent of poverty level. The federal poverty guidelines in 2004 established the poverty level for a family of four in the 48 contiguous states and Washington, DC at $18,850.

2006 U.S. Home Energy Affordability Gap

Total U.S. Affordability Gap = $29,808,824,730

- Average Gap per Household = $1,047

2006 State Home Energy Affordability Gap Ranking

State with Smallest Gap: Washington

- Average Gap per Household = $444

Home Energy Burden for the State of Washington by Federal Poverty Level		
Poverty Level	**Home Energy Burden**	**No. of Households**
Below 50%	35.1%	105,162
50 – 74%	14.1%	62,130
75 – 99%	10.1%	72,636
100 – 124%	7.8%	78,736
125 – 149%	6.4%	87,334
150 – 185%	5.2%	125,900

State with Largest Gap: Vermont

- Average Gap per Household = $1,949

Home Energy Burden for the State of Vermont by Federal Poverty Level		
Poverty Level	**Home Energy Burden**	**No. of Households**
Below 50%	78.9%	8,591
50 – 74%	31.6%	6,274
75 – 99%	22.6%	7,855
100 – 124%	17.7%	9,261
125 – 149%	14.5%	10,337
150 – 185%	11.9%	15,377

Source: Home Energy Affordability Gap Ranking: Dollar Gap per Household by State April 2007. The Home Energy Affordability Gap. *Fischer, Sheehan, & Colton, Public Finance and General Economics, Belmont, Massachusetts. April 2007. Available online at: http://www.homeenergyaffordabilitygap.com/downloads/2006_Released_Apr07/2006%20HH%20Gap%20by%20State.pdf. 14 February 2008.*

1.3. Benefits of Energy Efficiency in Affordable Housing

Benefits for Residents, Property Owners, and PJs

Creating affordable housing that is energy efficient offers important short- and long-term benefits for the nation in reduced pollution and demand for energy. There are also direct benefits to residents, property owners, state and local housing agencies, PJs, and HUD. These include:

- Energy bill savings for low-income families, property owners, state and local PJs, and HUD;
- Improved home performance (in terms of air quality or reduced maintenance) which creates a healthier environment for residents;
- Greater future financial stability for residents and property owners through increased savings;
- Improved marketability of the home when renting or selling;
- Reduced long-term maintenance costs due to the use of more durable products and building techniques; and
- Increased affordability of housing due to reduced utility costs.

Savings on Energy Bills

Compared with standard homes, energy efficient homes use substantially less energy for heating, cooling, and water heating. These efficiencies can result in annual savings of hundreds of dollars, which can add up to thousands of dollars saved on utility bills throughout the life of a property. These savings benefit whoever is paying the utility bills, including the homeowner, property owner, state or local housing agency, or HUD.

Improved Home Performance

Long-term building performance is not always a priority consideration when designing and building affordable housing. Furthermore, some low-cost designs and features may result in other adverse costs and/or risks to residents, such as failure to vent bathroom fans to the exterior which can result in moisture and mold problems. Improved home design and performance can improve the health and financial stability of low-income families.

By building affordable housing with energy-efficient techniques and products, low-income residents can live in more comfortable and healthy homes. Properly installed energy-efficient products, such as windows, insulation, ducts, and HVAC systems, can deliver better protection against cold, heat, drafts, moisture, pollution, and noise and help to ensure consistent temperatures between and across rooms, improved indoor air quality, and greater durability.

Future Financial Stability

Energy efficiency often results in savings in utility bills and maintenance costs. For low-income households, this might enable homeowners to pay for other necessities, such as food, rent, and medication. Over the long-term, families may be able to build savings for emergencies, education, and other long-term investments – making them more financially stable.

For property owners, developing energy efficient properties can strengthen a property's revenue and financial viability by slowing the rate of growth in utility and maintenance costs while also supporting higher occupancy rates due to enhanced property desirability. The property may also realize increased value from higher quality construction and more durable appliances and materials. The increase in capital value tied to Energy STAR certification is being recognized by appraisers.

Improved Marketability

Improved health, comfort, and safety; lower utility bills; less required maintenance; and superior indoor air quality can translate into an easier sale or rental at a higher return compared to less energy efficient homes. Property owners may spend less time and therefore less money, leasing up or selling units. For homeowners, energy-efficiency features in a home can result in lower utility costs, which can increase a home's value at resale.

Long-Term Maintenance Savings

Energy-efficient properties tend to be of higher quality and require less maintenance than standard properties. Therefore, energy efficiency features may extend the life of property. For example, energy-efficient and properly installed windows can help reduce the potential for condensation, which damages window sills, causes paint to crack, and encourages the growth of mold. With energy efficiency features, housing programs spend less on operating and maintenance costs over the life of the property because of the quality and durability of the property.

Additionally, if the property is sold to a low-income household, the household will likely have lower maintenance costs. The house will be less likely to fall into disrepair and require additional funding from the state or locality than if it were a standard home.

More Sustainable Affordable Housing and Additional Program Funds Leveraged

In addition to making existing housing units affordable, the savings in utilities and maintenance costs can increase operating revenue for rental property owners. This additional revenue makes affordable housing properties more financially sustainable than traditional properties because owners can use this revenue to address maintenance and capital replacement needs for a longer period without having to seek refinancing for repairs and rehabilitation. This revenue not only makes the property more financially sustainable, it will allow PJs and other agencies to put more program funds toward additional units, rather than having to use these funds to preserve existing properties that are in financial distress due to rising operating costs.

For PJs, the ability to leverage energy program funding can also augment state and local housing program budgets and may even be able to satisfy matching and leveraging requirements.

1.4. Benefits to HUD and Its Key Programs

In any single year, HUD assists more than five million renters and homeowners through its various programs, who occupy approximately five percent of all housing in the nation. HUD spends more than $4 billion each year on energy—more than 10 percent of its budget—primarily through utility allowances to renters, housing assistance payments to private building owners, and operating grants to public housing authorities. Of the $4 billion, HUD spends an estimated $1.1 billion each year on utilities in public housing alone, either in direct operating grants or in the form of utility allowances to individual residents.

Incorporating energy efficiency into HUD-assisted projects could yield significant cost savings to the Federal government, property owners, and building residents. Reducing energy bills by just five percent could yield a savings of $2 billion over the next ten years—funds that could be used to finance additional affordable housing for families.

Greater energy efficiency could conservatively save traditional public housing at least $82 million or result in as much as $165 million per year in savings.[5] Similar savings might be achieved in HUD's inventory of assisted multifamily housing, as well as other housing financed by HUD through its formula and competitive grant programs.

1.5. HUD's Priorities for Moving Forward

In July 2001, HUD established a department-wide Energy Task Force to identify measures that HUD could take to support the energy efficiency and conservation goals of the National Energy Policy. In establishing the Task Force, HUD's Deputy Secretary directed the Task Force to develop an Action Plan that addressed the following objectives:

- Improve energy efficiency and conservation in HUD-assisted rental housing;
- Expand the use of Energy Efficient Mortgages, consistent with sound underwriting principles;

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[5] U.S. Department of Housing and Urban Development. *HUD's Energy Action Plan.* 8 October 2007. Available online at: http://www.hud.gov/energy/energyactionplan.pdf.

- Provide technical assistance on energy issues to nonprofits and faith-based organizations; and
- Research and develop new energy-efficient technologies.

HUD's 2002 Energy Action Plan recommends 25 activities that HUD can undertake to support energy efficiency efforts. Attachment 1-1 provides the complete list. When implemented, the actions will encourage energy efficiency in some five million housing units that are assisted, insured, or otherwise subsidized through HUD's programs. HUD's overall goal is to significantly reduce energy use in HUD's inventory of public and assisted housing and in HUD-financed housing.

Partnerships for Home Energy Efficiency

Through a Memorandum of Understanding signed in September 2002, HUD works with EPA and DOE to expand the use of ENERGY STAR products in assisted and public housing, as well as in projects financed through other HUD programs, such as the Community Development Block Grant (CDBG) and HOME programs. As part of the agreement, HUD works with DOE and EPA to promote the purchase of ENERGY STAR qualified appliances by the nation's housing authorities, and by HUD's inventory of privately-owned assisted housing. The agreement also promotes the construction of new ENERGY STAR qualified homes through HUD programs. These efforts include developing ENERGY STAR informational and promotional materials which can be distributed to field staff, public housing authorities, formula and competitive grant recipients, and assisted housing property managers to help educate homebuyers and homeowners on the benefits of purchasing ENERGY STAR products or of building energy-efficient new homes.

HUD began implementing the recommendations in the Energy Task Force Action Plan with a Memorandum of Understanding with the Environmental Protection Agency (EPA) and the Department of Energy (DOE) to promote the use of ENERGY STAR. HUD joined EPA and DOE in 2005 with creation of the Partnerships for Home Energy Efficiency, which seeks to bring greater energy efficiency to the U.S. housing market by helping households save ten percent or more on home energy bills over the next 10 years. Savings of ten percent on home energy bills represents an almost $20 billion savings a year and would increase the affordability and comfort of homes, eliminate the need for more than 40 power plants, and prevent the greenhouse gas emissions equivalent to those from more than 25 million vehicles.[6] In addition, it would reduce demand for natural gas by more than 1 quad (quadrillion Btu). Note: a quad is a unit which expresses a very large amount of energy. In 2006, U.S. energy consumption was approximately 99 quad.[7]

HOME Program and Energy Efficiency

The HOME Program has taken actions to encourage PJs to undertake energy efficiency measures and to provide assistance to PJs in this area. HUD provides technical assistance to PJs and community housing development organizations (CHDOs) to encourage energy efficiency when using HOME and CDBG funds so they can better incorporate energy efficient practices into the development projects they undertake with HUD funds.

HUD encourages HOME PJs to incorporate ENERGY STAR qualified products and practices when conducting rehabilitation or constructing new housing. Housing that is constructed or rehabilitated with HOME funds must meet all applicable local codes, rehabilitation standards, ordinances, and zoning at the time of project completion, in accordance with 24 CFR 92.251. This section of the HOME Final Rule also requires that newly constructed housing must meet the International Energy Conservation Code (formerly known as the Model Energy Code). PJs can adopt higher standards and are urged to adopt the ENERGY STAR qualified homes standards.

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6 U.S. Department of Environmental Protection, Partnerships for Home Energy Efficiency. *Overview of the Partnerships for Home Energy Efficiency.* 5 October 2007. http://www.energysavers.gov/pdfs/phee_overview.pdf.

7 U.S. Department of Energy, Energy Information Administration. "Table 1.1 Energy Overview, Selected Years, 1949-2006." 27 June 2007. *Annual Energy Review 2006*. October 2007. http://www.eia.doe.gov/emeu/aer/pdf/pages/sec1_5.pdf.

The HOME Program has developed an internet-based training module on energy efficiency. Each Community Planning and Development (CPD) field office distributes ENERGY STAR information to CDBG grantees and HOME PJs in their areas. Following the distribution of information, the Boston field office has followed up with a training workshop, surveys, and telephone consultations. As a result, over 40 grantees and PJs have adopted ENERGY STAR, and a reported number of around 4,000 affordable ENERGY STAR housing units have been newly constructed in the region. In North Carolina, HOME funds have been used to finance energy-efficient, high-performance new construction in more than 800 new homes.

Effective in 2007, CPD requires HOME PJs and CDBG grantees to track the number of units built with HOME and CDBG funds to ENERGY STAR standards through the Integrated Disbursement and Information System (IDIS). In February 2006, HUD published a final rule on the IDIS performance measures to implement these new reporting requirements regarding ENERGY STAR qualified units.

Attachment 1-1:
HUD's Energy Strategy: Summary of Actions

Strengthen Partnerships with Federal Agencies and Local Communities to Promote ENERGY STAR and Energy Efficiency in the Residential Sector

1. Department-wide HUD promotes the use of ENERGY STAR products and standards through HUD's new Partnerships for Home Energy Efficiency with DOE and EPA.
2. Department-wide HUD establishes residential energy partnerships with cities, counties, states, and other local Partners.
3. The Federal Housing Administration (FHA) continues to strengthen HUD-DOE multifamily weatherization partnerships.
4. The Office of Field Policy and Management partners with local energy efficiency groups, HUD program offices, and other agencies to educate HUD customers about ways to reduce energy costs.

Strengthen Incentives and Implement New Statutory Requirements for Energy Efficiency through HUD Programs

5. Department-wide HUD provides incentives for energy efficiency in housing financed through HUD's competitive grant programs.
6. The Office of Public and Indian Housing bases appliance and product purchases in public housing on ENERGY STAR standards, unless the purchases are not cost effective.
7. The Office of Public and Indian Housing builds HOPE VI developments to a high level of energy efficiency.
8. The Federal Housing Administration encourages use of ENERGY STAR new home standards in the design, construction, and refinancing of Sections 202 and 811 projects.
9. The Federal Housing Administration develops incentives for energy efficiency through FHA multifamily insurance programs.
10. The Federal Housing Administration implements energy efficiency recommendations of the Consensus Committee in HUD-code homes.

Provide Training and Technical Assistance on Energy Efficiency for Homeowners, Renters, and Property Owners

11. Department-wide HUD provides training or information on energy efficiency to residents or organizations building or rehabilitating affordable housing.
12. The Office of Community Planning and Development encourages energy efficiency in HOME- and CDBG-funded new construction and housing rehabilitation projects.
13. The Office of Public and Indian Housing streamlines energy performance contracting in public housing.
14. The Office of Public and Indian Housing promotes energy conservation in federally-assisted housing on Indian tribal lands.
15. The Federal Housing Administration features the Energy Efficient Mortgage (EEM) as a priority loan product.
16. The Federal Housing Administration provides training on how FHA single family programs can be effectively used to promote energy efficiency.
17. The Federal Housing Administration promotes energy efficiency in assisted multifamily housing programs.

18. The Federal Housing Administration explores asset management strategies and guidance for energy efficiency in HUD-subsidized multifamily properties.
19. The Federal Housing Administration supports energy efficiency training for multifamily managers and maintenance staff.

Establish Measures to Track Progress in Reducing Energy Consumption and Ensure Accountability

20. Department-wide HUD includes energy efficiency performance measures in HUD's Annual Performance Plan and Management Plan.
21. The Office of Public and Indian Housing improves tracking and monitoring of energy efficiency in public housing.
22. The Federal Housing Administration continues to improve tracking and evaluate performance of Energy Efficient Mortgages.

Support Further Research and Technology Development

23. The Office of Community Planning and Development identifies opportunities and assists with feasibility analysis for Combined Heat and Power in public or assisted housing.
24. The Office of Policy Development and Research conducts energy-related policy analysis and research to support Departmental energy efficiency actions.
25. The Office of Healthy Homes and Lead Hazard Control develops computerized assessment tool for integrated energy and environmental retrofits.

Chapter 2: ENERGY STAR Qualified Homes

This chapter provides an overview of the ENERGY STAR qualified homes program and the requirements for obtaining certification. The chapter explains:

- *Requirements for an ENERGY STAR qualified home;*
- *How a property is certified;*
- *The benefits of achieving the ENERGY STAR qualified home label;*
- *The roles and responsibilities of key actors in achieving this certification; and*
- *Where to look for financial and technical assistance.*

2.1. What Is the ENERGY STAR Program?

ENERGY STAR is the U.S. government-backed label for energy efficiency. The ENERGY STAR label identifies homes, buildings, and consumer products that meet specific standards for energy efficiency and performance. A joint program of Environmental Protection Agency (EPA) and the Department of Energy (DOE), ENERGY STAR is designed to help individuals and organizations nationally and internationally adopt cost-effective, energy-efficient technologies and practices, and better manage their energy costs.

EPA introduced ENERGY STAR as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions in 1992. Computers and computer monitors were the first labeled products. The label was then extended to office equipment products and residential heating and cooling equipment, and in 1995 to new homes. In 1996, EPA partnered with DOE for particular product categories. Today, the ENERGY STAR label is on more than 50 types of consumer products, new homes, and commercial and industrial buildings. Products with the ENERGY STAR label deliver the same or better performance as comparable models while using less energy and saving money.

ENERGY STAR is a voluntary partnership between the government and more than 9,000 organizations, including 4,500 of the nation's homebuilders. These public and private organizations have joined forces with EPA and DOE through ENERGY STAR to promote energy efficiency. The voluntary partnership program provides technical information and tools for organizations and consumers about energy-efficient solutions and best practices for managing energy consumption.

Partners in ENERGY STAR

ENERGY STAR has more than 9,000 partner organizations that have committed to improving and promoting the energy efficiency of their products, homes, and businesses. Of those partner organizations:

- Almost 4,500 builder partners are constructing new homes that qualify and are certified as ENERGY STAR in every state and the District of Columbia.
- More than 1,700 manufacturers are using ENERGY STAR to label more than 40,000 product models.
- More than 900 retail partners, located in the U.S. and Puerto Rico, are selling ENERGY STAR qualifying products and bringing educational information to their customers.
- About 2,500 private businesses, public sector organizations, and industrial facilities are investing in energy efficiency and reducing energy use in their buildings.
- More than 40 states and 500 utilities are leveraging ENERGY STAR to improve the efficiency of commercial buildings and homes.

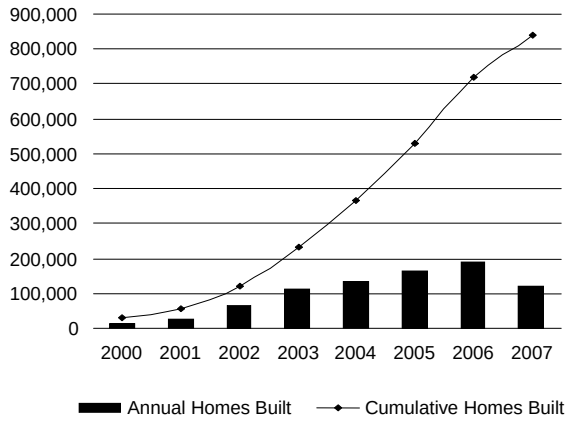
Source: U.S. Environmental Protection Agency, ENERGY STAR. ENERGY STAR Overview of 2006 Achievements. *10 April 2007. Available online at: http://www.energystar.gov/ia/partners/pt_awards/2006_Achievements_Overview.pdf, 8 October 2007.*

2.2. ENERGY STAR and Housing

Over time, EPA extended the ENERGY STAR label beyond consumer products to cover residential, commercial, and industrial buildings. In 1995, EPA launched ENERGY STAR qualified homes. These homes are 30 percent more efficient than those built in accordance with the Model Energy Code. In 1997, ENERGY STAR qualified homes expanded to include manufactured homes. By 2002, the ENERGY STAR label extended to office buildings, schools, hospitals, hotels, and grocery stores. In general, these buildings perform in the top 25 percent of the market.

In 2007, more than 120,000 new homes were constructed to meet ENERGY STAR standards, bringing the total number of ENERGY STAR qualified homes in the U.S. close to 850,000.

Figure 2-1: Growth of ENERGY STAR Homes



Source: EPA Climate Protection Partnerships Division. Energy Star Overview of 2007 Achievements. *Data as of March 1, 2008.*

Owners of these homes are saving more than $170 million annually on their utility bills. As a result of the ENERGY STAR program's expanding efforts, the total number of ENERGY STAR qualified homes nationwide has close to doubled in the past two years, with market penetration exceeding 20 percent of the new home starts in more than 10 states and 20 metropolitan areas.

For more information on ENERGY STAR in existing homes, see Chapter 4.

2.3. What Is an ENERGY STAR Qualified Home?

ENERGY STAR qualified homes are the result of a process by which the entire home is planned and then built for improved energy efficiency. The developer must design and construct the project to standards that ensure both energy and cost savings will be delivered to the property owner and the tenant. ENERGY STAR qualified homes are significantly more energy efficient than traditional homes because they use more effective insulation; higher performing windows; tighter construction and ducts; and more efficient heating and cooling equipment, lighting, and appliances. A family that lives in an ENERGY STAR qualified home benefits because the home is made of high quality materials, and the energy efficient features result in lower utility bills, better air quality, improved comfort, and lower maintenance demands.

2.4. ENERGY STAR Qualified Homes Standards and Requirements

Any home three stories or less can earn the ENERGY STAR qualified home label if it has been verified to meet the program's standards. Eligible types of homes include:

- Single family;
- Low-rise multifamily homes (three stories or less);
- Manufactured homes;
- Systems-built homes (e.g., structurally insulated panel (SIP), insulated concrete forms (ICF), or modular construction);
- Existing retrofitted homes.

The ENERGY STAR qualified home label is primarily intended for new construction, but it can be obtained for substantial rehabilitation of an eligible property. Because of the strict performance standards that must be met, homes that undergo less extensive rehabilitation are unlikely to cost-effectively meet the ENERGY STAR standard.

To earn the ENERGY STAR qualified home designation, a home must meet the following three criteria:

- Meet the appropriate Home Energy Rating System (HERS) Index (see Figure 2-2);
- Be verified and field-tested in accordance with the RESNET Standards by a RESNET-accredited provider; and
- Meet all applicable codes.

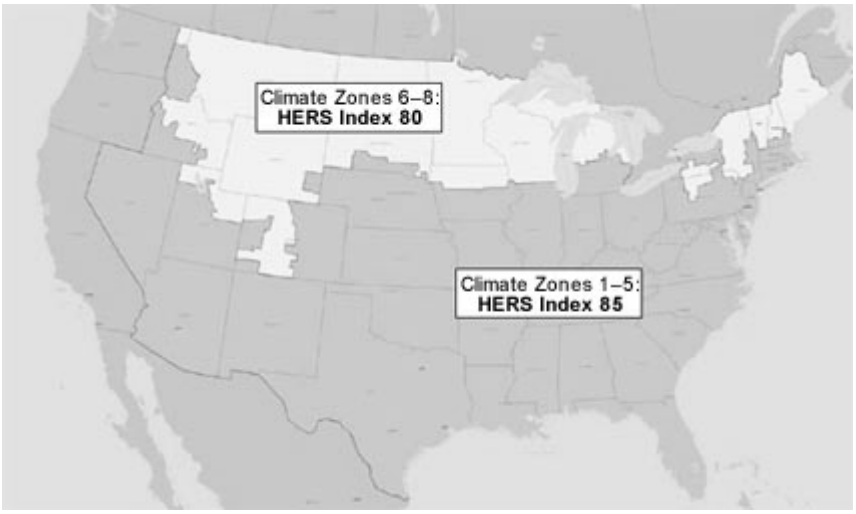
HERS Index

The HERS Index provides a numeric score indicating the relative energy efficiency of a home. The lower the score, the more energy efficient the home. An ENERGY STAR home must achieve a HERS Index score of:

- Less than or equal to 80 in the North; or
- Less than or equal to 85 in the South.
- Hawai'i, California, and the Pacific Northwest have regionally developed ENERGY STAR qualified home standards that have been allowed by EPA.

As a point of reference, a score of 100 represents the 2004 International Energy Conservation Code (IECC) code. Because the HERS Index is tied to the 2004 IECC and one point on the HERS Index is equivalent to one percent change in efficiency for a home, the ENERGY STAR qualified home standard is at least 15 percent more efficient than the IECC in the south and middle parts of the country; and 20 percent more efficient than the IECC in the north.

Figure 2-2: Maximum HERS Index Required to Earn the ENERGY STAR



Energy Codes and ENERGY STAR

Until 2006, the energy performance of ENERGY STAR qualified homes was based on the 1993 Model Energy Code (MEC). Specifically, to earn the ENERGY STAR label, a home had to be independently verified for be at least 30 percent more efficient than a home built to the 1993 MEC. In recent years, states have increasingly adopted a new national energy code, the International Energy Conservation Code (IECC) that took over the energy code role beginning with the 2005 MEC. This code is more rigorous than the MEC, particularly in the south. As a result of this change, the performance standards for ENERGY STAR qualified homes were also increased to ensure that ENERGY STAR continued to represent a meaningful increase in efficiency for consumers over standard code-built homes.

EPA adopted new standards that went into effect for homes permitted as of July 1, 2006. EPA set ENERGY STAR at two different levels, depending on the area of the country—15 percent more efficient than the 2004 IECC in the south and middle parts of the country; and 20 percent more efficient than the IECC in the north. Additional requirements for comprehensive air barrier details, which are not addressed by the code, further increase the overall performance of ENERGY STAR qualified homes by another five to eight percent.

2.5. Certifying ENERGY STAR for New Homes

HERS Rater and RESNET Standards

The developer is responsible for following the process to ensure a home is certified as an ENERGY STAR qualified home. The developer must contract with an independent third-party, known as the Home Energy Rater, or HERS rater. HERS raters inspect, test, and certify all homes seeking the ENERGY STAR qualified homes label. HERS raters follow the Home Energy Rating System (HERS) Index to determine the energy efficiency of a home.

HERS raters must be trained and certified by state agencies and the Residential Services Network (RESNET), which was established in 1995 by the National Association of State Energy Officials and Energy Rated Homes of America in order to develop a national standard for home energy rating systems. HERS raters are trained to evaluate construction techniques, take key measurements, and perform inspections and testing procedures to verify a home's efficiency performance. The HERS rater can also advise the builder on how to select the most appropriate energy-efficient features for a home and inspect and test the home during and after construction to verify that the home meets EPA's strict guidelines for energy efficiency.

Two Paths for Qualifying Homes

ENERGY STAR has two approaches to achieve the standards for an ENERGY STAR qualified new home.

- **Performance Path.** Under the ENERGY STAR Performance Path approach to qualification, a rater simulates a home's energy efficiency based on the building plans with specialized computer software. This allows the rater to identify the most effective upgrades to a specific property to meet ENERGY STAR performance standards.
- **Prescriptive Path.** Under the ENERGY STAR Prescriptive Path approach to qualification, the builder and rater use a set of climate-specific construction specifications developed by EPA called a Builder Option Package (BOP). Based on extensive analyses, the BOP specifications have been determined to result in homes that consistently meet ENERGY STAR standards.

Regardless of how the energy efficiency features are selected, HERS raters must also conduct on-site inspections and tests of a home. The process usually includes a blower door test, which tests for air leaks in the house structure or envelope and a duct blaster test, which tests for air leaks in the duct system. The HERS rater also completes a Thermal Bypass Checklist, which is a visual inspection of common construction areas where air can flow through or around insulation. This field verification ensures that a home's performance is consistent with ENERGY STAR standards. The standards for HERS, inspection protocols, and testing guidelines are maintained by RESNET.

For additional information about HERS, the HERS Index, and the rating process, see Attachment 2-2.

2.6. Who Are the Key Actors Involved?

HOME PJs, as well as other key affordable housing partners, all have a role in achieving ENERGY STAR standards and maintaining the home's performance. HUD encourages HOME PJs to promote or require ENERGY STAR qualified home certifications in their development programs, and to incorporate ENERGY STAR qualified products and practices whenever feasible in rehabilitation projects.

- **PJ.** While HOME requires PJs to adopt IECC standards in new construction, the PJ can choose to incorporate ENERGY STAR standards into its development programs. The PJ can encourage or require developers to meet ENERGY STAR standards when they proposing projects under suitable HOME-funded programs, update rehabilitation and new construction standards to address ENERGY requirements, and revise program procedures to confirm and document that developers are taking adequate steps to obtain an ENERGY STAR certification upon project completion. For more information about the roles and responsibilities of the PJ, see Chapter 3.
- **Developer.** When the PJ has determined that the HOME-assisted housing must meet ENERGY STAR standards, the developer must ensure the ENERGY STAR standards are integrated into the design and construction of the project. With the HERS rater, the project developer must thoroughly review the site plans.

The project developer is responsible for ensuring its contractors and subcontractors have enough information in the specifications and the training necessary to achieve ENERGY STAR standards.

- **Construction Contractor and Subcontractor.** The sole responsibility of the construction contractor and subcontractor is to build the project according to the plans and ENERGY STAR standards, as approved by the PJ. The contractors should be trained in the construction methods used to obtain ENERGY STAR certification.
- **HERS Rater.** A third-party certified HERS rater reviews the site plans with the developer to ensure the completed project will meet ENERGY STAR standards. The rater also inspects the design features and the efficiency measures incorporated into the project for appropriate installation and overall energy performance.
- **Property Owner.** Once the housing is completed, the property owner needs to maintain the energy efficient features of the home. Up-keep includes regularly scheduled inspections of efficient building features (such as duct work and insulation) to ensure ongoing performance as well as general maintenance of ENERGY STAR appliances. In situations where the unit occupant is not the property owner, the property owner is additionally responsible for educating and informing tenants of the appropriate ways to use energy efficient appliances within their unit to ensure they achieve their full potential.
- **Occupant.** Residents can reduce energy consumption and costs by following energy conservation practices, using appliances appropriately, and reporting malfunctions or symptoms that building features are failing to the property owner for resolution. It is important that the residents understand how to use the efficiency features in their units so that they achieve maximum energy efficiencies and savings. Residents can achieve further energy savings by conserving energy use. For instance, residents need learn to:
  - Turn off lights when not in use;
  - Use a programmable thermostat;
  - Turn off the heating or cooling system when leaving the home;
  - Use a ceiling fan in addition to (or instead of) the air conditioner to distribute the cool air so that less work is needed to make the room feel cool;
  - Use cold or warm water in laundry batches (unless dirty with oil stains) and only do laundry or dishes when a full load needs to be cleaned. This not only saves energy, but water as well.

2.7. What Are the Main Components of a Typical ENERGY STAR Home?

ENERGY STAR qualified homes are designed and built using a "whole-house" approach that incorporates a range of energy-efficiency features and systems to improve home quality and homeowner comfort, lower energy demand, and reduce air pollution. For more information on the "whole-house" approach used by ENERGY STAR, see Attachment 2-1.

The main components of a typical ENERGY STAR qualified home are:

- Effective insulation;
- High-performance windows;
- Tight construction and ducts;
- Efficient heating and cooling equipment;
- Lighting and appliances; and
- Third-party verification.

Effective Insulation

ENERGY STAR qualified homes must have properly installed and inspected insulation in floors, walls, and attics. This ensures consistent temperatures throughout the house, reduces energy use, and increases comfort for residents. As much as half of the energy used in a home is for heating and cooling. A properly installed insulation barrier prevents heat loss in the winter and heat gain in the summer, thereby reducing utility bills year round. When insulation is properly installed, the potential for condensation that can lead to decay of building materials is also reduced, thereby improving the durability of a home. If insulation is not properly installed, a home can have excessive heat gain during the summer and heat loss in the winter—forcing the heating and cooling systems to work overtime. The insulation in ENERGY STAR qualified homes meets or exceeds the latest national code requirements, providing year-round comfort while reducing utility bills.

High-Performance Windows

ENERGY STAR qualified windows use advanced technologies, such as protective coatings and improved frames, to help keep heat in during winter and out during summer. In addition to maintaining consistent temperatures throughout homes, they are better for the environment because they reduce the emissions of greenhouse gases and air pollutants from entering and exiting the house. High-performance windows are tailored for four climate zones and independently tested for superior energy performance. For example, windows in the North are optimized to reduce heat loss in the winter, while windows in the South are optimized to reduce heat gain during the summer. Because of their variations, windows that are energy efficient in Florida will not necessarily be energy efficient in Michigan.

The energy performance of all ENERGY STAR qualified windows and skylights is independently tested and certified according to procedures established by the National Fenestration Rating Council (NFRC). NFRC is a third-party, nonprofit organization that sponsors certified rating and labeling programs to help consumers compare the energy and performance features of windows and skylights.

Tight Construction and Ducts

ENERGY STAR qualified homes must have efficient and tightly sealed duct systems that carry air from central heaters or air conditioners to each part of the home and back again. Tight construction and efficient duct systems reduce drafts, moisture, dust, pollen, and noise. A tightly sealed home improves comfort and indoor air quality while reducing utility usage and maintenance. In a standard house, about 20 percent[8] of the air that moves through the duct system is lost due to leaks, holes, and poorly connected ducts. The duct systems found in ENERGY STAR qualified homes are third-party tested for tightness and verified to be properly insulated.

Efficient Heating and Cooling Equipment

Energy-efficient heating and cooling systems are necessary in ENERGY STAR qualified new homes. ENERGY STAR qualified heating and cooling systems can be quieter, reduce indoor humidity, and improve the overall comfort of the home. ENERGY STAR qualified heating equipment can be up to 15 percent[9] more efficient than standard models. Also, ENERGY STAR qualified homes built in the North typically include "right-sized" (the appropriate size for the load required) ENERGY STAR qualified heating equipment. ENERGY STAR qualified heating systems are designed to use less energy than standard systems and reduce the risk of back-drafting dangerous carbon monoxide exhaust into the home. Most ENERGY STAR qualified heating systems employ advanced technologies and high quality components, often resulting in longer equipment life and longer warranties compared to standard models.

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8 U.S. Environmental Protection Agency, ENERGY STAR. *Efficient Duct System*. Available online at: http://www.energystar.gov/ia/new_homes/features/DuctSystems_062906.pdf,8 October 2007.

9 U.S. Environmental Protection Agency, ENERGY STAR. *ENERGY STAR Qualified Heating Equipment.* Available online at: http://www.energystar.gov/ia/new_homes/features/Heating_062906.pdf, 8 October 2007.

Like heating costs in the North, cooling costs can make up a large part of a home's energy bill, especially in the South. ENERGY STAR qualified homes typically include right-sized ENERGY STAR qualified cooling equipment that lowers energy use, increases comfort, improves durability, and operates more quietly than standard models. Mechanical ventilation systems circulate fresh air using ducts and fans, rather than relying on airflow through small holes or cracks in a home's walls, roof, or windows. Mechanical ventilation systems control the source and amount of air that comes into the house, and can significantly improve a home's air quality by removing allergens, pollutants, and moisture that can cause mold problems.

Lighting and Appliances

ENERGY STAR qualified homes may also be equipped with ENERGY STAR qualified products, such as lighting fixtures, compact fluorescent bulbs, ventilation fans, and appliances. ENERGY STAR qualified appliances incorporate advanced technologies and use ten to 50 percent less energy than standard appliances. ENERGY STAR qualified appliances, (including refrigerators, freezers, dishwashers, and clothes washers), lower utility bills, and often have superior components and performance compared to standard appliances. Appliances account for nearly 20 percent of the average household's energy use. A comprehensive package of ENERGY STAR qualified appliances can save up to $80 a year in energy costs compared to standard appliances.[10]

An ENERGY STAR qualified compact fluorescent light bulb (CFL) uses about 75 percent less energy than a comparable standard incandescent bulb. CFLs also operate at less than 100°F and are safer than the halogen bulbs, which burn at 1,000°F. ENERGY STAR qualified fixtures and bulbs meet strict standards for longevity. In addition, ENERGY STAR qualified fixtures come with a 2-year warranty—twice the industry standard. Replacing the five most frequently used light fixtures in a home with ENERGY STAR qualified lighting can save about $65 each year in energy costs.[11]

Examples of ENERGY STAR Products that Save Energy in Homes

This list provides a sample of some of the more than 50 types of ENERGY STAR Products:

- **Light Bulbs.** ENERGY STAR qualified light bulbs use about 75 percent less energy than a standard incandescent bulb and last ten times longer.
- **Refrigerators.** The average new ENERGY STAR qualified refrigerator uses less energy than a 60-watt light bulb run continuously.
- **Clothes Washers.** ENERGY STAR qualified clothes washers use about 55 percent less water and 40-50 percent less energy than standard washers, for annual household savings of about $50. Full-sized ENERGY STAR qualified washers use 15-25 gallons of water per load, compared to the 30-35 gallons used by a standard machine.
- **Dishwashers.** New ENERGY STAR qualified dishwashers are at least 41 percent more efficient than standard new models.
- **Heating, ventilation, and air conditioning (HVAC).** Sealing and insulating with ENERGY STAR can result in an annual household savings of $200 (ten percent of the typical energy bill) in heating and cooling costs.

Source: U.S. Environmental Protection Agency, ENERGY STAR. ENERGY STAR Product Factoid Workbook. *August 2007.*

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[10] U.S. Environmental Protection Agency, ENERGY STAR. *ENERGY STAR Qualified Appliances.* Available online at: http://www.energystar.gov/ia/new_homes/features/Appliances_062906.pdf, 8 October 2007.

[11] U.S. Environmental Protection Agency, ENERGY STAR. *ENERGY STAR Qualified Lighting* .http://www.energystar.gov/ia/new_homes/features/Lighting_062906.pdf, 8 October 2007.

2.8. What Are the Benefits and Advantages of Achieving ENERGY STAR Label?

In addition to the benefits of achieving greater energy efficiency discussed in Chapter 1, achieving the ENERGY STAR qualified homes label offers many important additional advantages for homebuyers, including having a third party inspection, adding value to their home, increasing their discretionary income, and increasing the availability of special financing tools.

Third-Party Inspections

Having a third-party inspection gives homebuyers the peace of mind that their home meets the energy-efficient standards of ENERGY STAR, and will perform to those standards. Third party inspections provide homebuyers the assurance that their homes have properly installed energy-efficient features that deliver better protection against cold, heat, drafts, moisture, pollution, and noise; and help ensure consistent temperatures between and across rooms; improve indoor air quality; and have greater durability. The use of third party inspectors also makes it easier for HOME PJs to incorporate ENERGY STAR into their programs, because they do not have to hire or train staff to perform this function.

Adds Value to the Home

Increasingly, ENERGY STAR qualified homes are likely to appreciate in value over time. Because of the strict energy-efficient standards and the verification process, homebuyers are placing a greater value on homes with the ENERGY STAR label. By the end of 2007, close to one million homes are expected to earn the ENERGY STAR label. As more homes become qualified, ENERGY STAR will become an even more widely recognized standard that homebuyers look for when looking for a new home.

Increased Discretionary Income for Owner/Resident

Compared to standard homes, ENERGY STAR qualified homes use substantially less energy for heating, cooling, and water heating, which can result in $200 to $400 in annual savings, as illustrated in Figure 2-3. This energy savings translates to an increase in the discretionary income of the property owners and residents paying for utilities. Over the average seven to eight years that a homeowner typically lives in his/her home, the savings on utility bills can add up to thousands of dollars. Additional savings on maintenance can also be substantial.

Figure 2-3 illustrates that while there may be a slight increase in the mortgage of an ENERGY STAR qualified home ($15 per month or $180 over a year), the utility savings ($40 a month or $480 a year) that will be realized results in overall savings to the owner. These savings may increase over time as the cost of energy rises while the mortgage payment remains the same.

Figure 2-3. Average Costs and Savings of an ENERGY STAR Qualified Home

ENERGY STAR Qualified Home	Monthly	Annual
Additional mortgage cost*	-$15	-$180
Utility savings**	+$40	+480
Cost Savings	+25	+300

* *Based on $2,000 additional housing price/value*

** *Likely to increase while mortgage remains fixed*

Source: U.S. Environmental Protection Agency. "Benefits for Homeowners." Available online at: http://www.energystar.gov/index.cfm?c=new_homes.nh_benefits January 10, 2008

2.9. Costs and Savings for ENERGY STAR Qualified Home

The savings and benefits of an ENERGY STAR qualified home generally outweigh the initial purchase costs. Further, the savings achieved from developing or purchasing an ENERGY STAR qualified home are much greater than those achieved by simply installing ENERGY STAR appliances. While the per-unit up-front development costs of achieving the ENERGY STAR certification generally are modestly higher than a standard home and may require a greater subsidy from the PJ, these features are a good investment because they slow the growth of rapidly rising energy costs that homeowners and rental housing owners and residents will face. By holding down the growth of rising energy costs, the upfront investment to achieve the performance of an ENERGY STAR qualified home means that the HOME-funded homeowner and rental units are much more likely to remain financially viable over time. This means that these properties are also less likely to require additional financial assistance from the PJ in the future, as compared to standard housing developments given the trend in energy prices.

The experience of builders or architects can also have a significant impact on the costs and savings of an ENERGY STAR qualified home. Experienced ENERGY STAR builders have gone through the certification and inspection process several times and have a better understanding of EPA's standards for energy efficiency and how to meet those standards by using the most appropriate energy-efficient features for the type and location of the homes they are building.

2.10. What Technical and Financial Resources Are Available to Support Achieving ENERGY STAR for New Homes Label?

In many areas, financial resources and technical support can be leveraged to achieve ENERGY STAR. PJs and developers can secure funding through Federal grant programs, nonprofits, foundations, and lenders. For a list of specific funding resources, see Attachment 2-3. Technical support is also available through various Federal agencies and nonprofit organizations, and through their websites and databases. For a list of technical resources, see Attachment 2-4.

2.11. Energy Efficient Mortgages

Financing a home purchase using an energy efficient mortgage can also lead to savings. Energy Efficient Mortgages, also known as EEMs, can make it easier for borrowers to qualify for loans to purchase homes with specific energy-efficiency improvements. Lenders can offer conventional EEMs, FHA EEMs, or Veterans Administration (VA) EEMs.

- **Conventional EEMs** can be offered by lenders who sell their loans to Fannie Mae and Freddie Mac. Conventional EEMs increase the buyer's purchasing power when they buy an energy efficient home because the lender is able to increase the borrower's income by a dollar amount equal to the estimated energy savings. This is because the buyer's anticipated income available to pay the mortgage is greater, since he/she will spend less on utilities. The Fannie Mae underwriting criteria also allows lenders to adjust the value of the home to reflect the value of the energy efficiency measures.
- **Federal Housing Administration (FHA)** EEMs allow lenders to add 100 percent of the additional cost of cost-effective energy efficiency improvements to an already approved mortgage loan within certain guidelines. The additional costs can not exceed $4,000 or 5 percent of the value of the home, whichever is greater, up to a maximum of $8000. No additional down payment is required, and the FHA loan limits will not interfere with the process of obtaining the EEM. For more information, see FHA Mortgagee Letter 2005-21: HUD's Energy Action Plan and Energy Efficient Mortgages located at http://www.hud.gov/offices/adm/hudclips/letters/mortgagee.[12]

12 U.S. Environmental Protection Agency, ENERGY STAR. *What is an Energy Efficient Mortgage?* Available online at: http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.energy_efficient_mortgage. 8 October 2007.

- **The Veteran's Administration (VA) EEM** is available to qualified military personnel, reservists, and veterans for energy improvements when purchasing an existing home. To cover the cost of energy improvements, the mortgage loan amount can be increased up to: (1) $3,000 based solely on documented costs, (2) $6,000 if the increase in the mortgage payment is offset by the expected reduction in utility costs, or (3) more than $6,000 based on a value determination by VA. [13]

2.12. ENERGY STAR Bulk Purchasing

Through the ENERGY STAR Quantity Quotes, formerly known as the ENERGY STAR Online Bulk Purchasing Tool, multifamily building owners, public housing authorities, and state and local governments can save money on the purchase price of ENERGY STAR qualified products. This increases the return on investment and reduces the payback period. The tool, developed by DOE and promoted by the HUD Energy Task Force Region 9 Coordinator, allows large homebuilders and property owners to comparison shop for ENERGY STAR qualified products, including: light bulbs, light fixtures, clothes washers, dehumidifiers, dishwashers, refrigerators, and room air conditioners. Purchasers can easily locate available ENERGY STAR qualified products, make contact with the suppliers, and negotiate discounted prices through this online purchasing tool.

[13] Alliance to Save Energy. Energy Efficient Mortgages. 14 March 2008. Available online at: http://www.ase.org/section/_audience/consumers/refinanceremodel/refinancing/.

Attachment 2-1:
The Whole House Approach to ENERGY STAR

Building Envelope

The building envelope separates the interior of a home from the outside environment. This is the component of the building which greatly reduces a home's energy efficiency if a great deal of interior air is escaping. If air is leaking in or out, heating and cooling systems must run for longer periods to achieve the preferred temperature in the house. Common leakage points include around chimneys, ducts, and other holes for plumbing, wiring, and lighting as well as joining points of the house such as the roof and basement.

To create an efficient building envelope for new construction, a great deal of emphasis is placed on tight construction–ensuring the components of the house are fitted and joined together seamlessly to keep air from escaping. Optimum Value Engineering (OVE), a type of engineering in which less lumber is used in the construction of a building, is a common practice employed to remove wood from a home's walls in order to make room for more insulation. The increase insulation limits the heat transfer so that the home retains its interior air temperatures for longer periods without requiring heating and cooling systems to run as frequently. This accomplishes efficiency in materials as well as increasing the level of insulation and reducing the building's consumption of energy. OVE advanced framing techniques include:

- Studs spaced at 24 inches;
- A 2-foot modular design that reduces cut-off waste from standard-sized building materials;
- In-line framing that reduces the need for double top plates;

- Corners built with two studs; and
- Use of insulated headers over exterior building openings (or using no headers for non-load bearing walls).

The entire OVE process can be applied in the construction of a building, or individual components can be incorporated if not everything is appropriate for a specific project.

Once a home is constructed for efficiency, (with particular attention to ducts, vents and insulation, and caulking and sealing of seams or other potential leakage areas), weather stripping around points of entry such as windows and doors can further reduce the amount of conditioned air lost to the outside. Although windows and doors are not primary locations for air leakage, by weather stripping points of entry the builder can reduce some energy usage by the building's heating and cooling systems. ENERGY STAR qualified windows can also be installed to prevent heat gain or loss though windows. The appropriate window will vary, depending on the climate. In cold weather climates, energy efficient windows which have gas between the panes and a low emissivity treatment on the panes reduce the loss of heat through the windows. In warm weather climates, spectrally selective coating on panes reflect the sun's rays to reduce the greenhouse effect of air warming inside the home due to infrared light shining through windows.

The type and amounts of insulation that are installed throughout walls and roof to resist the transfer of heat throughout the home also vary by climate. Different regions of the U.S. require different grades of insulation. Builders must identify what grade is appropriate in a specific community. In order to receive the ENERGY STAR New Homes label, a home must pass the Thermal Bypass Checklist after initial construction, but before drywall is installed. A third-party HERS certified rater uses the checklist to inspect the framing of the home and ensure air and thermal barriers are continuous and complete, and that insulation is installed appropriately.

Mechanical Systems

The mechanical systems in the house are those that condition and deliver air into the home to increase the occupant's comfort. The largest component of a home's mechanical system is the ducts that deliver air from the heating and cooling system to the rooms of a home. If these ducts run through unconditioned spaces (like the home's attic and crawlspaces and have leaks, a large amount of conditioned air escapes into unconditioned space and causes the heating and cooling system to run longer than is necessary.

In creating an energy-efficient system, contractors should ensure the following:

- Ducts that deliver air to rooms of occupancy are sealed and do not leak air behind the walls or into attic areas;
- Ducts in unconditioned areas like an attic are insulated to prevent heat transfer as air is delivered to occupied rooms;
- Supply and Return vents are designed and located properly to deliver proper airflow;
- Air filters are installed. Air filters affect the indoor air quality more than energy savings but it is important to include them. Consumers should ensure that air filters appropriate to their HVAC system are installed and changed frequently so that they do not impede air flow.

Placing vents in areas that are cramped or blocked by pieces of furniture can restrict the delivery of air flow into a room from heating and cooling systems and provide less comfort for the home's inhabitants. In new construction and substantial rehabilitation, paying attention to vent placement and running ducts through conditioned spaces rather than through crawlspaces, attics, or unconditioned basements tends to be more a more energy-efficient practice.

The efficiency of the actual system which cools and heats the air in a building can also make a substantial difference in the efficiency of that building. Several HVAC systems have been labeled as ENERGY STAR can be installed in new homes, and some can be installed in older homes, upon the failure of older heating and cooling systems or when the property is being rehabilitated.

Within heating systems, heat pumps offer an energy efficient method for heating a home. Three types of heat pumps exist. The first collects heat from the outside air that it then distributes inside the building; the second collects heat from the ground for internal distribution; and the third from the groundwater. Heat pumps can double as a central air conditioner by collecting heat within the home and pumping it outside during warm weather months. Generally if a heat pump is not an option, look for efficient heating and cooling systems.

Depending on one's heating and cooling system, one of several indices measures its efficiency. The efficiency of cooling systems is expressed through their Seasonal Energy Efficiency Ratio (SEER) ratings and ENERGY STAR Energy Efficiency Ratio (EER). A system's SEER number indicates the amount of cooling that is supplied by the system in relation to the amount of watts the system requires. Consumers should look for high SEER numbers. ENERGY STAR recommends a minimum of 13 SEER/11 EER.

Air conditioners that were manufactured after January 23, 2006 must meet a minimum SEER of 13 or higher; the previous standard was 10. (Note: A SEER rating of 13 is 30 percent more efficient than 10.) The standard applies only to appliances manufactured after January 23, 2006. Equipment with a rating less than 13 SEER manufactured before this date can still be sold and installed. Since the average air conditioner lasts 15-20 years, most homeowners remain unaffected by this standard change.

In addition to the SEER rating on a heat pump for its cooling function, the Heating Seasonal Performance Factor (HSPF) rates the efficiency of its heating function. The HSPF is especially important to consumers that live in cold climates. ENERGY STAR recommends an HSPF of 8 or higher. If a home uses a furnace rather than a heat pump, the furnace's Annual Fuel Utilization Efficiency (AFUE) rating measures the amount of heat actually delivered to the house compared to the amount of fuel it requires. High AFUE ratings indicate more efficient systems. ENERGY STAR recommends an AFUE of at least 83 percent.

Another key component that adds to the efficiency of a building with little to no effect on the building's occupants is a programmable thermostat. Thermostats control the air temperature by sending a message to cut off the HVAC system when the interior air has achieved a pre-set designation. A programmable thermostat changes the air threshold at different times during the day based on how it is programmed. This allows the air temperature to rise or fall to uncomfortable levels while people are not in the house (during work and school hours) and bring the level back up to preferred temperatures when the building is again occupied. In installing a thermostat, attention should be given to its placement. Thermostats installed next to a window or lamp for instance may get an inaccurate temperature reading. The thermostat should be placed in an area where other components will not interfere with the temperature of the air around them. Occupants must learn how to use a programmable thermostat so that they program it to function as it is intended. Using a programmable thermostat incorrectly can actually increase energy usage.

Lighting and Appliances

By using ENERGY STAR qualified appliances, a household can reduce energy consumption and save significantly. Major ENERGY STAR products to look for include:

- Compact Fluorescent (CFL) bulbs;
- Clothes washers;
- Dishwashers;
- Refrigerators and freezers; and
- Dehumidifiers.

Lighting is one of the largest consumers of energy in a home. Traditional incandescent bulbs are very inefficient and most of the energy they use actually creates heat in addition to light. CFL bulbs create a brighter light without heat, using only one quarter of the energy used by incandescent bulbs. For instance, a 15 watt CFL bulb produces as much light as a 60 watt incandescent bulb. Today, existing CFLs offer brightness and a color rendition

comparable to incandescent bulbs. Additionally, CFLs last up to 10 times longer than incandescent bulbs. They more than pay for themselves with their low replacement rate and low energy usage. Although the CFL bulb costs slightly more than a typical incandescent, the consumer can earn back the higher cost in approximately six months through the energy savings.

Both clothes washers and dishwashers primarily use energy to heat water in the washing cycle. ENERGY STAR dish and clothes washers receive certification because they use at least 40 percent less energy to heat the water used for cleaning. Additionally, both types use less water in the washing cycle. Further, ENERGY STAR washing machines extract more water from clothes in the spin cycle than do traditional models. This shortens the drying time needed, thereby generating even more energy savings.

Energy efficient refrigerators and freezers use less electricity in order to produce cold air. An ENERGY STAR refrigerator and freezer unit uses at least 15 percent less energy than required by current Federal standards and 40 percent less energy than most conventional models sold in 2001.

A dehumidifier is a good investment that can reduce energy usage in the home, and improve the quality of life for its inhabitants by removing excess moisture from the air. Moisture in the air can lead to condensation, deterioration of building materials, and mold. Additionally, humidity, or excess moisture in the air can make the temperature feel much warmer or colder. By running a dehumidifier in especially damp rooms or installing a central dehumidifier for a home's HVAC system, residents may need to run their heating and cooling systems less frequently, thus saving energy. An ENERGY STAR qualified dehumidifier can save 10-20 percent more energy than a standard dehumidifier. Dehumidifiers are portable and can be used in rooms only as necessary. When a dehumidifier is running, doors and windows to the room should be closed. Dehumidifiers should be located away from dust and dirt. Most dehumidifiers have top-mounted air discharge and can be placed against walls while running. If a dehumidifier does not have top-mounted discharge, it should be located away from walls and furniture, so that air can circulate freely around the unit.

Builder Option Packages

In lieu of receiving the complete HERS certification, the EPA created Builder Option Packages (BOPs) to help contractors build homes to ENERGY STAR specifications. BOPs represent a set of construction specifications for specific climate zones that enable a home's energy performance to qualify for the ENERGY STAR label. Contractors working in a specific climate can choose to use BOPs rather than their own designs to meet ENERGY STAR requirements. If a BOP is followed, the home is subject to fewer inspection demands; a certified rater must verify that the BOP requirements have been met, but a custom HERS inspection and rating is not needed.

Attachment 2-2:
HERS Rating System

This attachment provides additional detail on the Home Energy Ratings System (HERS) and the process HERS raters follow to test and certify an ENERGY STAR qualified home. When specifying that a building is to meet ENERGY STAR standards, it is the responsibility of the developer to contact the HERS rater and complete the required procedures to obtain the ENERGY STAR label. It is not necessary for PJ staff to undertake any steps or actions described in this process. However, PJ staff may benefit by understanding how the HERS rating system works.

HERS Infrastructure

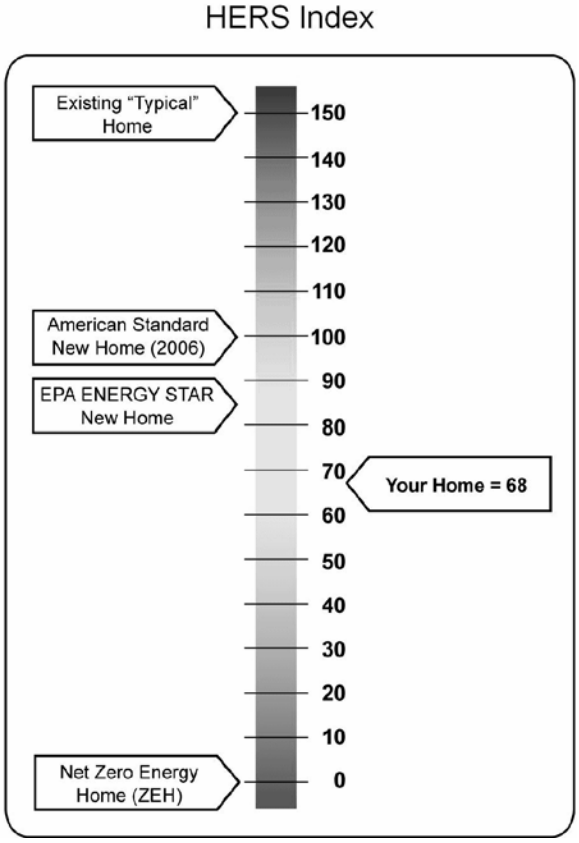
HERS is an energy index created and governed by three national standards:

- The National Association of State Energy Officials (NASEO)Technical Guidelines which prescribe the accepted methods and procedures for rating a home;
- The Mortgage Industry Home Energy Rating System (HERS) Accreditation Procedures which prescribe the methods and procedures for certification of the HERS System by individual state governments and the national home mortgage industry; and
- The Residential Services Network (RESNET) Training and Certifying Standards which prescribe minimum competencies for Trainers and certified raters.

Together, the three national standards create a complete infrastructure for building, testing, and certifying the energy efficiency of structures along standardized conditions. Raters and contractors are trained and certified by RESNET and state agencies to become HERS contractors and raters. After they receive and pass this training they can certify buildings using uniform protocols established by HERS and NASEO.

In some cases, ENERGY STAR programs are managed locally by an ENERGY STAR partner (typically a local utility company, state agency, or local association). These partners may train builders on ENERGY STAR standards, develop HERS infrastructure by training and certifying raters, and / or keep a database of qualified raters in the area. To verify a building meets ENERGY STAR qualified homes standards, the HERS rater submits the rating software file on that project to the ENERGY STAR partner in the area or to their local HERS provider. The ENERGY STAR partner compiles the records it receives from HERS raters and keeps a database of ENERGY STAR buildings. This information is periodically reported to the EPA to track ENERGY STAR buildings across the nation.

Nationally, HERS infrastructure is already in place to perform the necessary components to meet ENERGY STAR requirements. A developer simply needs to tap into this infrastructure through the local HERS provider or ENERGY STAR partner. By visiting the ENERGY STAR website, users can determine whether there is a local program sponsor. If there is not, the ENERGY STAR website has information about HERS certified raters working across the U.S. Interested parties can use their local HERS provider or the ENERGY STAR website to find a rater to help review project plans and incorporate efficiency measures as well as to test and inspect the installation and adequacy of those measures and verify the project as meeting the ENERGY STAR qualified homes standards. The ENERGY STAR website is http://www.energystar.gov/index.cfm?c=home_improvement.hm_improvement_contractors.



HERS Index

Every home that is tested receives a numeric score which falls somewhere within the HERS Index. The Index is a numeric scale that rates the energy efficiency of homes. A zero (0) on the scale represents a building with zero energy usage and a 100 on the scale represents a HERS Reference Home that meets the 2004 International Residential Code (IRC) guidelines and the 2004 International Energy Conservation Code (IECC) Performance Path. Every point on the scale represents a one percent change in the efficiency of the home. Homes with a lower score are more efficient. All homes that are inspected are assigned a score which indicates its energy efficiency relative to the HERS Reference Home.

HERS Index Thresholds

On the HERS scale, a home can score greater than 100 if it exceeds the energy usage of the HERS Reference Home. For instance, a typical existing home built in 1970 might earn a 130 on the scale. This means the home's efficiency is 30 percent worse than a home built to code (IRC 2004).

A home that meets the ENERGY STAR qualified homes standards is expected to exceed IRC standards by 20 percent in the North, and by 15 percent in the South. Therefore, to be certified, a home must earn a score of ≤ 80 in the North and ≤85 in the South on the HERS Scale.

Inspections and Testing Process

The developer must contract with a HERS certified rater to ensure that the building is inspected at the appropriate stages of development. The following inspections are required to meet ENERGY STAR qualified homes specifications:

- **Review of Building Plans.** In the design stage, building plans are reviewed for construction features or efficiency measures that can be incorporated into the project in order to reduce energy consumption by 20 percent (15 percent in southern states) as compared to a standard home. This review can be conducted by an IECC analyst when he/she reviews the building plans for compliance with the building code, or it can be conducted by a HERS rater.
- **Quality Insulation Inspection.** At an intermediate stage of construction, upon installation of the home's insulation, a HERS certified rater performs an initial inspection to confirm that the insulation is installed appropriately and according to ENERGY STAR standards. When the rater determines insulation is appropriately installed, he/she issues a quality installation certificate to the builder for his/her records.
- **Thermal Bypass Inspection List.** During the intermediate construction inspection, the HERS rater also performs a visual inspection of framing areas where air barriers are commonly missed and inspects insulation to ensure proper installation and alignment with air barriers. This checklist serves as an extra check to the Quality Insulation Inspection that the air and thermal barriers are continuous and complete. If all items are in compliance with checklist guidelines, the rater signs the Thermal Bypass Inspection List, certifying the building has passed. A building can only receive the ENERGY STAR label if this checklist has been signed. Both the builder and the rater keep a hard copy of the signed and completed checklist in their records.

- **Field Verification and Diagnostic Test**. Upon completion of the building, an ENERGY STAR eligible building must pass a final evaluation that verifies that the home's overall energy consumption is 20 percent (15 percent in southern states) less than a 2004 IECC standard home built in that community. The HERS rater uses a checklist to perform essential tests and inspections and enters this information into HERS approved rating software. This software is used to determine if the measures and building components within a project achieve the required HERS score and the home performs up to the efficiency level required by ENERGY STAR standards. When the home is found to be in compliance, the rater submits the file containing the final HERS rating and records of the previous Thermal Bypass Checklist and verification that the building is ENERGY STAR qualified to their HERS provider. Checklists used in this process vary across states.

- **Building Option Package (BOP) Verification**. An alternative to the complete HERS inspection, a builder may choose to build according to a BOP created by ENERGY STAR pertaining to the climatic region in which the building is constructed. BOPs include a set list of building features to include in order achieving the ENERGY STAR construction standard. A certified HERS rater can verify that the building was built according to a BOP and therefore meets ENERGY STAR standards. If a developer chooses this option, the HERS rater submits final verification of the building as an ENERGY STAR qualified home to its HERS provider registry using rating software as it does with the Field Verification Test.

Labeling Process

If a building passes the final inspection and documents all past inspections, the HERS rater verifies the building as an ENERGY STAR home. The rater affixes the ENERGY STAR label to the home's circuit breaker box and uploads acknowledgement of this to the HERS provider. The HERS provider keeps a record of all ENERGY STAR buildings in its territory. The developer additionally receives documentation of meeting ENERGY STAR standards for its own records.

Attachment 2-3:
Financial Resources for Energy Efficiency

There are numerous sources of financing that available to PJs, developers, property owners, and/or homeowners or homebuyers.

U.S. Department of Housing and Urban Development

- **HOME Investment Partnerships (HOME) Program.** HOME is the largest Federal block grant to state and local governments designed to create affordable housing for low-income households. Each year it allocates approximately $2 billion in formula grants among the states and hundreds of localities nationwide who often partner with local nonprofit groups. The HOME Program funds a wide range of activities to build, buy, and/or rehabilitate affordable housing for rent or homeownership or to provide direct rental assistance to low-income people. Improvements for energy efficiency measures in HOME-assisted units are eligible costs under HOME; however, HOME cannot be used as a stand-alone program to make energy improvements. For more information about the HOME Program, go to: http://www.hud.gov/homeprogram/.
- **Community Development Block Grant (CDBG) Program.** CDBG provides annual formula block grants to general units of local government and states to benefit low- and moderate-income persons, prevent or eliminate slums or blight, and address urgent community development needs that pose a serious and immediate threat to the health or welfare of the community. Improvements for energy efficiency measures can be funded with CDBG funds, in conjunction with CDBG-funded housing development. For more information about the CDBG program, go to: http://www.hud.gov/cdbgprogram/.
- **HUD/FHA Energy Efficiency Mortgage Program.** The Energy Efficient Mortgages Program (EEM) helps homebuyers or homeowners save money on utility bills by enabling them to finance the cost of adding energy-efficiency features to new or existing housing as part of their FHA-insured home purchase or refinancing mortgage. When FHA-insured buyers purchase a HOME-assisted unit, the PJ can refer the buyer to this source of funds. For more information about the EEM program, go to: http://www.hud.gov/offices/hsg/sfh/eem/energy-r.cfm.

U.S. Department of Energy

- **Weatherization Assistance Program (WAP).** Through WAP, weatherization service providers install energy efficiency measures in the homes of qualifying low-income homeowners free of charge to reduce energy usage and payments. WAP provides funding and technical guidance to states who partner with nonprofit agencies to deliver weatherization assistance. PJs can work with these nonprofits to assist homebuyers and homeowners that participate in the HOME Program. For more information about the WAP program, go to: http://www.eere.energy.gov/weatherization/.
- **Energy-Efficiency Funds and Demand Response Programs.** DOE lists incentives offered by utility companies, such as energy-efficiency and load management programs. For more information about energy-efficiency funds and demand response programs, go to: http://www1.eere.energy.gov/femp/program/utility/utilityman_energymanage.htm.
- **Special Offers and Rebates from ENERGY STAR Partners.** A searchable list of special offers and rebates available on ENERGY STAR qualified products by geographic area is available at: http://www.energystar.gov/index.cfm?fuseaction=rebate.rebate_locator.

U.S. Department of the Treasury - Internal Revenue Service

- **Low Income Housing Tax Credit (LIHTC).** The LIHTC program provides the private market with an incentive to invest in affordable rental housing. Federal housing tax credits are awarded to developers of qualified projects. Developers then sell these credits to investors to raise capital or equity for their projects, which reduces the debt that the developer would otherwise have to borrow. Because the debt is lower, a tax

credit property can, in turn, offer lower, more affordable rents. LIHTCs can help finance the costs of energy efficiency improvements in the construction, acquisition, or rehabilitation of HOME rental projects. In many states, developers applying for tax credits receive bonus points or other favorable considerations for incorporating energy efficiency features or developing ENERGY STAR qualified units. For more information about the Low Income Housing Tax Credit, go to: http://www.hud.gov/offices/fheo/lihtcmou.cfm

- **Federal Tax Credits for Energy Efficiency.** Federal Tax Credits reduce the amount of income tax homeowners have to pay by directly reducing the homeowner's tax liability. Note, not all ENERGY STAR qualified homes and products qualify for a tax credit. These tax credits are available for a number of products at the highest efficiency levels, which typically cost much more than standard products. Tax credits are available for many types of home improvements including insulation, replacement windows, and certain high efficiency heating and cooling equipment. Tax credits are also available to homeowners building new homes with photovoltaics, solar water heating, and/or fuel cells. For more information about Federal Tax Credits for energy efficiency, go to: http://www.energystar.gov/index.cfm?c=products.pr_tax_credits.

U.S. Department of Health and Human Services

- **Low Income Home Energy Assistance Program (LIHEAP).** LIHEAP is a block grant program administered by the Office of Community Services to help eligible low-income homeowners and renters meet their home heating and/or cooling needs, with financial assistance for utility bill payments and weatherization assistance. Each year it allocates approximately $2 billion in formula grants among the states, territories, and Indian tribes. The PJ can refer the residents of HOME-assisted units to this source for financial assistance with their utility bills. For more information about LIHEAP, go to: http://www.acf.hhs.gov/programs/liheap/.

Nonprofits and Foundations

- **Local Initiatives Support Corporation**. LISC provides loans, lines of credit, grants and recoverable grants, and equity investments to help community development corporations and other partners revitalize their neighborhoods. Through LISC's Green Development Center, nonprofits have access to financing and technical assistance for green projects. For more information about LISC, go to: http://www.lisc.org.
- **Green Communities**. Green Communities is a five-year, $555 million initiative by the Enterprise Foundation to build more than 8,500 environmentally healthy homes for low-income families. The initiative offers grants to help cover the costs of green components in affordable housing developments — improvements that increase the profitability, productivity, or usefulness of a property while preserving the quality of the environment. Financing assistance is available to nonprofit and for-profit developers, and includes planning and construction grants for the green components of affordable housing developments, and for tracking their costs and benefits; predevelopment, acquisition, and construction loans to support the development of affordable rental and homeownership housing that adheres to Green Communities criteria; and competitively priced LIHTC equity for new construction and/or rehabilitation of affordable rental housing that generally adheres to the Green Communities criteria. For more information about Green Communities, go to: http://www.greencommunitiesonline.org.

Lenders

- **Private Lenders.** Private lenders often offer energy efficient mortgages (EEMs) for single family and some multifamily property acquisition, refinance, rehabilitation, and construction. Fannie Mae and Freddie Mac also offer programs to buy EEMs from private lenders. For more information about these programs and to identify lenders who may offer EEMS, go to: http://www.fanniemae.com or http://www.freddiemac.com.

Utility Grant/Loan Programs

Some utility companies operate demand-side management (DSM) or system benefit charge (SBC) programs. DSM programs aim to reduce demands on the utility company's generation, transmission, and distribution systems by improving the efficiency with which their customers use energy. Some utility companies provide free energy audits and/or zero-interest loans to pay for the installation of conservation measures. SBC programs offer funding to improve energy efficiency. These funds are allocated in a variety of ways. PJs should contact their local utility companies to find out about opportunities that are available locally.

For instance, the California Public Utilities Commission (CPUC) issued $2 billion in funding for energy efficiency programs, including installation of qualifying energy-efficient products in multifamily buildings. This energy efficiency and conservation campaign is the most ambitious in the history of the U.S. utility industry. Some of the utility companies administering home improvement rebate programs in California include Pacific Gas and Electric, Southern California Edison, Southern California Gas Company, and San Diego Gas and Electric. For more information about the California Public Utilities Commission, go to: http://www.cpuc.ca.gov/puc/.

Attachment 2-4:
Technical Assistance and Support

PJs can contact the following agencies and programs to get information, technical assistance, and support for its initiatives to integrate energy-efficient features into their housing development programs.

Database of State Incentives for Renewables and Efficiency

The Database of State Incentives for Renewables & Efficiency (DSIRE) is a comprehensive source of information on state, local, utility, and Federal incentives that promote renewable energy and energy efficiency. DSIRE is an ongoing project of the North Carolina Solar Center and the Interstate Renewable Energy Council (IREC), funded by the U.S. Department of Energy. IREC supports market-oriented services targeted at education, coordination, procurement, the adoption and implementation of uniform guidelines and standards, and consumer protection. IREC's members include state and local government agencies, national laboratories, solar and renewable organizations and companies, and individuals. The North Carolina Solar Center, which is operated by the College of Engineering at North Carolina State University, promotes the use of renewable energy technologies and green building practices through technical assistance and training, policy research and analysis, education and outreach, and technology research, development, and demonstration. For more information about DSIRE, go to: http://www.dsireusa.org.

Alliance to Save Energy

The Alliance to Save Energy is a nonprofit coalition of business, government, environmental, and consumer leaders that support energy efficiency as a cost-effective energy resource under existing market conditions. The Alliance advocates energy efficiency policies that minimize costs to society and individual consumers and that lessen greenhouse gas emissions and their impact on the global climate. To carry out its mission, the Alliance to Save Energy undertakes research, educational programs, and policy advocacy; designs and implements energy-efficiency projects; promotes technology development and deployment; and builds public-private partnerships in the U.S. and other countries. Sorted by state, its website identifies state tax credits, energy efficiency codes, funds, and energy saving tips. For more information about the Alliance to Save Energy, go to: http://www.ase.org.

Partnership for Advancing Technology in Housing (PATH)

PATH is a public-private partnership sponsored by HUD's Office of Policy Development and Research (PD&R) that seeks to improve housing affordability and value through technology. PATH is a voluntary partnership between leaders of the homebuilding, product manufacturing, insurance, and financial industries and representatives of Federal agencies concerned with housing. The PATH website contains a wealth of tools and information for integrating advanced housing technologies into local projects. For more information about PATH, go to: http://www.pathnet.org.

Canada Mortgage Housing Corporation (CMHC)

Canada Mortgage Housing Corporation (CMHC) is Canada's national housing financing agency for affordable housing, improves building standards and housing construction, and provides information and analysis about the housing market to researchers and policymakers. CMHC has a library of technical and socio-economic research on its website, including CMHC's Housing Technology E-Newsletter which contains technical research, construction details, and innovative and better building case studies on topics on a wide range of related topics, such as healthy housing; energy efficiency; indoor air quality; and construction research, practices and codes. For more information about CMHC, go to: http://www.cmhc-schl.gc.ca/en/corp/index.cfm.

Rebuild America

Rebuild America is a voluntary program sponsored by the U.S. Department of Energy that helps community partnerships make profitable investments in existing buildings through energy-efficiency technologies. Rebuild America partnerships tailor its programs to local needs, choosing which buildings to renovate, how much energy to save, and the best technologies to use. Rebuild America focuses on several areas, including public and multifamily housing. Its website includes a Solution Center, which identifies tools and information to help improve energy-efficiency in retrofit and new construction projects, as well as low- and no-cost improvements. For more information about Rebuild America, go to: http://www.eere.energy.gov/buildings/program_areas/rebuild.html.

Green Power Network

The U.S. Department of Energy's Green Power Network provides news and information on green power markets and related activities. "Green power" refers to electricity supplied in whole or in part from renewable energy sources, such as wind and solar power, geothermal, hydropower, and various forms of biomass. More than 50 percent of retail customers in the U.S. now have the option to purchase a green power product directly from their electricity supplier. In addition, consumers can support renewable energy development through the purchase of green energy certificates. This site provides state-by-state information on Green Power Marketing in Competitive Electricity Markets and Utility Green Pricing Programs. In addition, the site lists marketers of Renewable Energy Certificates (RECs), also known as green tags or tradable renewable certificates, which represent the environmental attributes of the power produced from a renewable energy project. Whether or not consumers have access to green power through their local utility company or a competitive electricity marketer, consumers can purchase RECs without having to switch electricity suppliers. The website provides guidance on how large purchasers, such as businesses, government agencies, and universities can purchase green power. For more information about the Green Power Network, go to: http://www.eere.energy.gov/greenpower/.

Brightfields

In an effort to encourage productive use of brownfields and advance the use of clean and climate-friendly energy technologies, the Department of Energy is working with local governments and industry to link solar energy technologies to brownfields redevelopment. Brightfields seeks to address three of the nation's biggest challenges—urban revitalization, toxic waste cleanup, and climate change—by bringing pollution-free solar energy and high-tech solar manufacturing jobs to brownfields sites. Currently, DOE is working with cities in Illinois, California, Virginia, Minnesota, New York, and Connecticut to explore how brightfields can help their communities address concerns about land use, economic development, energy, air quality, and climate change. For more information about brightfields, go to: http://www.eere.energy.gov/.

Building America

Building America is a private/public partnership sponsored by the U.S. Department of Energy that conducts research to find energy-efficient solutions for new and existing housing that can be implemented on a production basis. For more information about Building America, go to:
http://www.eere.energy.gov/buildings/building_america/.

Million Solar Roofs Initiative (MSR)

The Million Solar Roofs Initiative, sponsored by the U.S. Department of Energy, will enable businesses and communities to install solar systems on one million rooftops across the U.S. by 2010. The DOE is working with partners in the building and solar industries, local governments, state agencies, electric service providers, and nonprofit organizations to remove market barriers and strengthen grassroots demand for solar technologies. To meet the goal of one million solar rooftops, the initiative is developing a pool of existing Federal lending and financing options; soliciting voluntary participation by state and local governments and groups; accelerating the use of solar energy systems in Federal buildings; and leveraging other financial support and incentives. The initiative's website includes a large collection of related links, plus a substantial list of documents related to solar water and space heating, case studies of successful solar power use, and information on training and education. The

Additional Resources section features the solar yellow pages. The website also lists grant and incentive programs. For more information about MSR, go to: http://www1.eere.energy.gov/solar/solar_america/about.html.

Wind Powering America

The U.S. Department of Energy's Wind Powering America site provides state-by-state wind project information, including validated wind maps, anemometer loan programs, small wind guides, legislative briefings, wind working groups, and state-specific news. For more information about Wind Powering America, go to: http://www.eere.energy.gov/windandhydro/windpoweringamerica/index.asp.

Chapter 3: Incorporating ENERGY STAR Qualified Homes into HOME-Funded Activities

This chapter describes the types of HOME-funded activities suitable for incorporating ENERGY STAR qualified homes, and offers practical guidance for successfully implementing ENERGY STAR in these activities. This chapter will help HOME PJs and their partners understand the key decisions that they face, good practices that support smooth implementation, and steps that they can take to build local capacity and support.

3.1. ENERGY STAR Qualified Homes and HOME PJs

HOME state and local PJs play an important role in the development of quality affordable housing. They decide what HOME-assisted housing gets built and where, when, and *how* it is built. A growing number of HOME PJs are encouraging or requiring HOME-funded projects to meet ENERGY STAR standards and obtain an ENERGY STAR certification. HUD urges PJs to promote or require that HOME-assisted housing qualify as ENERGY STAR projects, particularly for newly constructed single family and small rental housing. Attachment 3-1 shows the number of ENERGY STAR certified homes assisted by the HOME Program in 2007.

3.2. HOME-Funded Activities Suitable for ENERGY STAR Qualified Homes

ENERGY STAR qualified homes programs encourage builders to construct energy efficient single family and small multi-unit properties.

To qualify as ENERGY STAR, projects must be three stories or less, and be certified by a HERS rater to use *at least* 20 percent less energy in northern states and 15 percent less energy in the South than the standard design required by the 2004 International Energy Conservation Code (IECC). The PJ can also adopt a higher standard, if it so chooses.

Any existing HOME-funded activities that finance the development of residential structures that meet the height requirement may have the potential to meet ENERGY STAR standards. Several HOME eligible activities are suitable for ENERGY STAR projects, including:

- New construction of single family units (most common);
- Land acquisition;
- Single family substantial rehabilitation;
- Multifamily (not exceeding 3 stories) new construction;
- Multifamily (not exceeding 3 stories) substantial rehabilitation; and
- Homebuyer assistance.

The PJ can determine to which of its HOME activities it will apply the ENERGY STAR standard. For example, a PJ could require or give funding preference to that low-rise (1- or 2- story) rental new construction projects that meet ENERGY STAR standards.[14]

HUD CPD Field Offices facilitate information-sharing among PJs and CDBG grantees that are using and reporting on ENERGY STAR. PJs that are experienced with ENERGY STAR can help less experienced PJs by explaining how they implemented it. PJs that are willing to provide assistance in ENERGY STAR and those looking for support from a more experienced PJ should contact the local CPD Field Office for assistance.

Regardless of whether a PJ directly subsidizes construction, PJs can require developers to meet ENERGY STAR standards, or offer incentives to those funding applicants who do so voluntarily, for instance, a PJ could:

- Require that the acquisition of land for either new construction or substantial rehabilitation projects only receive HOME assistance if the development taking place on the land will achieve an ENERGY STAR certification; or
- Encourage homebuyers participating in a down payment assistance program to purchase an ENERGY STAR certified home by providing a financial incentive (additional down payment assistance, or reduced interest rate) to those that do.

The PJ can impose requirements or offer incentives regardless of whether the program is administered by a subrecipient, or whether the project is developed by a CHDO or for-profit developer.

Build San Antonio Green: City Promotes ENERGY STAR in Affordable Housing

The City of San Antonio, Texas has developed its "Build San Antonio Green" program which establishes requirements for any single family affordable housing development that uses city funds. Among its standards, it requires new homes to be built to the ENERGY STAR qualified home standard. As of the end of 2007, up to 200 single family affordable homes had been built in San Antonio using these guidelines. Of these, HOME funds were invested in a subdivision of 55 homes that were built according to the Build San Antonio Green standard.

Lesson: Initially, some properties were only a few points shy of the allowable HERS score, and the units did not meet the ENERGY STAR standard. This was due, in part, to a mistake by project architects— small homes needed more thermal envelope per square foot than noted on the specifications. As a result, builders learned to run their home designs and specifications through an analysis to check that the design would pass prior to construction. In many cases, even when construction is completed, ENERGY STAR provides sufficient flexibility to correct problems if the HERS score falls short, particularly if the problems are caught early in the process.

[14] The regulation covering energy standards for HOME is 24 CFR 92.251(a)(1). The text cites the Model Energy Code issued by CABO, but HUD has interpreted this to apply to the successor IECC.

3.3. Key Steps When Incorporating ENERGY STAR into HOME-Funded Activities

The ENERGY STAR program was designed to easily integrate into the housing development process, and already has an infrastructure to support its implementation in many states. Promoting ENERGY STAR homes is consistent with the HOME Program's overall goal to increase the supply of adequate, affordable housing in the nation.

HUD recommends that HOME PJs follow several key steps to adequately address ENERGY STAR standards in their HOME-funded activities. PJs will implement most of these steps up-front as they revise their activities to address ENERGY STAR. Once ENERGY STAR is incorporated, ongoing responsibilities are easily handled through routine functions performed by PJs.

Below are nine key steps that HUD recommends that PJs follow:

1. Identify Housing Activities Where ENERGY STAR Is Compatible with Local Program Goals

Initially, PJs should examine their local housing priorities and identify the HOME-funded activities that are suitable for ENERGY STAR. Then, they should analyze how and where ENERGY STAR can play a role. HUD encourages PJs to consider incorporating ENERGY STAR into their single family and small rental development programs, particularly in areas where rising energy costs could affect the long-term financial sustainability of projects.

In promoting energy efficiency, the PJ and the local development community have several choices about how to incorporate ENERGY STAR. They can:

- Require developers to build ENERGY STAR qualified homes;
- Offer incentives to encourage the development of ENERGY STAR qualified homes; or
- Fund a pilot program to gain experience and build capacity in ENERGY STAR.

2. Assess State and Local Contractor Capacity and Additional Sources of Support

Once a PJ chooses the activities where it will incorporate ENERGY STAR, it must then examine the current level of local capacity to develop ENERGY STAR projects. A PJ should consider:

- The overall number and capacity of developers and contractors working in its community;
- The availability of HERS raters and experienced installers;
- The availability of developers and contractors with experience in ENERGY STAR or similar projects that can serve as mentors or consultants;
- The existence of active ENERGY STAR-related or other energy efficiency programs in the community, (such as DOE Weatherization), and the types of resources these programs offer; and
- Funding institutions in the community with experience financing ENERGY STAR homes.

Are Energy Efficiency Rebates Considered Match?

All PJs must provide matching contributions valued at 25 cents for each dollar of HOME funds spent on affordable housing projects. Matching contributions must be made from non-federal resources. Energy efficiency rebates and assistance may count as match contributions when they are from a non-federal source and targeted to low-income households. Most rebates are available to all users (i.e., households of any income level), so they would not count as match. Further, depending on the design of the local HOME program, the developer may receive the rebate in which case the rebate would be included in the budget as a cost savings and would not count as a match contribution. For more information about counting energy efficiency rebates as match, contact the HUD Field Office representative.

Based on the results of its assessment of capacity, PJs should classify their local ENERGY STAR capacity as strong, moderate, limited, or none using the guidelines below.

- **Strong.** The state or area has a network of experienced HERS raters and there are several developers with affordable housing experience who work in the area and have successfully developed ENERGY STAR homes.
- **Moderate.** The state or area has a limited supply of experienced HERS raters and at least two or three reputable developers in the area have experience developing ENERGY STAR homes. These developers need not have affordable housing development experience.
- **Limited**. There are no HERS raters currently working in the state, but there are raters from other nearby states who have expressed a willingness to work with the PJ if it promotes ENERGY STAR in its HOME activities. Developers have little or no experience with ENERGY STAR, but are interested in gaining experience.
- **None.** There are no HERS raters currently working in the state, and little interest from the developer community in gaining experience with ENERGY STAR.

Attachment 3-2 identifies the number of HERS raters in each state. EPA updates this information quarterly.

Once PJs have assessed the capacity in their communities, they can estimate how many ENERGY STAR projects that they might be able to develop currently, and what type of investments and partnerships they might need to develop to expand the number of ENERGY STAR qualified projects in the future.

3. Decide Whether to Encourage or Require ENERGY STAR

The PJ should decide whether to require or encourage ENERGY STAR projects, based on its assessment of local capacity:

- In areas with moderate to strong capacity to develop ENERGY STAR projects, the PJ should consider making ENERGY STAR a requirement, particularly for newly constructed single family housing and small rental housing.
- In areas with moderate or limited capacity, the PJ should consider offering incentives to developers to build ENERGY STAR projects. Making ENERGY STAR a requirement in these PJs might hurt unit production. Examples of incentives include:
  - Rate proposals according to the efficiency of the project design specifications (either by offering bonus points for efficiency above a HERS score of 100, or subtracting points from the total score if the finished project will not meet ENERGY STAR standards);
  - Offer density bonuses to developers that follow ENERGY STAR standards;
  - Waive fees or regulatory restrictions on projects that follow ENERGY STAR standards;
  - Streamline processing and/or approval of projects that follow ENERGY STAR standards;
  - Increase funding subsidy to pay up-front costs for projects with efficient systems; and/or
  - Increase funding subsidy to pay the cost of the inspections that are required to achieve the ENERGY STAR qualified home label.
- In areas with limited or no capacity, PJs should consider establishing a pilot program for one or two years, alone or in conjunction with offering incentives to help build experience and local capacity. Pilot programs can help increase capacity, as well as provide valuable lessons about the best ways for PJs to support ENERGY STAR projects effectively. Several years ago, HUD's Region 1 suffered from a shortage of HERS raters, but HUD's CPD field office pushed for certification in its ENERGY STAR projects. In so doing, communities in Region 1 experienced a market response from contractors who realized the benefit of receiving their HERS rater certification.

Promoting ENERGY STAR through CHDOS: Pomona, CA

Pomona, California along with several other communities in Southern California, is one of the first communities to begin the process of incorporating ENERGY STAR standards into its HOME Program activities. Pomona plans to work with its CHDO developers to strengthen their understanding of the ENERGY STAR qualified homes program and offer them technical assistance in any capacity building efforts necessary to implement the ENERGY STAR standards.

Results of ENERGY STAR Policy in Utah

The State of Utah's Division of Housing and Community Development manages the Olene Walker Housing Loan Fund (OWHLF). OWHLF functions as a revolving loan fund that uses state legislative appropriations, U.S. Department of Agriculture (USDA) Rural Development program funding, and HUD HOME allocations for new construction of, and renovations to affordable housing.

Utah's ENERGY STAR policy

- All new construction projects receiving OWHLF funding are required to adopt ENERGY STAR standards.
- All rehabilitation projects receiving OWHLF funding are encouraged to adopt ENERGY STAR standards.
- OWHLF offers financial incentives to developers that incorporate ENERGY STAR standards, including reduced interest rates and greater loan amounts.

Costs of ENERGY STAR

- Incremental per unit development costs are:
  - Average of $2,300-$2,500 per single family unit.
  - Average of $1,900-$2,100 per multifamily unit.
  - Results in additional loan cost of only $85 per year for homebuyers.
- Cost to Obtain ENERGY STAR qualification rating
  - $250 per single family unit.
  - $350 per multifamily unit.

Savings of ENERGY STAR

Single-family ENERGY STAR qualifying homes save about $200 per year in utility savings.

Example: A typical single family home located in Utah County has yearly energy costs of $1,429 without ENEGRY STAR and $974 with ENERGY STAR. This represents a 32 percent savings to the homeowner.

Results of ENERGY STAR Policy

During 2007, 180 multifamily and 34 single family units were completed and qualified for ENERGY STAR. To date, OWHLF has funded the development and renovation of 1,599 units of affordable housing that meet ENERGY STAR.

For more information about OWHLF, see its website:
http://community.utah.gov/housing_and_community_development/OWHLF/.

4. Revise HOME Program Procedures and Documents to Ensure that Developers Build According to ENERGY STAR Standards

If a PJ decides to require that projects receiving HOME funds meet ENERGY STAR standards, its HOME Program descriptions, written guidelines, funding announcements, and written agreements with developers should state explicitly that HOME funding is contingent on the project meeting ENERGY STAR standards, and receiving an ENERGY STAR certification following the completion of construction.

Note: Incorporating ENERGY STAR standards into HOME-funded activities does not require specific additions to the local building code.

Sample language to incorporate ENERGY STAR into program descriptions or written guidelines is shown below:

> *"To address the priority [PJ Name] places on energy efficiency and sustainability in HOME-funded projects, all new and substantial rehabilitation in residential buildings up to three stories that receive HOME funds must meet the standards for ENERGY STAR Qualified New Homes. All procedures used for this rating shall comply with National Home Energy Rating System guidelines. To ensure that these projects meet the required standards, [PJ Name] will require its ENERGY STAR verification from a HERS certified rater as evidence of compliance with funding requirements."*[15]

If a PJ requires ENERGY STAR and a Builder Option Package exists for the PJs climate zone, the PJ also could establish in its written guidelines and construction standards that the projects that must meet those specifications.

If a PJ does not require projects to meet ENERGY STAR standards but wants to encourage ENERGY STAR projects by offering incentives, this intent should likewise be written into program descriptions, guidelines, and funding announcements. For projects that receive the incentive (e.g., bonus points, supplemental funding), the written agreements should specify that ENERGY STAR certification is a required condition of the funding or financing received.

Promoting ENERGY STAR in HOME: Richland, WA

Many communities are responding to HUD's encouragement to promote ENERGY STAR. Richland, WA required ENERGY STAR standards and certification in its 2006 HOME project funding for the development of three single family homes. Despite the additional ENERGY STAR requirements, the City found that it received the same response from developers as to other RFPs that did not require ENERGY STAR. The ENERGY STAR requirement in the RFP allowed the City to help subsidize the increased affordability of energy efficient, sustainable homes for low-income households.

Sample language to require ENERGY STAR projects that could be incorporated into a program funding announcement or Request for Proposal (RFP) is shown below:

> *"All new and substantial rehabilitation in residential buildings up to three stories shall be designed to meet the standard for ENERGY STAR Qualified New Homes. All procedures used for this rating shall comply with National Home Energy Rating System guidelines."*[16]

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[15] U.S. Department of Housing and Urban Development. "ENERGY STAR for Grantees" training presentation. September 2004, updated August 2007.

[16] U.S. Department of Housing and Urban Development. "ENERGY STAR for Grantees" training presentation. September 2004, updated August 2007.

Sample language to encourage ENERGY STAR projects that could be incorporated into a program funding announcement or RFP is shown below:

> *"All new or substantial rehabilitation in residential projects up to three stories that meets the standards for ENERGY STAR qualified homes will receive an additional 10 rating points. All procedures used for this rating shall comply with National Home Energy Rating System guidelines."*[17]

Determining Utility Allowances for ENERGY STAR Properties

HOME requires PJs to provide a utility allowance to rental property owners, where the tenants are paying their own utilities. The utility allowance represents the average cost of utilities, and is deducted from the HOME Rent limits to determine the maximum amount of rent that can be charged to a tenant. For ENERGY STAR properties, PJs may find that actual utility costs are far less than the PJ's utility allowance. PJs should consider adopting a different utility allowance for ENERGY STAR properties.

For ENERGY STAR properties, the PJ should work with the property owner to gather data on actual utility usage, and actual utility costs. It is appropriate to base the utility allowance on actual usage, as follows:

1. **Anticipated utility consumption.** For newly constructed ENERGY STAR properties, estimate the utility usage on engineering projections. For rehabilitated ENERGY STAR properties, estimate projected utility consumption based on the history of the property's utility consumption (including performance data following the completion of the improvements), if available.
2. **Review the actual utility consumption and costs after first year of operation.** The PJ should ask the owner to collect and submit copies of utility bills from all tenants for one year and analyze projected versus actual consumption.
3. **Make adjustments to the utility allowances based on actual data.**

Remember, when determining utility allowances, tenant behavior impacts the utility consumption. PJs should encourage property owners to instruct tenants on how to use the unit's energy efficiency features, and provide other helpful tips on energy conservation. If tenants are leaving windows open in the winter or keeping air conditioning units on while they are not home in the summer, utility consumption will increase.

If additional funding is given to developers as an incentive to build ENERGY STAR projects, written agreements with developers should make clear the amount of additional funding given and obligate the developer to follow ENERGY STAR standards or return the incentive funding to the PJ.

5. Train Program Staff

Although PJ staff does not need in-depth knowledge of the technical requirements associated with the ENERGY STAR program, a PJ that adopts ENERGY STAR should take steps to ensure that staff has a functional understanding of the program in order to answer questions and refer developers to appropriate resources. Basic knowledge of the ENERGY STAR program is important for writing any adopted ENERGY STAR requirements into loan and other program documents.

6. Conduct Outreach and Education to Program Partners and ENERGY STAR Service Providers

To further promote the adoption of ENERGY STAR standards, a PJ may link developers to state or local ENERGY STAR or other energy organizations. As PJs identify these partners, they should identify the types of services and resources they offer developers building ENERGY STAR projects, and the procedures for requesting funding or technical resources. By educating developers about these organizations and the resources they offer, PJs offer additional tools that developers can leverage for their ENERGY STAR projects.

[17] U.S. Department of Housing and Urban Development. "ENERGY STAR for Grantees" training. September 2004, updated August 2007.

7. Implement Procedures for Monitoring Developer Performance

As part of the ENERGY STAR qualified homes certification process, a HERS rater must inspect and verify that the building meets required efficiency standards. Therefore, a PJ does not need to incorporate new inspection criteria into its existing procedures for HOME-funded projects. It must incorporate the HERS rater's inspection into its process, and the HERS rater must verify that the project complies with ENERGY STAR requirements and that the developers have adhered to the construction requirements. Proof of this verification should be documented in the project file with all other HOME-required documentation.

8. Continue Periodic Outreach and Education

As PJs follow these steps to incorporate ENERGY STAR into their HOME Program activities, they will become increasingly familiar with community partners that are working to promote energy efficiency and ENERGY STAR. PJs should regularly conduct outreach to attract new partners, as well as to maintain local support and attract additional developers. As developers increasingly respond to ENERGY STAR goals, PJs can educate them about the partners and resources that exist to help them do so.

9. Report Completed ENERGY STAR Housing Units in IDIS

Since implementing ENERGY STAR is a priority for HUD, the number of ENERGY STAR homes created through the HOME Program is one of the program's outcome measures. The Integrated Disbursement and Information System (IDIS) allows the PJ to indicate whether a project developed with HOME funds meets ENERGY STAR standards and received an ENERGY STAR certification. HUD requires that PJs report any certified ENERGY STAR units in the appropriate IDIS field; this field may be left blank if no such units have been developed. By developing and tracking ENERGY STAR units, PJs gain recognition for their accomplishment. Reporting ENERGY STAR units in IDIS also allows HUD to show the impact that the HOME Program has achieved in creating energy efficient homes. More importantly, however, IDIS compiles information about projects supported with HOME funds nationwide and tracks program progress at a national level. Congress uses this information to determine whether HUD is meeting its stated objectives and allocates funding according to the program's ability to meet national priorities. As energy efficiency grows in importance on the national policy agenda, this information will help policymakers set appropriate expectations to balance housing production goals with achieving energy efficiency in housing development programs.

PJs need adequate procedures to track ENERGY STAR homes and accurately report the number of units constructed according to ENEGY STAR standard. The PJ can only report in IDIS those units that pass the rigorous ENERGY STAR certification process. Accurately reporting ENERGY STAR homes in IDIS allows the PJ to track its success with ENERGY STAR requirements or incentive programs.

3.4. Good Practices to Support Success

In addition to the key steps for implementing ENERGY STAR in HOME-funded activities, there are additional actions that PJs can take to build local capacity, public support, and achieve the greatest impact with homeowners. Best practices involve educating the community about the ENERGY STAR program and its goals and the resources that exist to help them; building the capacity of developers; and educating homebuyers of ENERGY STAR homes about ways to realize the full benefits and savings of their new homes.

Educate Key Local Stakeholders about ENERGY STAR

Before incorporating ENERGY STAR into their HOME-funded activities, some PJs may need to build support among their stakeholders, including local government entities, property developers and owners, affordable housing advocates, and program beneficiaries.

Local stakeholders, particularly developers, may have concerns about the higher up-front costs of ENERGY STAR qualified products and homes. PJs may need to educate their stakeholders and demonstrate that even where the up-front costs are greater for ENERGY STAR, the cost-savings that result from the improved efficiency pay

for those increased costs over time. Additionally, because of the energy savings achieved through ENERGY STAR and the willingness of other agencies to fund the up-front investment needed, a developer may be better able to leverage funds to augment his/her budget. By leveraging financial support from other agencies, PJs may be able to satisfy HOME match requirements as well.

If a PJ meets resistance within the local development community, it might consider funding a pilot program to finance a small number of ENERGY STAR projects proposed by different developers. The PJ should take time to measure and analyze the results of the pilot. Once the pilot is complete the PJ can share the results/benefits and the lessons of the pilot with the development community.

Resources are available through ENERGY STAR to assist PJs in "marketing" ENERGY STAR to their stakeholders, including:

- Marketing materials and training resources; and
- Publications, such as annual reports, brochures, posters, and guides.

These and other resources are available at http://www.energystar.gov.

Identify and Supervise Developers with Limited Experience

Developers with relatively limited or no capacity and/or experience building ENERGY STAR projects often encounter a number of challenges in the development process. These can cause delays or unexpected costs and may result in the home not being able to obtain the final certification. Sometimes these factors can cause development costs to escalate beyond the point of feasibility and lead to the abandonment of a project or the developer's future reluctance to pursue similar projects. Some common challenges confronted by developers with limited experience developing ENERGY STAR projects include:

- **Coordinating contractors.** Often a developer that has not built projects to ENERGY STAR standards in the past may need to use new, or additional, contractors in an ENERGY STAR project because of the contractor's familiarity with ENERGY STAR building practices. Finding and working with new or additional contractors can add time to the project, as more entities must coordinate with one another's work schedules. When developing ENERGY STAR projects, the timing for contractors may differ from past projects and the developer should build time into the schedule for contractors to work together to install efficiency measures as well as for necessary inspections at appropriate stages of the project. This additional coordination may catch an inexperienced developer off guard. Inadequate planning for, or coordination of, contractors can result in delays and cost overruns in projects.
- **New technologies.** ENERGY STAR buildings often use building techniques and technologies at the edge of innovation in construction practices. A CHDO, developer, or contractor with little previous experience in similar projects may be unfamiliar with these building components and technologies. This can lead to delays and additional costs because of construction mistakes and the time it takes to "learn on the job."
- **Experience obtaining third-party certification.** Without previous experience in developing ENERGY STAR projects, a CHDO, developer, and/or builder may be unfamiliar with how and when to work with the HERS rater and the steps necessary to obtain the ENERGY STAR certification. If the HERS rater is not involved at the proper steps in the process, the design, construction, and performance of the building is jeopardized; possibly leading to delays and additional costs to revise project plans (at best) or the failure of the building to achieve ENERGY STAR efficiency requirements and third-party verification (at worst).

The challenges described above increase the performance risk during the development process. A PJ can take steps to reduce these risks when working with less experienced developers and CHDOs by:

- **Reviewing the CHDO's/developer's capacity and procedures.** Consider the capacity of the CHDO/developer and determine if it has adequate plans and procedures to manage the project, hire and coordinate the appropriate contractors, involve HERS raters, and maintain appropriate documentation. For developers with limited ENERGY STAR experience, consulting with an advisor or HERS rater early in the design process can help ensure that initial project plans do not require substantial reworking after the HERS rater's review of the plans. This saves time and money.
- **Provide technical assistance throughout process.** PJs also may provide technical assistance to less experienced developers to help them identify contractors with ENERGY STAR experience, and guide them to address the challenges described above. When hiring a construction contractor, the developer should carefully review the experience and capabilities of the builder to determine if they have adequate knowledge and capacity to reasonably complete the project in an efficient and timely manner. Familiarity and experience in the appropriate technologies, previous experience building ENERGY STAR qualified homes, and the adequacy of procedures to involve HERS raters at the appropriate points in the process should be considered. If the builder chooses to use a Builder Option Package, the developer should review the plans to assess the feasibility of incorporating the recommended systems.

Educate Homeowners to Maintain Energy Efficiency Features and Reduce Energy Costs While Maintaining Comfort

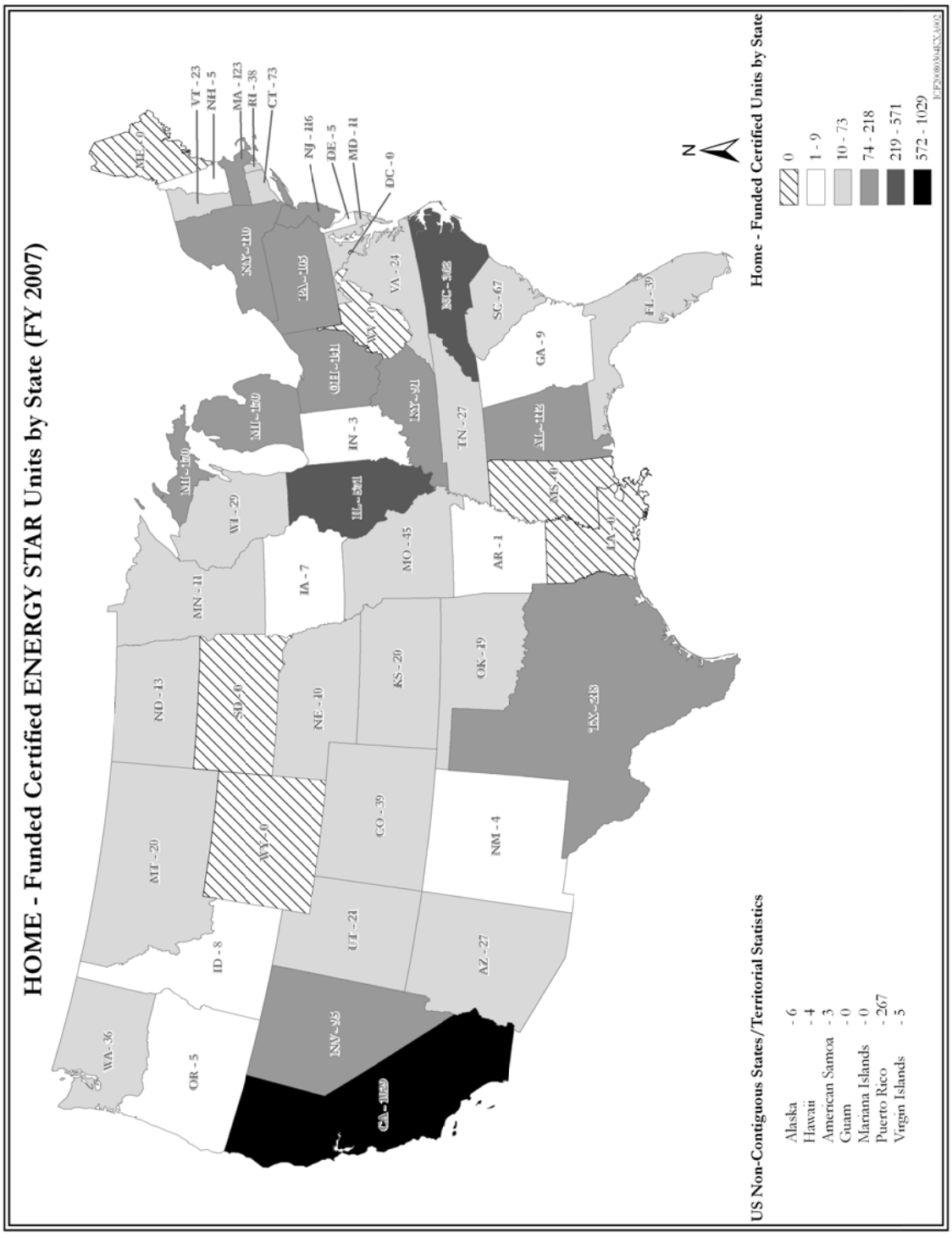
PJs can play an important role by educating homeowners about ways they can reduce energy consumption and, therefore, their energy costs. Energy use can be reduced when residents change their behaviors and break certain energy use habits in the home, such as turning out lights that are not in use, or turning off the heating/cooling system when leaving the house. In addition, consumers need to learn how to use their energy equipment effectively but efficiently. For example, consumers can save energy by:

- Using a programmable thermostat correctly;
- Using a ceiling fan in addition to (or instead of) the air conditioner, to distribute cool air so that less work is needed to make the room feel cool;
- Using cold or warm water in laundry batches; and
- Doing laundry or dishes only when a full load needs to be cleaned. (This saves water as well.)

Consumers must also learn to maintain their energy efficiency products so that they continue to function as they were designed. In some cases, consumers believe ENERGY STAR products to be less efficient than standard products because they do not use them effectively. PJs should require or encourage the CHDOs and developers that build ENERGY STAR homes to educate the homebuyers about how to use the products and systems in their homes appropriately. At a minimum, developers and CHDOs should provide residents with the manuals that accompany the energy efficiency features in their home.[18] A PJ might further encourage the developer of a project to create educational packets or demonstrations to orient the resident in an ENERGY STAR unit to the features and proper use of those features. Working with consumers about how to correctly use the ENERGY STAR components of their homes will enable them to get the maximum performance from these measures while efficiently using energy.

[18] Domus, Paul Knight. Your Energy Savings: A Resident's Guidebook. (Midwest Edition) Partnership for Affordable Housing, March 1998. Available online at: http://www.hud.gov/offices/cpd/energyenviron/energy/library/documents/residenthndbk/mwhndbk.pdf.

Attachment 3-1:
HOME-Funded Certified ENERGY STAR Units by State (FY 2007)



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Attachment 3-2:
HERS Raters in United States, by State

This list shows the number of HERS raters certified to work in each state as of February 2008. EPA updates these figures quarterly. Note that some raters may be certified to work in a state, but are physically located in a neighboring state.

State	Number of HERS Raters*
Alabama	10
Alaska	11
Arizona	17
Arkansas	10
California	58
Colorado	25
Connecticut	14
Delaware	9
District of Columbia	7
Florida	35
Georgia	23
Hawaii	7
Idaho	14
Illinois	25
Indiana	25
Iowa	13
Kansas	14
Kentucky	17
Louisiana	7
Maine	8
Maryland	18
Massachusetts	13
Michigan	35
Minnesota	17
Mississippi	7
Missouri	13
Montana	9
Nebraska	9

State	Number of HERS Raters*
Nevada	19
New Hampshire	18
New Jersey	15
New Mexico	16
New York	50
North Carolina	45
North Dakota	6
Ohio	25
Oklahoma	11
Oregon	9
Pennsylvania	27
Rhode Island	8
South Carolina	24
South Dakota	4
Tennessee	20
Texas	54
Utah	9
Vermont	11
Virginia	30
Washington	10
West Virginia	4
Wisconsin	31
Wyoming	6

* *Information about the number of HERS raters was collected from the ENERGY STAR database of HERS raters for New Homes and is Current as of February of 2008.*
See http://www.energystar.gov/index.cfm?fuseaction=new_homes_partners.showHomesResults&partner_type_id=RATER&s_code=ALL

Chapter 4: Incorporating Energy Efficiency Measures into Moderate Rehabilitation and Other Activities

This chapter describes different approaches that PJs can use to incorporate energy efficiency improvements into those programs where achieving ENERGY STAR standards is not feasible: rehabilitation projects and large unit development that is greater than three stories high (new construction or rehabilitation). Energy efficiency is desirable in these projects because it benefits the occupants and the owners by lowering operating costs and increasing comfort for residents.

Specifically, this chapter:

- *Identifies steps PJs can take to incorporate energy efficiency improvements into HOME-funded rehabilitation programs;*
- *Describes typical sources of energy loss in older homes and identifies low-cost, and moderate- or high- cost improvements that address them;*
- *Reviews methods PJs can use to select energy efficiency measures to use in specific rehabilitation projects;*
- *Identifies steps PJs can take to incorporate energy efficiency improvements into HOME-funded development of multi-unit properties greater than three-stories in height; (Note: This subject is addressed separately toward the end of this chapter); and*
- *Explains the importance of educating homeowners and occupants in the use and operation of the energy efficient measures, in order to minimize their utility costs and improve their comfort.*

Even though rehabilitation activities and large multifamily property development do not fall within ENERGY STAR standards, energy efficiency measures in these development activities have many benefits:

- *Energy savings for residents and property owners, resulting in greater financial stability;*
- *Healthier environment for residents;*
- *Improved marketability of properties;*
- *Long-term maintenance savings through the use of more durable products and building techniques; and*
- *Increased affordability of housing through reduced utility costs.*

4.1. Steps to Incorporate Energy Efficiency Improvements into Rehabilitation Activities

In a moderate rehabilitation project, the scope and scale of the work generally is not extensive enough to achieve the standards for ENERGY STAR qualified homes. By making prudent and thoughtful choices about which energy efficiency measures are appropriate to a rehabilitation project, given its scope and budget, PJs can still achieve significant energy savings in rehabilitation projects. PJs need to develop their own standards and procedures for making these determinations based on analysis of what makes the most financial sense for a project.

It is helpful for the PJ to develop general guidance on how energy efficiency measures should be incorporated into its rehabilitation program(s). HUD encourages PJs to establish minimum guidelines for energy efficiency in rehabilitation projects and to encourage partners to apply additional measures which will improve energy efficiency. Within the framework of these guidelines, PJs can then evaluate specific energy efficiency needs on a project-by-project basis.

The steps below present a variety of approaches to incorporating energy efficiency measures into PJ HOME programs. In many respects, these steps parallel the steps outlined in Chapter 3 for incorporating ENERGY STAR qualified homes standards into PJ procedures, and the steps can be implemented in a similar manner. However, because rehabilitation projects vary in scale and scope, PJs face some additional decisions when considering how to best incorporate greater energy efficiency measures into its rehabilitation activities.

Summary of Suggested Steps for Incorporating Energy Efficiency into Rehabilitation Programs	
Step 1	Identify local capacity and supplemental funding that can support energy efficiency measures.
Step 2	Adopt procedures and policies that reflect energy efficiency measures' compatibility with local program goals.
Step 3	Determine programmatic roles and responsibilities for staff and partners.
Step 4	Conduct outreach to program stakeholders to educate, involve, and inform.
Step 5	Revise HOME program procedures, property standards, and construction guidelines to reflect new energy efficiency policies.

1. Identify Local Capacity and Supplemental Funding

In many communities there are a variety of resources that may be available to support energy efficiency measures. PJs should:

- Seek and reach out to potential partners;
- Consider how to incorporate available resources into their programs;
- Assess the experience and capacity of the contractor community, including contractors' ability to respond to new energy efficiency standards; and
- Enhance communication and coordination of efforts between stakeholders.

Understanding the capacity of local contractors and suppliers can help PJs design their programs. For example, by knowing the number of qualified auditors or building performance inspectors that a PJ can rely on, the PJ has an idea about how many projects it can inspect for energy performance each year and the impact such inspections will have on the project's schedule. Exhibit 4-1 identifies the types of organizations PJs should identify and contact.

In rare circumstances, a PJ may find that its community does not currently have the resources to perform energy audits or provide low-income households the assistance necessary to implement efficiency measures. In these circumstances, PJs can support the community's effort to enhance its energy efficiency infrastructure by:

- Supporting efforts to increase contractor capacity by increasing training and mentoring opportunities;
- Developing its own in-house expertise in energy efficiency measures;
- Cross-marketing and promoting energy efficiency programs and the HOME Program to potential participants;
- Identifying funding sources to support program activities; and
- Providing quality assurance for activities by promoting best practice activities.

2. Adopt Procedures and Policies that Reflect Energy Efficiency Measures' Compatibility with Local Program Goals

Unlike new construction activities, the range of rehabilitation activities a PJ supports can span from modest to substantial funding per unit (i.e., from one thousand dollars per unit to over ten thousand dollars per unit). Therefore, a PJ should assess its various rehabilitation programs and determine the capacity of each program to incorporate greater energy efficiency, and the potential cost and benefit of doing so. For example, a PJ may determine that when it provides a modest amount of funds for rehabilitation combined with homebuyer assistance, it is both cost-effective and appropriate to require an energy audit. But, it may determine that it is not appropriate to require homebuyers to secure any specific energy efficiency measures. However, this same PJ may determine that when it provides substantial development funds for rehabilitation of homes for homebuyers, it is cost-effective and appropriate to require the developer to undertake certain measures to achieve energy efficiency. Each PJ should incorporate energy efficiency into as many of its HOME Program activities as reasonable.

Exhibit 4-1: Potential PJ Partners in Energy Efficiency

Home Performance with ENERGY STAR partners. Home Performance with ENERGY STAR, a national program from the EPA and DOE, offers a comprehensive, whole-house approach to improving energy efficiency and comfort at home, while helping to protect the environment. The program includes home improvement inspectors who perform energy audits, and provide information about the latest technologies for improving energy efficiency, and resources to help make existing residential buildings more efficient. The ENERGY STAR inspections involve diagnostic testing that is more extensive than an energy audit, and includes an examination of air filtration, duct leakage, and combustion safety. This testing is the most thorough evaluation available.

The program was initiated as a market-based approach to increasing energy efficiency in existing housing, and the program has recently expanded to include affordable housing. Currently, New York State and Wisconsin fund affordable housing demonstrations of the program.* The ENERGY STAR Program sponsor monitors the quality of work performed by all participating contractors under a quality assurance plan. This must include either a rigorous technician certification and contractor accreditation process; or third-party inspections on at least 15 percent of completed work.

In each of the communities in which it operates a local sponsor (such as nonprofits and utility providers) manages the program and recruits home improvement contractors who are qualified to perform comprehensive home assessments. See Attachment 4-1 for a list of areas that offer Home Performance with ENERGY STAR, as of 2007. PJs should contact the Home Performance with ENERGY STAR partner in their region or community, to learn about what services and support, they can provide and if any local organizations plan to join.

- **Weatherization agencies.** These agencies provide technical expertise; conduct energy audits (by qualified inspectors); and identify cost-effective energy saving techniques, diagnostic equipment, and new sources of financial leverage. There are ample opportunities for PJs to form partnerships with these organizations. For instance, a PJ could contract with a weatherization agency to inspect and test buildings before rehabilitation activities, in order to identify the best energy efficiency measures for a particular project.
- **Local utility companies.** Utility companies often provide free or low-cost energy audits for their customers and might be willing to partner with a PJ to conduct energy inspections of homes slated for rehabilitation. Additionally, many local utility companies offer financing options for buyers purchasing ENERGY STAR appliances or undertaking other energy efficiency measures.
- **Regional energy consortia and alliances.** Many communities have consortia of local energy stakeholders (such as energy companies, advocates, and policy makers) who promote energy efficiency measures in a community. These groups often have knowledge of, or access to, resources to support energy efficiency actions and can help grow the capacity of local contractors or promote a PJ's activities.

* *Home Energy* has published several articles that describe the progress of Home Performance with ENERGY STAR, including in March/April 2003 and July/August 2006. Available online at: http://www.homeenergy.org/.

The PJ should consider a series of factors when determining what level of energy efficiency measures it wants to incorporate into its different rehabilitation activities, including:

- **Amount of assistance.** Generally, the greater the amount of assistance the PJ provides, the more appropriate it is to incorporate more comprehensive energy efficiency guidelines.
- **The payback period.** Generally, it is appropriate to require developers to undertake measures with a short payback period and encourage developers to undertake measures with a longer payback period. A PJ may consider more comprehensive requirements when there is an ongoing relationship with the project or beneficiary.
- **Beyond economic benefits.** Some energy efficiency measures are appropriate even if the economic benefits are modest, or when the cost of undertaking certain measures is equal to or greater than the energy cost savings that will be realized. HUD allows HOME funds to be used in these situations, when there are additional benefits such as improved health and safety of residents or mitigation of the risk of spikes in future energy costs. A PJ should consider those energy efficiency measures that may go beyond economic benefits.

The section of this chapter, "Methods for Selecting Energy Efficiency Measures in HOME-Funded Activities," offers additional guidance on how to select specific improvements on a project-by-project basis, in different types of rehabilitation.

3. Determine Programmatic Roles and Responsibilities

As a PJ works to design how it will incorporate greater energy efficiency into its rehabilitation activities, it must consider the role its staff and partners will play in implementation to ensure that energy efficiency measures are adopted and installed properly. There are three basic approaches a PJ may consider.

- **Develop in-house expertise.** In addition to creating the written standards, a PJ may train its own staff, such as its rehabilitation specialists, how to conduct home energy audits or building performance inspections; and how to analyze the cost and pay-back periods of energy efficiency measures. Based on its own analysis, the PJ could decide which specific energy efficiency measures to include in rehabilitation job.
- **Use local subrecipient.** If the capacity exists in the community, it may be more efficient for a PJ to work through a subrecipient. A PJ can require its subrecipient to conduct or obtain the energy audit or building performance inspection and use the subrecipient's assessment to make a determination about which energy efficiency measures to undertake in each rehabilitation job. The PJ must monitor the subrecipient to ensure that the activities are conducted in accordance with the PJ's guidelines and standards.
- **Use contracted energy auditors.** If a PJ does not want to develop its in-house capacity, but wants to have more control over the process than contracting with a subrecipient to obtain energy audits, a PJ may contract with qualified local contractors to conduct energy audits or building performance inspections. The PJ would require the contractor to submit a report with recommended energy efficiency measures and estimated costs and savings directly to the PJ. The PJ would also need to monitor the contractor.

The need for PJ staff training depends on the approach the PJ takes, what responsibilities its staff carries out, and what tasks are undertaken by third parties. If the PJ chooses to use third parties, its staff may not need in-depth knowledge of the technical requirements associated with conducting energy audits or Home Performance with ENERGY STAR inspections. However, any PJ that adopts energy efficiency activities within its HOME activities will benefit from educating staff about the ENERGY STAR program and energy efficiency. Staff should have at least a functional understanding of energy efficiency measures and available resources so that they can monitor their partners effectively, and answer questions from subrecipients or program participants.

4. Conduct Outreach to Program Stakeholders

When a PJ considers changes or modifications to its programs to incorporate energy efficiency, it should reach out to the homeowners and developers that are affected by the program, as well as the utility companies and energy auditors and other funding sources that may contribute to the program. HUD recommends that the PJ's outreach efforts address the three objectives below:

- **Explain the benefits and purpose of the proposed changes.** Some partners or stakeholders may have concerns about cost implications of incorporating energy efficiency measures into the housing rehabilitation programs and may not fully understand the benefits of such measures. Discussing the benefits and goals for the changes will help ensure that partners and stakeholders are on board with proposed changes.
- **Use stakeholder input to inform decisions.** Partners and stakeholders can provide valuable insights about how best to incorporate energy efficiency measures into HOME-funded activities. Getting input from partners and stakeholders early in the process can give the PJ time to incorporate suggestions into decisions about program changes and respond to any concerns.
- **Educate stakeholders about changes in procedures.** As part of initial outreach efforts, and once program changes have been finalized, a PJ should explain the changes so the partners and stakeholders understand them. By taking the time up-front to present the changes and answer questions, a PJ reduces the likelihood of misunderstandings or misinformation about program changes, which could negatively impact their implementation.

5. Revise HOME Program Procedures, Property Standards, and Construction Guidelines

If a PJ chooses to require or encourage developers that participate in its rehabilitation program(s) to undertake an energy audit or building performance inspection and/or incorporate energy efficiency measures, this should be reflected in the PJ's HOME written guidelines and written agreements. Addressing energy efficiency in rehabilitation requires crafting guidelines based on different rehabilitation activities or levels of rehabilitation assistance.

HOME requires that rehabilitation projects meet the PJ's written rehabilitation standard, state or local housing codes, or, in their absence, a national model code. As of the publication date of this manual, energy efficiency measures beyond these standards are not required by HUD. However, HUD encourages PJs to develop program guidelines that result in improved energy efficiency performance beyond the minimum standards required.

PJs should consider the following issues and questions when they determine how best to create their energy efficiency guidelines for rehabilitation programs.

- Use of energy audits or building performance inspections for rehabilitation projects that conclude with recommendations and estimated costs and savings for energy efficiency measures. PJs should assess whether they want this for all rehabilitation; or whether to make it optional for smaller rehabilitation projects, and/or for homeowner rehabilitation activities. In making this decision, PJs should consider:
  - Is there a local provider(s) that can perform energy audits?
  - Is there a partner that does/can perform energy audits free of charge for qualifying participants?
  - What is the cost of energy audits?
  - Given the level of rehabilitation to be carried out, is the information generated by the energy audit able to be incorporated into the project budget?
- Development of a policy that articulates an equitable and usable standard about what energy efficiency measures apply to any given project, given the amount of funding and the unique features of the project. The written guidelines should describe how a PJ or its subrecipient will determine when energy efficiency measures will supersede other rehabilitation measures proposed in a project and prescribe specific measures be considered for each program. In developing these guidelines, PJs should consider:
  - Once basic health, safety and durability issues are addressed, what priority will efficiency improvements hold relative to other property improvements?

- Are there efficiency measures that should always be required?
- Can other property improvements be applied in ways that enhance energy efficiency?
- How does the cost of a particular measure compare to the projected cost savings for the client?
- Is the measure easy to use and maintain?
- What level of priority is given to client preferences?
- Is implementation of the guidelines feasible, given the funding allocated to each project, or are adjustments necessary?

By answering the questions above, a PJ can create guidelines that effectively respond to the different circumstances of various rehabilitation activities. Few program administrators have all the information they need to develop guidelines that address all circumstances. It is important to view the implementation of any new standard as a pilot effort that provides information, and to continue to improve the standard as costs, performance, and client reactions are encountered.

There are many ways to approach these issues. The PJ may require that rehabilitation projects above a certain funding threshold must have an energy audit and certain minimum measures must be applied. The same PJ might establish two different guidelines for rental rehabilitation projects. For smaller projects or properties in relatively good condition, the PJ might require developers/contractors to incorporate all identified low-cost energy efficiency measures and make case-by-case decisions about moderate-cost measures after all other structural and cosmetic issues are addressed. For substantial rehabilitation projects, the PJ might require that developers/contractors undertake all low- and moderate-cost energy efficiency measures.

For all guidelines, PJs should incorporate the flexibility to waive some requirements based on feasibility in order to account for specific property conditions and project priorities.

Sample of a PJ's Guidelines on Energy Efficiency in Rehabilitation Programs

- The rehabilitation standard will require that every rehabilitation project must incorporate certain basic features of safety and energy efficiency, such as safety and efficiency inspection of the heating/cooling system and appropriate treatments (as described in the section below).
- The rehabilitation standards will incorporate proper air sealing for work on walls, floors, ceilings, doors, windows, and electrical outlets. All cracks and joints must be thoroughly sealed and draft-free. (Include these provisions regardless of whether air-tightness will be formally tested.)
- The project will meet minimum standards for ventilation, attic insulation, and crawlspace treatment. (Some sample standards for these are discussed below.)
- The project will meet a standard for replacement windows and doors, depending on feasibility in the projects being carried out. If possible, require ENERGY STAR rated items.
- Once the project has met all applicable property standards, ENERGY STAR appliances must be used, where budget permits.

Once a PJ has decided on its written guidelines, it should update inspection and monitoring checklists to confirm that energy efficiency measures were properly completed and installed.

It is essential that the PJ also provide educational material to occupants and homeowners about operating and maintaining the energy efficiency measures to maximize their cost and energy savings.

4.2. Energy Efficiency Features for HOME-Funded Activities

Generally, there are four key sources of energy loss in older homes:

- Air leakage;
- Poor-functioning heating and cooling systems;
- Insufficient and poorly installed insulation; and
- Inefficient or leaky windows.

There are several low- and moderate-cost items to address these primary sources of energy loss. These items are easily incorporated into most moderate rehabilitation projects and can maximize energy savings. PJs should consider requiring the low-cost features as a minimum standard for its rehabilitation activities, and consider requiring the moderate-cost features for larger rehabilitation efforts. In general, the low- and moderate-cost features can be incorporated into nearly every project, but at times there are specific property needs, geographic considerations, budget concerns, or other reasons why some of these features may not be feasible to implement.

For any energy efficiency measure to realize its full potential, it must be properly installed. Failure to properly install an item can eliminate any cost savings and may create a health hazard. For example, venting bathroom and kitchen fans into an attic or unconditioned space, instead of to the exterior, can cause moisture problems and mold growth. Failure to install insulation properly so that a continuous vapor barrier is created will substantially reduce the effectiveness of the insulation. For all rehabilitation projects, PJs must insist that materials and appliances are installed according to the manufacturer's specifications to maximize energy savings. During inspections, building inspectors must check for and verify that items are properly installed.

4.3. Typical Low-Cost Features

Low-cost measures are either inexpensive to implement or they have a short payback period making them cost-effective. Some of these features may tie into existing weatherization programs to support their completion:

- Manage air flow by sealing air leaks;
- Seal and insulate ducts;
- Address problems with combustion equipment;
- Increase insulation; and
- Install programmable thermostats.

Manage Air Flow in the Structure

Sealing air leaks is the most critical and least expensive of the energy efficiency measures to implement. To manage air flow properly, the following three items must be addressed simultaneously:

- Seal the building envelope as tightly as possible so it does not leak;
- Segregate the combustion part of equipment (such as furnaces and water heaters) from the building envelope so they do not use or pollute the same air that people breathe; and
- Provide adequate ventilation so that moisture and fumes can be removed from the airtight envelope and fresh air can come in when needed.

Seal the Building Envelope

Sealing air leaks alone can trap moisture and polluted air in the home. Measures to seal air leaks should be taken in combination with measures to address problems with combustion equipment, and ensure adequate ventilation.

Wherever the components of the thermal envelope meet, there is potential for an air leak. Although some gaps are intentionally placed in the envelope, such as utility openings, they are normally sealed with caulk, weather-stripping, or some other material to prevent unintended air leakage. Buildings that have structural damage or decay are likely to have a "leaky" thermal envelope that results in unwanted air exchange. Air exchange occurs through infiltration or exfiltration, equal parts of air coming into the home and equal parts going out. Air leakage from cracks and gaps in a house's thermal envelope accounts for approximately one-third of its energy loss.

Sealing air leaks from holes, gaps, cracks, penetrations, and electrical receptacles through a combination of weather stripping and strategic use of caulk or spray foam can significantly reduce the amount of conditioned air lost to the outside, thereby reducing the amount of energy needed to heat and cool the dwelling unit. In addition to saving energy, controlling air leakage can also reduce moisture problems and reduce the influx of odors and contaminated air from the basement and other units. Reducing air leaks can also increase the overall comfort of residents.

Segregate and Maintain Combustion Equipment

Combustion appliances are those which burn fuels such as gas, oil, coal, and wood for warmth, cooking, or decorative purposes. Examples include furnaces, water heaters, space heaters, ranges, fireplaces, and clothes dryers. Combustion appliances use air to burn fuel and produce exhaust gases that should be, and normally are, directly vented to the outside to avoid introducing combustion by-products into the house.

Specification writers and occupants must understand air flow in and around these combustion appliances. A standard home furnace uses two air flow systems to operate and the two systems should be completely separate from one another. Each system should have equal amounts of air entering and leaving.

One system is the air that is heated and blown through the ducts to keep the home warm. Air in the house must be able to circulate from the supply registers, usually in each room, to the return register or registers, usually centrally located. Otherwise some rooms may be pressurized and others de-pressurized, both increasing leakage into and out of the house. So, interior doors should not seal airtight, or rooms should be connected with openings or registers that allow for air flow.

Many older homes had built-in pipes and openings for combustion air, but the openings were later sealed in remodeling and weatherization efforts. This is a safety hazard, as well as inefficient.

The second air system is the air the furnace uses to burn its fuel, and this must be unrestricted. This air must come from outside the house to the combustion area of the furnace and be exhausted outside, via the flue or chimney. Otherwise the furnace sucks air out of the house or exhausts burned gases into the house, or both. Either scenario is both dangerous and inefficient. It is critical that furnaces, water heaters, fireplaces, and woodstoves have a direct source of outside air, usually a pipe allowing air to be drawn directly the where the flame is and to the area of the exhaust flue.

When both systems are balanced *and* separate from each other, the furnace can work at its maximum efficiency and safety.

Provide Adequate Ventilation

Exhaust venting and whole-house ventilation should be examined.

1. Exhaust venting

Combustion exhaust can be a problem in homes that have been sealed against air leaks in particular, so it deserves special consideration. Combustion exhaust venting may be accomplished in several ways. The most typical is an atmospheric or natural draft vent—the buoyancy of the hot exhaust gases carries the combustion products through the appliance and up the flue. Other methods include a fan-assisted or powered combustion system—whereby a small blower forces or draws combustion air and flue products through the furnace and exhausts combustion gases out the flue to the outside; or a sealed combustion or 100-percent-outdoor-air appliance, which brings combustion air directly into the burner via sealed inlets connected to the outside with the help of a fan-assisted exhaust.[19]

When combustion ventilations systems malfunction because of inappropriate appliance selection, improper installation, leaky flues, cracked heat exchangers, or an inadequate supply of combustion air, they can cause a range of very serious problems:

- Cracked heat exchangers are the most serious problem because exhaust gases are directly sucked into the air that circulates through the house.
- A leaky or blocked exhaust flue forces exhaust gases back into the house. The potential danger from this problem is mitigated somewhat if the combustion appliance is segregated from the home's conditioned air circulating system.
- The air supply is restricted (often because the house was completely sealed up) so the unit sucks exhaust air back into the structure in order to burn it. This pollutes the air in the house with moisture (resulting in both biological growth -mold and damage to the house) and poisonous gas (commonly called *combustion spillage* or *backdrafting*).
- The unit gets its air from the house, thus sucking air into the house through every possible crack and opening, creating cold drafts and significantly exacerbating any leaks in the building envelope. In this situation, the unit is also burning and exhausting air that has already been heated, thus wasting the heat already created.

To prevent these problems, all combustion appliances should have a working exhaust vent to the outside for exhaust air (including the kitchen stove by means of an exhaust fan). Any appliance that exhausts air to the outside, except the kitchen stove, should ***also have an adequate direct supply of outside air to burn*** **supplied by a pipe or vent coming from outside the building.** This includes wood stoves and fireplaces. Any combustion appliance that is *not* vented from and to the outside, except the kitchen stove, should be removed before air sealing is carried out.

For serious safety reasons, to the maximum extent feasible, the combustion activity of an appliance should be separated from the building envelope and conditioned air.

Inspectors should pay particular attention to combustion equipment to ensure that it is properly installed and vented. After installation of combustion and/or ventilation equipment, and after sealing air leaks and duct work, combustion equipment should also be tested to be sure that it functions properly. The installer should use an established procedure for conducting this test, such as Appendix D of the International Fuel and Gas Code or ASTM E1998, *Guide for Assessing Backdrafting and Spillage from Vented Combustion Appliances*.[20] All furnaces should be specifically checked to assure that the heat exchanger, where conditioned air is heated by the combustion in the furnace, has no leaks or cracks that would allow combustion air to enter the building envelope's air.

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[19] U.S. Department of Energy. *Technology Fact Sheet: Combustion Equipment Safety*. October 2000. Available online: http://www.eere.energy.gov/buildings/publications/pdfs/building_america/26464.pdf

[20] This document is available online at: http://www.epa.gov/iaq/homes/hip-combustion.html October 15, 2007.

2. Provide whole house ventilation

Aside from assuring that the exhaust gases are properly vented, it is critical that the air that circulates in the home is periodically refreshed and pollutants can be removed. If a building does not have mechanical ventilation, it is recommended that a ventilation system be installed before any significant air leakage reduction is performed. At a minimum there should be exhaust fans provided for the kitchen range and the bathrooms. Air sealing should be done *only* in conjunction with an assessment of the building's ventilation system to ensure adequate air quality. [21]

Typical approach

A common approach includes the following elements:

- Always require that fuel-burning appliances such as furnaces, wood stoves, and water heaters be inspected for safe and proper operation;
- Always require that combustion appliances be provided with a direct supply of outside air through a pipe that terminates near the appliance;
- Wherever feasible, segregate the appliance from the conditioned air space with a sealed door;
- Always install a CO_2 detector in the living area of the home;
- Set an efficiency standard for furnaces as well as other HVAC components. For example, require all furnaces to operate at 75 percent AFUE or be replaced; and
- Require that exhaust fans be provided for all kitchens and baths, wherever feasible.

Seal and Insulate Ducts

Ducts that move air to and from a forced air furnace, central air conditioner, or heat pump are vulnerable to air leaks and are often big energy wasters. Sealing and insulating these ducts can improve the efficiency of a home's heating and cooling system by as much as 20 percent.

For optimum effectiveness, seal ducts that run through unconditioned spaces, such as the attic, crawlspace, unheated basement, or garage. Use duct sealant (mastic) or metal-backed (foil) tape to seal the seams and connections of ducts. Never use duct tape. After sealing the ducts in those spaces, wrap the ducts in insulation to keep them from getting hot in the summer or cold in the winter and affecting the conditioned air running through them. Next, seal ducts that are accessible during the rehabilitation activities that are located in the heated or cooled part of the house.

Make sure that the system has a balanced air flow so that the air pressure in each room is normal. Blowing air into a room, but not providing it a way to return to the HVAC unit, pressurizes the room and exacerbates any air leaks. One way to address this is to require installation of either a return register, a transfer grill, or a 1-inch gap under the door in any room with a supply register. After equipment is installed, a worst-case depressurization test should be conducted by a PJ-approved inspector.

Replace air filters regularly, as dirty filters slow down air flow and make the system work harder to keep the home warm or cool — wasting energy. Educate occupants or property maintenance staff about the importance of changing the air filter at least every three months.

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[21] Abt Associates. *Energy Conservation for Housing: A Workbook*. January 1998. p. 7-37 – 7-39.

Typical Approach

A common approach includes the following elements:

- Inspect all ducts and seal all joints with mastic. Where ducts and registers join the interior surface, use foam or mastic to eliminate all gaps or leaks.
- Insulate all ducts in unconditioned spaces to a minimum of R-4, preferably higher.
- Where feasible, run ducts inside the building envelope.

Increase Insulation

Up to one-third of the heat loss in a home may be attributed to poor insulation of the walls and attic, depending on climate and structural conditions. Even a home with a tight thermal envelope may benefit from insulation to further retard the flow of heat into or out of a unit. Insulation is rated using an R-value, the value to which the insulation resists heat flow. The higher the R-value, the more effective the insulation is at limiting heat transfer. Inadequate amounts of insulation can result in a wall or attic having a low R-value, which results in energy loss. However, poorly installed or failing insulation can have the same effect.

There are several common types of insulation — fiberglass (in both batt and blown forms), cellulose, rigid foam board, and spray foam. Reflective insulation (or radiant barrier) is another insulating product which can help save energy in hot, sunny climates.

When correctly installed with air sealing, each type of insulation can deliver comfort and lower energy bills during the hottest and coldest times of the year. Insulation works best when air is not moving through or around it. So it is very important to seal air leaks before installing insulation to ensure the best performance from the insulation.

For the biggest savings, the easiest place to add insulation is usually in the attic. A quick way to see if more insulation is needed is to look across the uncovered attic floor. If the insulation is level with or below the attic floor joists, more insulation is probably needed. The recommended insulation level for most attics is R-38 (this is about 12–15 inches of insulation, depending on type). In the coldest climates, the recommended level is R-49.

Typical Approach

A common approach includes the following elements:

- Inspect all insulation for full coverage. In attics, cover fiberglass batts with continuous loose-fill insulation.
- Insulate all accessible spaces capable of being properly vented to the recommended level for the region. (Recommended insulation levels by region are available on the ENERGY STAR website.) Provide adequate venting, seeing that there are no gaps or openings in insulation except where required for safety.
- Evaluate all houses for the feasibility and advisability of installing wall and floor insulation to the recommended levels. Specifically address potential moisture problems and their mitigation.
- Do not use fiberglass batts and rolls where any full coverage insulation such as blown cellulose can be installed.

Fiberglass batts and rolls are notorious for having small gaps between them and the adjoining surfaces, as well as very easily moving out of place.

Install Programmable Thermostats

Programmable thermostats automatically adjust a home's temperature settings, lowering or raising the temperature of the home so that the heating or air conditioning system runs while the home is in use, and the temperature adjusts while the occupants are away or sleeping. Programmable thermostats are more convenient and accurate than manual thermostats and improve a home's comfort. They contain no mercury and when used properly save about $150 a year on energy bills.

Installation of programmable thermostats should be accompanied by instructional information for occupants so they know how to use the thermostats to receive their full benefit.

4.4. Typical Moderate- to High-Cost Features

Energy efficiency features that have a moderate or high cost make them difficult to implement in small rehabilitation projects, but they provide effective energy efficiency savings and should be considered for all projects when feasible:

- Upgrade the HVAC system;
- Change placement of return and delivery registers and ducts;
- Install ENERGY STAR appliances; and
- Replace windows.

Upgrade HVAC System

Together, heating and cooling equipment account for about one-half of the energy usage in a typical house.[22] Significant opportunities to reduce energy costs exist through the use and proper maintenance of high-efficiency heating and cooling appliances.

EPA's ENERGY STAR program has developed the following guidelines to assess whether a replacement of an HVAC system (including the air conditioner, heat pump, furnace, or boiler) as part of moderate rehabilitation activities, is appropriate. If two or more items in the "Time to Replace" column apply to the system, then replacement is a good idea.

Continue to repair existing system if:	Time to replace existing system if:
Under 10 years old (under 15 years for a furnace or boiler)	Over 10 years old (over 15 years for furnace or boiler)
Good service record	Has had repeat problems
Major repairs made recently; only minor repairs needed	Extensive or costly repairs needed
On/off cycling is not excessive	On/off cycling seems excessive
Performing up to expectations	Not performing up to expectations

When replacing an HVAC system, proper sizing is essential. Bigger is not always better. Oversized equipment operates in short run cycles, not allowing the unit to reach efficient operation and remove humidity from the air — the space is often less comfortable and might actually result in higher utility bills.

[22] U.S. Environmental Protection Agency, ENERGY STAR. "Heat and Cool Efficiently." Available online at: http://www.energystar.gov/index.cfm?c=heat_cool.pr_hvac January 7, 2008.

Exhibit 4-2: Combined Heat and Power

For large multi-unit buildings of 80 or more units with master metering and access to natural gas, PJs should consider HUD's *2002 Energy Action Plan2* initiative #20: to promote the use of combined heat and power (CHP) in housing. CHP — also known as "cogeneration" — is the simultaneous production of two or more useful forms of energy from a single fuel consuming device.

CHP systems recycle waste heat and convert it to useful energy. Generally, CHPs achieve overall efficiencies of close to 80 percent. Instead of buying all the building's electricity from a utility company and separately purchasing fuel for its heating (mechanical) equipment, most--or even all--of the electricity and heat can be produced for less money by a small on-site power plant operating at a higher combined efficiency. The type of CHP system commonly applied to multifamily housing uses a device that contains an engine, similar to that found in a car or truck, or a microturbine that drives a generator to produce electricity. The heat (thermal energy) produced by this process is recovered and used to produce hot water or steam, operate a chiller or serve as a desiccant instead of being exhausted from the engine and transferred through the engine radiator (as in an automobile).

To determine if CHP is a feasible option for an existing large multi-unit building, Attachment 4-2 provides more information on CHP along with a framework and directions for screening software used to conduct a preliminary analysis of a building's feasibility for utilizing CHP.

Consider Placement of Return and Delivery Registers and Ducts

Poorly placed ducts and registers can result in energy loss. If the rehabilitation involves changes to the duct system and location of air return and delivery registers, the contractor should carefully consider the location of registers and ducts. Although the design of the existing duct system and the house influences where ducts and registers can be located, consider the following guidelines:

- When possible, place ducts in conditioned spaces to reduce heat loss. If ducts must be located in unconditioned spaces, be sure they are well insulated.
- Do not locate return and delivery vents near each other as the hot or cool air delivered through one register will be drawn right back into the return vent.
- Provide for a balance of air flow between supply and return ducts. The amount of air supplied to and from an air handler is designed to be in balance.
- As part of achieving a good balance of return and supply air, avoid locating heating or cooling return registers in the basement. Basements tend to be confined spaces resulting in "air starved" equipment that does not perform at optimum levels; in addition, there is an increased risk for pulling carbon monoxide into the system from nearby oil or gas fired equipment.

Install ENERGY STAR Appliances

As discussed in Chapter 3, replacing old appliances with ENERGY STAR appliances can result in substantial energy and financial savings for occupants. The decision to replace existing appliances with ENERGY STAR appliances usually depends on the age and condition of the existing appliances. If appliances are near the end of their expected life or in poor repair, replacing them during a moderate rehabilitation project with ENERGY STAR appliances is usually a cost-effective decision.

Replace Windows

Windows on older properties often leak air. Air leaks easily through loose fit, damaged, or missing weather stripping, putty, or caulk. Even without leaks, windows have R-values that are less than one-tenth of the R-value of the exterior walls. Thus, windows, especially older poorly maintained ones, are highly inefficient at preventing heat loss. New windows, especially ENERGY STAR-rated windows, can be a cost effective means of integrating rehabilitation goals and energy efficiency concerns. If replacing old windows is not an option, be sure to caulk windows properly to prevent leakages.

In a moderate rehabilitation project, replacing all the windows in a property can quickly become expensive. However, installing ENERGY STAR windows can help reduce an energy bill by up to 15 percent, depending on geographic location. The benefits of ENERGY STAR windows are realized in both cold and warm climates. Cold air is kept out of the home as well as summer heat as the windows transfer much less of the sun's heat into a home.

Older windows, installed before 1978, may contain lead-based paint, which poses a potential health threat to occupants, especially young children. Replacing windows that have lead-based paint will create a healthier home for occupants. Windows that may have lead-based paint must be replaced using lead safe work practices and may be subject to the Lead Safe Housing Rule 24 CFR part 35. For more information on lead-based paint requirements and concerns, visit http://www.hud.gov/lead.

4.5. Methods for Selecting Energy Efficiency Measures to Use in HOME-Funded Activities

The energy efficiency measures that will have the greatest impact on energy performance in a particular moderate or modest rehabilitation project depends on the condition of the specific property. PJs must examine the condition and design features of each building, identify the costs and savings for different measures that may be part of each rehabilitation job, and then make a determination about the best way to achieve energy efficiencies.

A PJ, subrecipient, or property owner has several methods for analyzing the condition of a property and determining the expected costs and savings that are specific to the property in question. PJ staff do not need to do this analysis or have the in-depth technical knowledge required to examine buildings and calculate costs and savings, but should have a basic understanding of what goes into the analysis so it can make prudent decisions about what energy efficiency measures to implement.

Based on local capacity, priorities, and program activities, a PJ should consider the methods that are most appropriate for their program, and the specific building being rehabilitated:

Method #1: Participate in Home Performance with ENERGY STAR

As explained previously in this chapter, Home Performance with ENERGY STAR is a national program, available only in locally-sponsored areas and its application to affordable housing is now being piloted. PJs should check with the local or regional utility, regional energy consortia, or EPA field office to determine if its area has joined or plans to join this program.

If the program is available, the ENERGY STAR home improvement contractor can conduct a detailed visual and diagnostic inspection of the whole house to determine the energy saving improvements that can be implemented in the rehabilitation project. The contractor can generate a report for the PJ and homeowner to use to determine which energy efficiency measures they will implement. The PJ (or subrecipient) can then work with qualified contractors through the program to install the measures, verify that renovations have improved home performance, and determine that safety standards are met with post-installment diagnostic tests.

The benefits of using the Home Performance with ENERGY STAR approach include:

- The inspection is more extensive than a basic energy audit and includes energy efficiency and related health and safety issues;
- The inspection report identifies expected costs and savings, making it easier for the PJ to identify cost-effective options; and
- The report identifies the biggest saving opportunities, taking the guess work out of which energy saving measures will have the greatest financial benefit to the homeowner or property owner.

Method #2: Use a Qualified Energy Auditor or Home Energy Rater

Energy audits are a systematic way to evaluate energy savings at a property. While, not as extensive as the Home Performance with ENERGY STAR assessments, energy audits provide diagnostic testing and generally include upgrade recommendations with cost-effectiveness analysis. Most communities have some qualified inspectors. A qualified energy auditor can generally be located through the partners identified earlier in the chapter, including weatherization agencies, local utility companies, and regional energy consortiums, as well as through RESNET and the Building Performance Institute.

Energy auditors can use a variety of methods to test how energy is wasted in a building. Exhibit 4-3 lists the most common energy auditing methods and a brief description of each.[23]

In the event that a qualified energy auditor is not available to the PJ, or the PJ has determined it is more beneficial to use its own staff to assess energy improvements, staff can use one of a multitude of existing checklists to perform an on-site assessment. A PJ should contact utility companies or the ENERGY STAR program for good checklists.

Method #3: Use On-Line Calculators

While an on-site inspection of a home provides the most accurate assessment of energy use and efficiency measures, an on-site inspection is not always feasible, or the PJ may want to estimate the cost effectiveness of proposed measures before engaging in a detailed assessment of the home. On-line tools can provide relatively sound information about efficiency measures that are appropriate, their estimated cost, and energy cost savings that may be achieved, based on the characteristics of the project that the user provides.

There are several decent on-line tools that PJs can use:

- **HUD Rehabilitation Advisor:** HUD's Energy Efficient Rehabilitation Advisor is an easily accessible on-line tool that allows interested parties of any level of experience or involvement to gain access to recommendations for energy efficiency rehabilitation. The Advisor tool uses general information about the proposed building (type, location, age) and the user's role in the proposed project (such as, building owner, contractor, designer, lending agency) to recommend efficiency measures, estimate the cost of those measures, identify the monetary savings the measure should achieve, and provide the approximate amount of time it will take for the measure to pay its cost back.

HUD Rehab Advisor uses information about a project to estimate energy and cost savings efficiency measures will achieve.

[23] U.S. Department of Energy. "Weatherization Technologies." Available online at: http://www.eere.energy.gov/weatherization/wx_technologies.cfm July 14, 2008.

Exhibit 4-3: Common Energy Audit Methods

Blower Door Testing: Blower doors are variable-speed fans equipped with a frame and shroud that permit them to fit inside a variety of doorframes. Since leakier houses require more airflow to induce a given pressure difference, blower doors can measure the relative leakiness of a house and the location of many leaks. This information provides a clear target for air sealing. Once the job is complete, blower doors also provide feedback on the effectiveness of the work. In addition, blower doors can help diagnose which parts of a house do not need to be sealed.

Thermographic Inspections: Thermography measures surface temperatures by using infrared video and still cameras and thermography inspections can be used to determine where insulation is needed, and whether it has been installed correctly. Thermographic scans can also be used with in combination with a blower door test. While the blower door helps exaggerate air leaking through defects in the building shell, the thermographic scan can be used to identify the specific location of a leak.

PFT Air Infiltration Measurement Technique: The PFT technique measures changes over time (a few hours to several months) when determining a building's air-infiltration rate. While this test cannot locate exact points of infiltration, it does reveal long-term infiltration problems. At the end of the test period, the results are sent to the Tracer Technology Center at Brookhaven National Laboratory for analysis. The Tracer Technology Center sends the customer a computerized test report that includes the average air infiltration rate. The PFT technique is very accurate but expensive and timely consuming.

Duct Blaster Testing: Like the blower door test, a duct blaster tests the system for air leaks. However, the Duct Blaster fan is connected directly to the duct system at the air handler cabinet, or a return grille. The dust blaster results in a precise leakage measurement and estimates efficiency losses from those leakages. The duct blaster test will quickly isolate leaks in the duct system while a blower door test identifies duct leaks as well as improvements needed in the thermal envelope of a home.*

Comfort-based Audits or Occupant Interviews: Although technology-based audits are very effective at identifying specific leaks and areas of the home that would benefit from improvements, for occupied units, the Energy Auditor can glean a great deal of information from the residents. Residents can identify which rooms are too hot or too cold; where there are drafts; which windows develop condensation; and where in the house there is excessive moisture, mold or mildew, peeling paint, water stains, odors, or rotting or buckling ceilings or walls. These questions can supplement a one-time audit by giving the auditor information about how the home performs in other seasons, such as where ice dams form, which rooms may stay cool in the summer but lose heat quickly in the winter (or vice versa).

* The Energy Conservatory. *Diagnostic Tools to Measure Building Performance.* Available online at: http://www.energyconservatory.com/applications/applications1.htm, 2007.

The Advisor bases its recommendations on ENERGY STAR performance specifications where they exist, HUD's guidelines for conducting energy efficient rehabilitations, and general building and climactic characteristics. The recommendations and savings figures attached to them are rough estimates for what might be expected for an actual project. The Rehabilitation Advisor additionally offers the benefits each recommended measure can achieve outside of energy savings.

A number of different variables are required to generate the actual estimates – specific climate, building components, construction type, age, fuel type, etc. The information generated – cost, savings and payback data – are representative of a typical building in the specified region and are a realistic illustration of typical results. This is a very quick, no-cost start to examining the savings to be gained by pursuing an energy efficiency rehabilitation project. Such preliminary information may help with planning, budgeting, and proposing a project.

The HUD Energy Efficient Rehabilitation Advisor is an on-line tool that can be found at: http://rehabadvisor.pathnet.org/index.asp.

- **ENERGY STAR On-Line Calculator:** For many ENERGY STAR products, EPA offers an energy savings calculator that also makes a determination of energy savings and payback periods. These calculators allow the user to enter product- specific information into the tool to automatically determine cost savings. The calculators also include default figures to provide a general estimate of savings and payback periods. These calculators are available on the ENERGY STAR website (see Appendix 1: Resources for more information).
- **Home Energy Saver:** The Home Energy Saver, developed at Lawrence Berkeley National Laboratory in partnership with ENERGY STAR, the Department of Energy, and HUD's PATH program, is an on-line calculator that is primarily designed for consumers. It can be used by third parties, such as PJs, to calculate a home's energy use and to identify ways to save energy in the home.

  This calculator is available through the ENERGY STAR website or at: http://hes.lbl.gov.

4.6. HOME-Funded Activity: Development of Multi-Unit Properties Greater than Three Stories

There are currently no established energy performance standards for new construction of multi-unit properties over three stories in height. Therefore, PJs need to decide what energy efficiency measures make sense for these developments, given the property's design and the PJ's objectives for the property. Many of the design principles presented in Chapters 2 and 3 can be incorporated into these types of properties, although there is not currently a required testing and certification process.

If a PJ seeks to address energy efficiency in the development of large multi-unit properties, HUD recommends that it seek the input of an experienced designer to assist them. PJs may also want to simply encourage or make energy efficiency measures for these projects optional, until standards are developed.

ENERGY STAR and High-Rise Buildings

To address energy efficiency opportunities for the mid-rise and high-rise residential market, EPA is piloting an ENERGY STAR labeling program for multifamily buildings with four or more floors. As of 2008, these pilot projects are located in New York, Oregon, and Colorado. These projects use a modeling approach to identify cost effective energy efficiency measures for the building type. To achieve the ENERGY STAR label under these pilots, a newly constructed building must be 20 percent more energy efficient than a building constructed to American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1, a national energy standard for mid- and high-rise buildings; and must score in the top quartile of the EPA residential benchmarking tool. The pilot phase of this program is expected to last until 2009. At that time, EPA will evaluate information generated by the pilots to understand how and whether ENERGY STAR goals are achievable at the national level for larger buildings.

State and Local Initiatives to Determine Standards

In addition to the EPA's ENERGY STAR pilot program, several states and local governments are establishing and testing standards. For example, the New York State Energy Research and Development Authority (NYSERDA) has launched its New York Energy $mart^{SM} Multifamily Building Performance Program. This program seeks to improve building performance by 20 percent over current ASHRAE standards (see Appendix 1, Resources for contact information).

4.7. Steps to Incorporate Energy Efficiency Measures into HOME-Funded Development of Large Multi-Unit Buildings

PJs should watch for further guidance from HUD and EPA regarding energy efficiency standards for high-rise, multifamily buildings, and may wish to follow the efforts of other state and local housing agencies. In the interim, PJs can promote improved energy efficiency in these large, multi-unit properties by encouraging CHDOs and developers to incorporate energy efficiency measures that are suitable and cost effective given the design of their projects. Much of this can be based on the design features described in Chapters 2 and 3 as well as information specific to these types of projects that is included in the Energy Efficiency Features section of this chapter.

PJs that decide to encourage efficiency in large multi-unit buildings will face several important decisions about how to structure and implement these efforts. The steps recommended below can help PJs address these decisions and select design guidelines or standards for new development of large rental properties that are consistent with program goals and local priorities.

1. Assess State and Local Contractor Capacity and Additional Sources of Support

To ensure that any new guidelines or standards can be implemented by the local or regional development community, a PJ needs to understand the current level of local capacity to develop large multi-unit rental properties that incorporate energy efficiency measures. A PJ should consider:

- The overall number and capacity of developers and contractors working in its community;
- Whether there are developers and contractors with experience in ENERGY STAR or incorporating energy efficiency into larger buildings who can carry out the PJ's program and/or serve as mentors or consultants; and
- Whether there are energy efficiency programs that are active in the community (such as DOE Weatherization), whose resources might be available to the program and applicable to larger buildings.

2. Decide Whether to Encourage or Require Energy Efficiency Measures

Considering the existing local capacity, a PJ then can determine whether to require or encourage energy efficiency measure in these projects. The PJ's approach must be compatible with the PJ's own priorities, existing guidelines, and standards. The PJ should consider whether to require or encourage specific energy efficiency measures or standards, or whether a combination of approaches makes sense.

In areas with limited or no capacity, PJs should take steps to build experience and local capacity. PJs can do this by launching a pilot program for one or two years, and by offering incentives to developers to participate. Pilot programs not only build capacity, they can provide valuable lessons about how PJs can effectively promote energy efficiency in large multi-unit projects.

In areas with some capacity, the PJ should consider the following approaches:

- Encourage developers to incorporate energy efficiency measures to the extent that it is feasible and cost-effective. The PJ might indicate that it is looking for such measures and encourage developers to propose what actions the developers are able to achieve.
- Encourage developers to meet energy performance standards that exceed existing code requirements by a certain percentage. The PJ could award bonus points for proposals that meet these criteria. The PJ would need to work out an inspection and verification process to determine that the performance standard was met.
- Establish baseline requirements that all proposals and projects must meet. These requirements could include:
  - Use of energy efficient or ENERGY STAR appliances in all units;
  - Installation of high efficiency HVAC systems;
  - Use of energy efficiency lighting in common areas; and/or
  - Review of project design documents to avoid leaks that lead to energy loss.

For any of the above approaches, the PJ should consider whether to provide any incentives for developers that follow the selected approach, such as:

- Density bonuses;
- Waiver of fees or restrictions on projects;
- Streamlining the processing and/or approval of projects; and/or
- Increased funding levels to pay up-front costs for efficient systems.

3. Revise HOME Program Procedures and Documents to Ensure that Developers Achieve Energy Efficiency Guidelines

If a PJ decides to require that HOME-funded projects meet higher energy efficiency standards, its HOME program descriptions, written guidelines, funding announcements, and written agreements with developers should state explicitly that HOME funding is contingent on the project meeting the new standards.

If a PJ does not require projects to meet higher energy efficiency standards but wants to encourage projects to address energy efficiency by offering incentives, this intent should likewise be written into program descriptions, guidelines, and funding announcements. When a project receives an incentive (such as bonus points or supplemental funding), the written agreement should specify how the PJ will verify that the promised standard was met, and specify that meeting the standard is a condition of funding.

If additional funding is given to developers as an incentive to incorporate energy efficiency measures or standards into projects, written agreements with developers should specify the amount of additional funding given and obligate the developer to follow the agreed-upon standards or return the incentive funding.

4. Conduct Outreach and Education to Program Partners

To further promote the adoption of energy efficiency standards, a PJ may link developers to state or local energy organizations. As PJs identify these partners, they should identify the types of services and resources they offer developers building energy efficient projects, and the procedures for requesting funding or technical resources. By educating developers about these organizations and the resources they offer, PJs offer additional tools that developers can leverage for their projects.

5. Verify Building Performance through Commissioning

For new construction of large multi-unit properties, a PJ should consider hiring an independent contractor, usually a mechanical engineer, to verify the performance of key systems following construction of the property. This is known as commissioning. Commissioning is the process of verifying that key systems in a new building function as intended, and communicating the intended performance to the building management team. This usually occurs when the building is turned over for occupancy. However, the commissioning firm can also review plans prior to construction and determine if they are likely to achieve the expected performance. In practice, commissioning costs are not included in design fees and are viewed as an additional cost which makes the practice less common than perhaps is desirable. As a result, it is seldom pursued properly. Particularly for large properties, PJs may want to budget for the additional cost for commissioning to ensure that energy performance and operational goals are met.

The ENERGY STAR program recommends taking the following four actions when pursuing commissioning.

1. **Communicate** the property's energy performance goals during commissioning to ensure that the design target is met. Encourage energy-use tracking that will allow performance comparisons to be made over time.
2. **Specify detailed commissioning activities** in project contracts. Seek separate funding for commissioning work to ensure that it is given the appropriate level of importance.
3. **Hire experts** that specialize in building commissioning. Include the commissioning firm as part of the design team early in the project.

4. **Finalize and transfer a set of technical documents** including manufacturers' literature for systems and components. Supplement technical literature with summaries of intended operation. Provide additional explanation for innovative design features.[24]

4.8. Homeowner and Occupant Education

To realize the full cost savings of the energy efficiency measures and maximize the benefits of improved comfort and durability of the property, occupants and property owners must know what energy efficiency measures are in the home, and know how to use and maintain them. Residents who do not know about the energy efficiency measures may continue to use "coping" strategies that they utilized prior to the renovation to maintain the comfort of the home, although such strategies are no longer needed and negate the expected energy savings. Property owners should update maintenance procedures to reflect the requirements of new equipment or other measures. The information provided should relate the specific features in the home.

Before an occupant moves into, or back into, a newly developed unit, PJs should make sure that the following actions are taken:

- Identify all the energy efficiency appliances or products installed in the unit and provide the occupant with all informational materials on how to operate and maintain these products to maximize energy efficiency;
- In multifamily properties, notify the occupants about the importance of reporting maintenance requests;
- Provide occupants with informational materials regarding the use of non-toxic cleaners to maintain healthy indoor air environment;
- Teach occupants about how and when to use fans and ventilation systems to maximize their effectiveness; and
- Follow up with occupants after they have lived in the unit for a period, in order to answer questions or address concerns about the energy efficiency features of the unit, that arise after occupancy.

PJs, subrecipients, and property owners should be careful not to "talk down" to occupants or dictate behavior, but to provide occupants with information so they can maximize their health, comfort, and financial savings from the energy efficiency measures.

[24] U.S. Environmental Protection Agency and U.S. Department of Energy. ENERGY STAR. http://www.energystar.gov/index.cfm?c=new_bldg_design.new_bldg_design_guidance

Attachment 4-1:
Home Performance with ENERGY STAR Locations

Home Performance with ENERGY STAR is available in the following areas, as of 2007. Check the ENERGY STAR website for updated lists and contact information:

Arizona
FSL Home Improvements

California
Anaheim Public Utilities
California Building Performance Contractors Association

Colorado
E-Star Colorado

Georgia
Southface Energy Institute

Idaho
Idaho Energy Division

Illinois
Tri-County Construction Labor-Management Council (TRICON)

Massachusetts
National Grid (MA)

Maryland
Maryland Energy Administration

Maine
Maine Whole House Energy Efficiency

Missouri
Missouri Department of Natural Resources

New Jersey
New Jersey Board of Public Utilities

New York
New York State Energy Research and Development Authority (NYSERDA)
Long Island Power Authority (LIPA)

Ohio
FirstEnergy Corporation

Oregon
Energy Trust of Oregon

Rhode Island
National Grid (RI)

Texas
Austin Energy

Vermont
Efficiency Vermont

Wisconsin
Wisconsin Focus on Energy

Wyoming
Wyoming Energy Council, Inc.

Attachment 4-2: Calculating Preliminary Feasibility for Installing Combined Heat and Power in an Apartment Building

The U.S. Department of Housing and Urban Development (HUD), the Department of Energy (DOE) Oak Ridge National Laboratory (ORNL) and the eight DOE Regional (CHP) Application Centers have an initiative to promote the use of combined heat and power (CHP) in apartment buildings. The average efficiency of the fossil-fueled central power generating plants in the U.S. is around 33 percent and has remained virtually unchanged for 40 years. This means that two-thirds of the energy in the fuel is lost as heat. CHP systems generate electricity at the apartment building, recycle waste heat and convert it to useful energy. These systems can achieve overall efficiencies higher than 80 percent without transmission losses. The value of that heat is what drives the economics for using CHP.

CHP can significantly reduce a multifamily building's annual energy costs. Instead of buying all the building's electricity from a utility company and separately purchasing fuel for its heating (mechanical) equipment, most—or even all—of the electricity and heat can be produced for less money by a small power plant in the building operating at a higher combined efficiency. CHP can help relieve grid congestion and can improve the environment by reducing emissions. The recent Intergovernmental Panel on Climate Change (IPCC) report recognized CHP as "one of the leading responses to climate change currently commercially available."

The type of CHP system commonly installed in multifamily housing uses a package that contains a gas-fired reciprocating engine (a refined version of that found in a car or truck), or a microturbine, that drives a generator to produce electricity. Instead of being exhausted, the heat (thermal energy) produced by this process is recovered and used to produce domestic hot water and space heating, and to operate an absorption chiller or power a desiccant (drying) machine.

- For a webcast summary of HUD's promotion of CHP, go to: http://www.hud.gov/webcasts/archives/envirhealth.cfm and bring up Part 2; CHP begins at the 51 minute point and runs for about 20 minutes.
- For more technical information see: "CHP Technologies," http://www.eere.energy.gov/de/chp/chp_technologies/tech_status.html and http://www.epa.gov/chp.
- For a list of DOE Regional CHP Application Centers see: http://www.eere.energy.gov/de/chp/chp_applications/chp_application_centers.html.
- For two guides and computer feasibility screening software for considering CHP in multifamily housing see the HUD website at: http://www.hud.gov/offices/cpd/library/energy/index.cfm.
  - **CHP Guide #1**: "Q&A on Combined Heat and Power for Multifamily Housing" explains the basics of CHP for apartment building owners; and
  - **CHP Guide #2**: "Feasibility Screening for Combined Heat and Power in Multifamily Housing" describes EPA's preliminary screening tool and the computer software prepared by the Oak Ridge National Laboratory for completing worksheets in the Guide.
    - **CHP Feasibility Screening Software** provides an estimate of simple paybacks from utility savings resulting from CHP. ORNL has expanded the scope of the software to consider cooling and space heating, in addition to the original analysis of the potential based on use of domestic hot water. Use Version 2.1 of the expanded software is available at: http://eber.ed.ornl.gov/HUD_CHP_guide_version_2.1
    - **The User Manual for Version 2.1** can be downloaded from the above web address. (It is similar to the Help file.) The Manual contains detailed explanations of who should use it, what it does, and how to use it. It explains menu commands that enable the user to print "Results" and save the screen information in a Word file. There also is detailed information about the types of equipment used, e.g. reciprocating engines and microturbines.

Buildings with 80 or more units, master-metered, with access to natural gas, may be most appropriate. The user should access the software, enter his/her utility data, and save and print the Results and Screen Shots. Estimates include: cogeneration system size, power consumption dollar savings, demand dollar savings, total electric and fuel cost savings, system operating costs, total cogeneration operating cost, net savings and simple payback in years. The user can then send the files to HUD at the number listed below for comments. DOE Regional Application Centers also provide follow-up comments.

The analysis performed by this program is adequate for a coarse screening to let building operators know whether or not they should consider CHP more seriously. Encouraging results are only a prelude to a more rigorous analysis to be performed by engineering professionals using much more detailed information on building heating and electricity loads and CHP equipment. For a quick theoretical reading, without the monthly data, the user can enter "Utility Rate Data" tab data on electricity and natural gas pricing, and on the "Miscellaneous Input Information" tab, enter State, City, and Heated and Cooled Areas data, as a minimum. With only these data, Method 3 will calculate the estimated results on an appropriately-sized system. (Select the Method 3 check box on the Results tab.)

Utility Information

	Electricity			Natural Gas		Fuel #2	
	kWh	**kW**	**$**	**() therms ( )CCF**	**$**	**[quantity] ( )gallons**	**$**
Jan							
Feb							
Mar							
Apr							
May							
Jun							
Jul							
Aug							
Sep							
Oct							
Nov							
Dec							
Annual Total			$		$		$
Average Cost	**xxxxxx**	**xxxxxx**	**$ Per kWh**	**xxxxxx**	**$ Per therm**	**xxxxxx**	**$ Per gallon**

Building Information

Name of Contact _____ Telephone # _____

Email address _____

Name of development _____

Year constructed _____ # floors _____ # dwelling units _____ # residents _____

Square footage to be heated _____ and/or cooled _____

Electric Rate Schedule Data

Name of electric utility _____ Electric rate _____

Energy charge _____ /kWh Demand charge _____ /kW per month

Standby or supplemental demand charge _____ /kW per month

Fuel adjustment charge from most recent bill _____ /kWh

Natural Gas Rate Schedule Data

Name of gas utility _____ Gas rate _____

Gas cost per unit of consumption _____

Units of consumption: ( ) per million Btu (MMB) ( ) per therm ( ) per decath

( ) per hundred cubic feet (CCF) ( ) per thousand cubic feet (MCF)

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Chapter 5: Incorporating Green Building Practices that Improve Housing Performance

This chapter introduces green building practices that improve the indoor conditions for occupants, minimize a property's adverse impacts on the environment, and enhance building performance. It summarizes the benefits of incorporating green building practices into affordable housing and provides guidance to PJs about helpful steps to take when considering green building practices for their HOME-funded activities. The chapter also presents an overview to a range of green building practices that communities can incorporate into their affordable housing activities.

5.1. What are "Green" Building Practices?

Homebuyers, renters, residential and commercial developers, property managers, and government agencies are all demonstrating a growing interest in sustainable or "green" building practices. Green building is no longer championed by just a small group of citizens and advocacy organizations. This interest is driven not only out of recognition of the environmental impact of buildings, and by the tangible benefits to property owners and occupants in terms of long-term building performance and reduced operating costs. Green buildings are increasingly seen as economically-smart buildings that have both immediate and long-term benefits for developers, owners, PJs, and residents.

5.2. What Does "Green" Mean?

According to the EPA, "green or sustainable building is the practice of creating healthier and more resource-efficient models of construction, renovation, operation, maintenance, and demolition."[25] While energy efficient buildings are a critical component of "building green," building green moves beyond energy conservation and includes other factors such as:

- **Indoor Environment.** Designing and operating buildings that are healthy for their occupants.[26]
- **Water.** Designing and operating buildings that use water efficiently.
- **Materials.** Using building materials that, in comparison to competing brands, have a reduced effect on the environment throughout their life cycle (e.g. recycled content, low toxicity, energy efficiency, biodegradability, and/or durability).
- **Waste.** Reducing the waste from construction, remodeling, and demolition.

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[25] U.S. Environmental Protection Agency, Green Buildings home page, at: http://www.epa.gov/greenbuilding/ September 28, 2007

[26] The Construction Industry Compliance Assistance Center. http://www.cicacenter.org/gbover.html September 28, 2007

Green building methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. However, the most significant benefits can be obtained if the design and construction team takes an "integrated design" approach from the earliest stages of a building project.

5.3. Benefits to Building Green

Often with only modest cost, incorporating green building practices can result in both short- and long-term benefits, including:

- **Economic Benefits**
  - Reduce operating costs for owners;
  - Create, expand, and shape markets for green product and services;
  - Improve occupant health and therefore productivity, as occupants are sick less often (fewer allergies, respiratory problems) and miss fewer days of school or work; and
  - Minimize strain on local infrastructure by reducing waste handled by sewer and solid waste authorities.
- **Environmental Benefits**
  - Enhance and protect biodiversity and ecosystems;
  - Improve air and water quality;
  - Reduce solid waste disposal by using recycled materials, more durable materials, and reducing excess scrap materials; and
  - Conserve and restore natural resources.
- **Occupant and Social Benefits**
  - Enhance occupant comfort and health with improved indoor air quality;
  - Enhance worker and occupant safety; and
  - Improve overall quality of life with improved health and more financial resources for other household priorities.[27]

According to a study for the California Sustainable Building Task Force in 2003, an initial increase in up-front costs of approximately two percent for green design can yield lifecycle savings of more than ten times the initial investment, or 20 percent of total construction costs (based on a conservative estimate of a 20-year building life).

The study found that if $40,000 is initially invested in green design and features in a $2 million dollar project, the initial investment is repaid within two years. Over a 20-year period, savings amount to $400,000.[28] Further, while the benefits to the occupants in terms of health, comfort, and safety are often more difficult to quantify in economic terms for a specific project, such benefits should not be overlooked when considering the benefits of green building practices.

5.4. Green Building Guidelines

As interest in green building grows, national agencies and organizations are working to establish guidance and standards to support the development of green buildings. These organizations have developed voluntary guidelines to help communities and developers design, build, and operate housing that minimizes its impact on the

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[27] U.S. Environmental Protection Agency, Green Buildings. "Why Build Green?" http://www.epa.gov/greenbuilding/pubs/whybuild.htm September 28, 2007

[28] Kats, Greg, Principal Author. (Capital E: 2003). The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force. http://www.mtpc.org/cleanenergy/greenbuilding/impactsavings.htm

environment. Three such guidelines developed by national organizations, are summarized below. While each set of guidelines uses a different structure, there is substantial overlap in the types of building practices covered. The implementation of these guidelines ranges from a formal third party certification process to voluntary guidelines to be used by developers or owners as deemed appropriate. Contact information for these organizations is provided in Appendix 1: Resources.

HUD encourages PJs to consider adopting green building practices in their affordable housing projects when it is feasible and consistent with local program goals. However, HUD does **not** require PJs to implement green building practices, nor does it endorse one set of guidelines over another.

Leadership in Energy and Environmental Design (LEED) – U.S. Green Building Council

The U.S. Green Building Council (USGBC) is a nonprofit organization composed of leaders from every sector of the building industry working to promote buildings that are environmentally responsible, profitable, and healthy places to live and work. The USGBC developed The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ which is a common standard for the design, construction, and operation of high performance green buildings. Based on this rating system, a project may receive certification of meeting one of four different performance levels: certified, silver, gold, or platinum. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of building performance. These areas are:

- Sustainable site development;
- Water savings;
- Energy efficiency;
- Materials selection; and
- Indoor environmental quality.

Green Communities Initiative, Enterprise Community Partners

Enterprise Community Partners established the Green Communities initiative to mainstream green building and sustainable development in the affordable housing industry. Through Green Communities, Enterprise provides financial support and technical expertise to enable developers to build and rehabilitate homes that are healthier, more energy efficient, and better for the environment on a cost-effective basis. They also work with state and local governments to ensure their housing and economic development policies are sustainable.

Projects supported by Green Communities must meet a set of criteria established by Enterprise. These criteria, designed to align with the LEED criteria, involve the following eight topics.

- Integrated design process;
- Location and neighborhood fabric;
- Site improvements;
- Water conservation;
- Energy efficiency;
- Materials beneficial to the environment;
- Healthy living environment; and
- Operations and management.

Green Home Building Guidelines, National Association of Home Builders

The National Association of Home Builders (NAHB) has developed voluntary green building guidelines that target builders and home builder associations looking to incorporate green building practices into the development, design, and construction of new homes. The guidelines are available from NAHB for free and contain six main sections:

- Site preparation and design;
- Resource efficiency;
- Energy efficiency;
- Water efficiency/conservation;
- Occupancy comfort and indoor environmental quality; and
- Operation, maintenance, and education.

5.5. Key Steps When Incorporating Green Building Practices

PJs can incorporate green building practices into both new construction and rehabilitation activities. When PJs incorporate green building practices into their activities together with energy efficiency measures, it reduces operating and maintenance costs for owners and occupants, enhances the durability of the property, and improves the quality of life for residents.

At the same time, PJs face the challenge of determining which green building practices are feasible and cost-effective given the scope and nature of projects. The suggested steps below present a series of good practices to help PJs successfully incorporate green building practices into their development programs in a way that is consistent with state and local program priorities, as well as local capacity.

Basic Steps Similar to Incorporating ENERGY STAR

To incorporate green building practices into HOME-funded activities, a PJ can follow many of the same steps described in Chapter 3 for ENERGY STAR projects, with a focus on green building practices. These steps include:

- Identify housing activities where green building is compatible with local program goals;
- Assess state and local contractor capacity and additional sources of support;
- Decide whether to encourage or require green building practices;
- Revise HOME program procedures and other written materials to ensure that developers meet green building guidelines;
- Train program staff;
- Conduct outreach and education to program partners;
- Implement procedures for monitoring developer performance; and
- Continue period outreach and education.

Additional Considerations Specific to Green Building Practices

The steps above parallel the steps outlined in Chapter 3. In addition to these steps, green building practices involve several additional considerations beyond those identified for ENERGY STAR.

- **Identify state or local green building goals, program, or requirements.** State and local governments are increasingly establishing their own green building goals, programs, or requirements for their communities. Determine if such goals, programs, or requirements exist or are under development in communities within the PJs program area. If they do exist, make sure to address the relevant elements in HOME-funded activities.

- **Select the standards or guidelines to use.** Unlike ENERGY STAR, which has established performance standards, no single recognized standard exists for green building practices. PJs need to decide whether to rely on one of the existing standards (such as LEED), tailor existing standards to their own circumstances, or develop their own standards. Working with existing standards is likely to be the most efficient, but PJs still need to determine which set of standards is the best fit for their community. (Note, the following section provides guidance on how PJs can approach this question.)
- **Determine the program approach to addressing green building practices.** When examining its existing housing activities and determining how to encourage or require green building practices. PJs need to decide whether to develop a stand-alone program for supporting green building, or to incorporate green building practices into existing activities. For example, a PJ could:
  - Establish a separate activity, distinct from current housing activities that requires developers to achieve specific green building standards;
  - Offer incentives for meeting green building practices under its current funding process; or
  - Revise its standards to require some green building practices, such as those related to water conservation and healthy home design, while providing incentives or bonus points for additional green building practices.
- **Choose the method for monitoring and/or certifying the use of green building practices.** This may be done by PJ staff, a qualified third-party, or with developer self-certification that the green building practices were incorporated into the building.
- **Build in flexibility to allow for expansion and innovation.** When considering how to incorporate green building into HOME-funded activities, HUD encourages PJs to adopt approaches that are flexible enough to accommodate changes and innovation in green building practices and technologies. As the field of green building continues to grow, there will be new resources, lessons, and practices that emerge or become increasingly cost-effective. A program design that can capture these changes will be able to grow without requiring major program changes or restructuring to take advantage of this new knowledge.

5.6. Green Building Practices

The remainder of this chapter provides overview information on some specific green building practices that address:

- Site design;
- Building materials and construction practices;
- Renewable energy;
- Water conservation;
- Healthy home design; and
- Operations and management.

This information should help PJs assess and select green building practices that are consistent with local program goals and priorities. Each description summarizes how the building practice addresses sustainable building design, and also identifies key design considerations that impact the effectiveness of the practice.

PJs can simply adopt an established set of practices (e.g., LEED or Green Communities), or develop its own set of practices. PJs that opt to develop their own set of individual practices can use the overview below as a starting point to identify the set suitable to their activities. PJs should ask the following questions when selecting practices suited to their housing activities:

- How important are the benefits of this practice given local program goals and priority community needs?
- Should this practice apply to new construction only, or should it also apply to rehabilitation? If applicable to rehabilitation, what size or types of rehabilitation are most applicable?

- Does this practice, or elements of the practice, closely reflect existing program requirements or guidelines which could be easily updated to fully incorporate the green features of the practice?
- Should a practice or element of a practice be added as a program requirement or guideline, or should it be encouraged in program procedures?
- What program requirements, guidelines, or procedures need to be updated to allow for a green practice to be utilized?

HealthyBuilt Homes: Building Green with ENERGY STAR Standards

North Carolina HealthyBuilt Homes is a voluntary, statewide green building certification program supported by the North Carolina Solar Center, the State Energy Office, Home Builder Associations, and other professional building organizations.

Who is the program targeted at?

Small to medium sized home builders who may not have the resources to compete with larger green builders.

What are the guidelines for certification?

- **Site and Landscaping.** Use of erosion control methods and native, non-invasive species;
- **Energy.** All homes are ENERGY STAR certified;
- **Indoor Air Quality.** Use of fresh air systems, moisture control, non-toxic materials;
- **Water.** Conservation through landscaping, fixtures, appliances; and
- **Materials.** Use of durable and renewable, recycled, and engineered products.

What are the benefits of HealthyBuilt Homes?

- Reduced risk of mold;
- Third party verification;
- Reduced energy and operating costs;
- Improved comfort and durability;
- Higher home value; and
- Environmental protection.

What does the HealthyBuilt Home Program offer to participating homebuilders?

- Recognized green certification;
- Technical and marketing assistance;
- Design reviews;
- Workshops; and
- Field consultation services.

How many HealthyBuilt Homes have been built?

As of 2007, there were 105 certified HealthyBuilt Homes and 489 homes "in progress" in the Western North Carolina area.

For more information about HealthyBuilt Homes, see http://www.healthybuilthomes.org.

PJ program staff does not need to know the technical details of carrying out each green building practice, but it should understand each concept so it is able to effectively work with contractors and developers. However, the PJ's building and construction specialists should have training in the green building practices encouraged by the PJ to assure effective oversight and monitoring of developers, CHDOs, and subrecipients carrying out these practices. Finally, it is a good practice to obtain technical assistance from an experienced green building advisor who understands the technical aspects, and brings direct experience with a range of green projects.

5.7. Site Design

When designing and improving a site, green building practices look to minimize the impact on the surrounding environment and preserve or restore natural features. While these activities typically apply to new construction projects, and in some circumstances they may also apply to rehabilitation.

- Locate building, roads, and parking to preserve highest value vegetation and environmental features;
- Construct homes with an orientation designed to maximize solar potential, based on climate;
- Plant trees to increase shading and moderate temperatures, based on climate;
- Minimize slope disturbance and limit development footprint on steep slopes;
- Consider terracing, retaining walls, and landscaping to reduce long-term erosion;
- Plan landscaping to minimize water demand while preserving the natural environment;
- Select turf grass and plants that are native to the area;
- Group plants together that have similar watering needs; and
- Grow privacy screens and fencing, rather than constructing them.

Controlling rainwater and groundwater. Failing to properly control these elements can create moisture problems inside the building, which is discussed in more detail later, but also impacts the durability of the building. Successful rainwater and groundwater control can benefit landscaping and reduce water demand for plants.

Rainwater Control

The key objective in controlling rainwater is to direct rainwater downward and outward, away from the building. This can be achieved by layering materials to shed water. Overhangs and canopies keep water away from walls and windows. Effective site grading can keep water away from the foundation. Proper drainage is critical in successfully controlling rainwater. New construction or renovation activities should consider drainage of the:

- Site;
- Ground;
- Building;
- Assembly; and
- Openings (doors and windows).

Groundwater Control

The key objective in controlling groundwater is to keep it away from the foundation wall perimeter. This can be achieved by draining groundwater with sub-grade perimeter drains. This can be done for basements, crawlspaces, and slabs. For either new construction or rehabilitation activities, consider the following techniques to control groundwater:

- Create a capillary break. This can be achieved by dampproofing exterior basement walls.
- Consider interior basement insulation choices carefully. Interior basement insulation and finished walls are vulnerable to moisture problems. When insulating a basement wall use a layer of form board to prevent moisture problems.
- Avoid carpets on below-grade slabs, unless slabs are insulated. If a carpet is on an uninsulated slab, when the climate is cold with high humidity, the carpet creates an ideal climate for dust mites and mold growth.
- Use exterior drainage when feasible. If exterior drainage is not practical or feasible, interior perimeter drainage can be used and connected to an interior sump pump.

Many of the elements of green site design and rain and groundwater control incorporate good design features and common sense that can be achieved with minimal, if any additional cost, depending on the features of the property. These practices increase the durability of a building and reduce maintenance and operating costs. These elements should be considered in all new construction projects and to the extent feasible with rehabilitation projects.

5.8. Green Building Materials

The use of green building materials can reduce construction debris and improve indoor air quality. EPA estimated that 136 million tons of building-related construction and demolition debris materials were generated in the U.S. in 1996. Most of this was from renovation and demolition: concrete and mixed rubble accounted for 40-50 percent of the waste; and debris and wood accounted for another 20-30 percent.[29] In addition, building materials that off-gas chemicals can pollute the inside air of new buildings, with some new buildings having chemical concentrations 100 times greater than outside levels.

While the environmental conditions and criteria may vary from project to project, many factors can be considered when selecting building materials or processes. In all or most building projects these have modest cost impacts. Also, a variety of materials are available, representing a range of improvement over conventional materials. The range may go from conventional products to those that are "good" with a modest benefit over the conventional product, "better" with a significant improvement, and "best" which represents the "greenest" product available. While requiring the "best" green approach for all building materials may not be cost-effective or realistic, increasing the use of "good" and "better" materials while moving in the direction of "best" materials is beneficial.

Green materials generally have all, or most, of the following features:

- **Low toxicity**. Select materials for which the manufacturer has reduced the use of toxicity of a product. Do not use carcinogenic compounds and ingredients.
- **Low or no emissions**. Select products that have low or zero emissions of volatile organic chemicals (VOCs) and avoid the use of chlorofluorocarbons (CFCs). Pressed wood products, adhesives, and many finishes (such as paints and varnishes) contain VOCs.
- **Recycled content**. Use products or materials comprised of recycled content, with a preference for post-consumer content.
- **Recyclable**. Use products or materials that are recyclable at the end or their useful life.
- **Sustainable**. Consider products that come from renewable natural resources harvested from sustainably managed sources, preferably with an independent certification.
- **Durable**. Select products and materials that are more durable and last longer than conventional counterparts. For example, stone, brick and concrete are more durable materials than wood and vinyl products, and they retain solar heat in the winter and remain cool in summer.

Seattle's SeaGreen Program

The City of Seattle has developed guidelines and incentives to promote green building in its community. For its affordable housing activities, the Seattle Office of Housing, working with local affordable housing experts, developed a sustainable building guide for nonprofit developers entitled "'SeaGreen' Greening Seattle's Affordable Housing." This guide is presented in a checklist format with strategies presented as achievable, essential, or recommended. The guide covers topics including enhanced design, site and water, energy efficiency, health and indoor air quality, materials efficiency, and operations and maintenance. Applicants for funding from the Office of Housing are required to submit a sustainability plan based on the SeaGreen guide. Funding is limited and competitive, so successful applications generally incorporate most SeaGreen Action Items into their project designs.

For more information go to:
http://www.seattle.gov/dpd/GreenBuilding/

[29] *Characterization of Building-Related Construction and Demolition Debris in the United States.* Prepared for USEPA by Franklin Associates under subcontract to TechLaw, Inc. June 1998

- **Moisture-resistant**. Select products and materials that resist moisture or inhibit the growth of mold or biological contaminants.
- **Energy efficient**. Use materials, components, and systems that reduce energy consumption. Refer to Chapters 3 and 4 of this guide for more information on ENERGY STAR and other energy efficient building practices.
- **Water conserving**. Select products and systems that reduce water consumption and design landscaping to reduce water needs.[30]

PJs can use the green building guidelines established by LEEDS, Enterprise Foundation, NAHB, or other organizations as the basis for encouraging developers and contractors to utilize green building materials.

5.9. Resource Efficiency

When constructing or rehabilitating a home or multifamily building, it is both environmentally friendly and potentially cost-effective to use resources efficiently, and not waste materials. Green building guidelines can provide detailed information and guidance on specific techniques and processes that contribute to resource efficiency. These guidelines often address the following types of issues:

- Reduce the amount of material used and waste generated. This can be achieved through:
  - Efficient floor plan,
  - Advanced framing techniques that use fewer materials while maintaining structural integrity,
  - Building dimensions that minimize the need for cutting materials,
  - Building materials that do not require additional finish on-site, and/or
  - Pre-cut or pre-assembled building systems or methods.
- Enhance the durability of the building. This can be achieved by incorporating design features that minimize the degradation and weathering of building materials to maximize the expected life of the material or product. This can be achieved by controlling moisture, described in more detail below.
- Disassemble or deconstruct buildings when feasible. Reuse these salvaged materials when possible.
- Use building materials with recycled content.
- Conduct on-site recycling of materials and waste.
- Use materials manufactured from renewable resources.
- Use locally available materials and products.[31]

5.10. Renewable Energy

Previous chapters of this guide discuss improving energy efficiency in buildings, with a focus on ENERGY STAR and building new homes to the ENERGY STAR qualified homes standard. Energy efficiency is a central component of green building, as a building that wastes energy is not an environmentally-friendly building. Renewable energy sources are energy efficient and have the environmental advantage of utilizing non-carbon based fuel as a primary source of energy. These renewable energy systems often have a high initial cost, which may make them less attractive, but their long-term energy savings are generally substantial. Other project-specific

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[30] Froeschel, Lynn. "Environmental Assessment and Specifications of Green Building Materials." *The Construction Specifier*. October 1999. NOTE: There are many descriptions of green building materials. We have used the elements listed by Ms. Froeschel because it was frequently referenced by other organizations, and because of her clear and concise descriptions. Although the article may be old, the concept and description remain valid and relevant.

[31] National Association of Home Builders Research Center. *Green Home Building Guidelines*. Available online at: http://www.nahbrc.org/greenguidelines/checklist_resource.html October 10, 2007

factors also need to be considered when determining whether to use these approaches. Geographic location, site design features in terms of space and solar orientation also impact whether these renewable energy systems are practical for an affordable housing project.

Solar Thermal Energy Systems

One of the most cost-effective ways to include renewable technologies into a building is by incorporating solar hot water. A typical residential solar water-heating system reduces the need for conventional water heating by about two-thirds. It minimizes the expense of electricity or fossil fuel to heat the water and reduces the associated environmental impacts.

Most solar water-heating systems for buildings have two main parts: (1) a solar collector and (2) a storage tank. Solar water heaters use the sun to heat either water or a heat-transfer fluid in the collector. Heated water is then held in the storage tank ready for use, with a conventional system providing additional heating as necessary. The tank can be a modified standard water heater, but it is usually larger and better insulated. Solar water heating systems can be either active or passive, but the most common are active systems.[32]

Solar water heating systems can be installed in most locations, even in northern most climates with pipe-freeze protection systems, and are based on the solar orientation of the building.

Photovoltaic Energy Systems

Photovoltaic (PV) energy systems use semi-conductors to convert sunlight into electricity. For housing projects, the most common system design uses flat-plate PV modules or panels. These panels can either be fixed in place or allowed to track the movement of the sun. They respond to sunlight that is either direct or diffuse. The simplest PV array consists of flat-plate PV panels in a fixed position.

PV systems can be designed in numerous settings and with different features, including as a stand-alone system or connected to generators. However, housing PV systems are most often connected to the existing utility grid. Homeowners or multifamily property owners can use a grid-connected PV system to supply some of the power they need and use utility-generated power at night and on very cloudy days. When the PV system supplies power to the grid as well as to a specific building or piece of equipment, the utility becomes a kind of storage device or battery for PV-generated power.

When considering a PV system, it is necessary to check the site to determine that it has enough solar energy to meet the building's electricity needs efficiently and economically. Check with a local system supplier to perform a solar site analysis.

When mounting PV modules on a roof, consider:

- Orientation to the sun, with exposure to the south. Modules can face up to 45° east or west of true south without a significant decrease in performance.
- Roof orientation and condition.
- Local landscape features that shade the collector daily or seasonally.
- Local weather conditions (foggy mornings or cloudy afternoons) that may affect the optimal orientation and subsequent electricity production of the PV modules.

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[32] U.S. Department of Energy. *Energy Efficiency and Renewable Energy: Solar Water Heating.* Available online at: http://www1.eere.energy.gov/solar/sh_basics_water.html October 5, 2007

In multifamily buildings, PV systems can be used to reduce energy consumption in numerous ways, including:

- Lighting in hallways and common areas;
- Lighting in parking lots and exterior walkways; and
- Electricity to laundry rooms and facilities.

Colorado Court – Santa Monica, California

Colorado Court is a 30,150-square foot, five-story, 44-unit affordable housing development designed by the Santa Monica architecture firm Pugh Scarpa Kodama (PSK) and developed by the nonprofit Community Corp. of Santa Monica. The building is built to LEED certification standards and among its many green building features, the building's façade consists of 199 photovoltaic panels which supply most of the building's peak load energy demand. The unused energy created by the panels is returned to the electric grid during the day and electricity is retrieved from the grid during the night, if needed. The total energy savings for the building is over $6,000 per year and the payback period for the energy saving features is estimated to be 10 years.

For more information go to: http://www.californiasolarcenter.org/solareclips/

Although improvement in solar technology continues and the costs of these systems are coming down, the initial investment for a PV system is still high compared to conventional system. As the costs for PV systems decrease, they may become more economically beneficial, but currently (2007) they may only make sense for some affordable housing projects with the right conditions, including lots of sun exposure.

Wind Power

Small wind turbines, mounted on towers between 80 and 120 feet tall, can generate electricity from the wind for home use. With on-site installations documented in at least 47 states, wind is a recognized renewable energy source for distributed generation of power on residential home sites. A wind-powered generator, or turbine, situated at the top of a high tower, has blades which spin to generate electricity. The electricity can either be used locally and/or any excess energy generated can be sold to the utility company. In a typical residential application, the power from the wind turbine is connected to the main electric service wire to the home. Special interconnection equipment allows powering the home, or sending the excess power generated by the turbine back to the utility grid.

Due to their height, wind turbines are best suited for remote or low-density residential lots of one acre or more. Until there are further advances in technology and costs are reduced, wind power is unlikely to be a viable option for most affordable housing projects.

Geothermal Power

Geothermal heat pumps (sometimes referred to as GeoExchange, earth-coupled, ground-source, or water-source heat pumps) have been in use since the late 1940s. Geothermal heat pumps (GHPs) use the constant temperature of the earth as the exchange medium instead of the outside air temperature. This allows the system to reach fairly high efficiencies (300 percent to 600 percent) on the coldest of winter nights, compared to 175 percent to 250 percent for air-source heat pumps on cool days.

Dalton's Edge—Allegheny County, PA

Dalton's Edge is a 120-unit senior affordable apartment complex in Allegheny County, PA. The building incorporates several green building features, including a geothermal heating and cooling system.

Even though the installation price of a geothermal system can be several times that of an air-source system of the same heating and cooling capacity, these additional costs are paid back in energy savings in five to ten years. System life is estimated at 25 years for the inside components and 50+ years for the ground loop.

The biggest benefit of a GHP is that it uses 25 percent to 50 percent less electricity than a conventional heating or cooling system. According to the EPA, a geothermal heat pump can reduce energy consumption—and corresponding emissions—up to 44 percent compared to an air-source heat pump, and up to 72 percent compared to electric resistance heating with standard air-conditioning equipment. [33]

The cost benefits for geothermal power are more reliable than wind or solar. There are space and soil considerations to the application of geothermal power, but they are less significant than those for wind. While geothermal may not be an appropriate approach in all situations, it may be feasible and effective in many situations and should be considered on a project-by-project basis. Because geothermal systems are custom-designed to fit the features of the project site, consult a contractor experienced in geothermal systems before pursuing this option.

5.11. Water Management

In addition to controlling rainwater and groundwater, as discussed above, there are two other elements of water management that contribute to a green building. These water management practices can be easily incorporated into all affordable housing projects with minimal cost, but significant short- and long-term savings in operating and maintenance costs.

- **Interior moisture control.** Controlling water and moisture is a critical factor to establishing a healthy home. Water and moisture lead to mold, insects, rodents, and dust mites, all of which harm the indoor environment. Failure to control water can also contribute to property deterioration and increase maintenance costs. Interior moisture primarily concerns the buildings plumbing.
- **Water conservation.** Conserving water and installing water-saving appliances and devices reduces water usage which, in turn, lowers water utility costs.

Interior Moisture Control

Plumbing is bound to leak. Therefore, where feasible, plumbing should be installed in interior walls where it can be most easily found and fixed. It is good practice to avoid plumbing in insulated exterior walls and ceilings as these areas are subject to greater temperature swings, which put expansion and contraction pressures on pipes, and can result in leaks and breaks. Good practices for controlling plumbing leaks include:

- **Bathrooms**
  - It is best to use cement board, fiber board, or paperless gypsum board.
  - Do not use paper-faced gypsum board in wet areas such as tub and shower enclosures. If gypsum board is used, keep it off the floors everywhere at baseboard locations. This reduces the chance of water coming in contact with the paper-faced wall board.
- **Clothes washers and water heaters**
  - Place clothes washers in rooms with floor drains and with a floor covering that can be wet mopped.
  - Use reinforced hose connectors on clothes washers to prevent leaks.
  - Install water heaters in rooms with drains and floors that are not water sensitive. In warm climates, it best to put water heaters in a garage. Do not install water heaters in attics.
  - Provide shut-off valves for washers and water heaters that are easily accessible and visible.

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[33] U.S. Department of Energy. *Energy Efficiency and Renewable Energy: Geothermal Heat Pumps.* Available online at: http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12640 October 10, 2007

- **Air conditioning systems**
- Note, air conditioning systems serve as dehumidifiers as well as a source of cooling air, which means that they condense air on a cold coil and drain the condensation to a drain or the outside.
- Wherever air conditioners are installed, their drain pans must be constructed and installed so that they drain properly.

Water Conservation

Water is a valuable resource and there are many available products that reduce water usage, as compared to conventional products. According to EPA, the average household spends as much as $500 per year on its water and sewer bill. By making just a few simple changes to use water more efficiently, households can save about $170 per year. Furthermore, reducing water usage reduces energy bills as less water needs to be heated. EPA has established the WaterSense[SM] program to label products that are water efficient. For new construction and rehabilitation projects, look for the following products with the WaterSense[SM] label:

- **High efficiency toilets**. High efficiency toilets use less than 1.3 gallons per flush. Unlike the first generation of "low-flow" toilets, advances in design allow for less water usage with no trade-offs in terms of performance.
- **Bathroom sink faucets**. In 2008, EPA will issue its WaterSense label for bathroom sink faucets that will use no more than 1.5 gallons per minute. These high-efficiency faucets and accessories (such as faucet aerators) can reduce the standard flow by more than 30 percent without sacrificing performance.
- **Showerheads**. EPA is looking to improve showerhead performance and is defining the criteria for a high performance showerhead.
- **ENERGY STAR appliances**. Install ENERGY STAR dishwashers and clothes washers to reduce water demand.
- **Point-of-use hot water heating systems**. Also known as tankless hot water heaters, point-of-use hot water heaters are installed near sinks or other demand areas and provide hot water on demand. They are more efficient because there is no storage tank and no heat loss from storing water or transporting hot water through pipes.

5.12. Healthy Home Design

Environmental hazards in the home harm millions of children and adults each year. Many of these hazards are caused by poor indoor air quality resulting from carbon monoxide, chemicals released from materials, radon, nitrogen oxides, sulfur oxides, soot and other particles. In addition, mold and mildew harms the indoor environment and can impact the integrity of the home itself. When building or renovating a building, the PJ can reduce these hazards and improve the indoor environment for the occupant by taking some simple steps. As described in Chapters 3 and 4, buildings that meet ENERGY STAR standards do not have these types of problems.

The additional financial cost for the design features described below should be modest or cost-neutral. These should become standard practice in all affordable housing projects as they are critical to ensure the health and safety of occupants.

Ventilation

Good ventilation is essential to controlling humidity and indoor air pollutants. There are two types of ventilation, each of which are needed for a healthy home, spot ventilation and dilution ventilation.

Spot ventilation addresses ventilation needs at specific locations where pollution or moisture is most common or likely, such as bathrooms and kitchens. Spot ventilation includes:

- **Kitchen and bathroom fans.** Every home should have exhaust fans in the kitchen and in every bathroom, vented to the outside. Kitchen range hoods should be exhausted to the outside to prevent moisture, odor, and pollutants from circulating throughout a home.
- **Clothes dryers** should be vented to the outside as they are a significant source of moisture and pollutants.

Dilution ventilation seeks to address low-levels of pollutants that exist throughout a home. Dilution ventilation can be provided by a continuous and fan-powered exhaust or supply system. Effective dilution ventilation requires a good distribution system, such as forced air duct system and a source of outside air throughout the house. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) establish standards to guide professionals on the design and maintenance of indoor air environments. When designing a dilution system, ASHRAE Standard 62.2 should be followed to establish dilution ventilation rates for new and renovated homes.[34] If the building specifications or standards for a PJ do not already incorporate this ASHRAE standard, the PJ should consider incorporating it into specification or standards.

Emissions Control

Combustion appliances, such as gas-burning stoves, ovens, furnaces, boilers, and water heaters, can produce carbon monoxide if not installed properly or operating correctly. Carbon monoxide is a major health threat in homes and can cause death. Carbon monoxide is not the only by-product of combustion appliances. Even "clean" burning appliances produce water vapor, nitrogen oxides, sulfur oxides, and carbon dioxide, all of which can cause health problems for occupants. Controlling these emissions is a component of having good ventilation, as described above, but because of the particular hazards associated with combustion appliances, these emissions require specific attention.

For both new construction and rehabilitation projects, the PJ should incorporate the following elements to control dangerous emissions in a home:

- Use electric ranges and ovens with exhaust fans, when feasible. If gas stoves and ovens are necessary, install them in combination with exhaust ventilation. All cooktops and ovens should be installed with range fans that exhaust to the exterior.
- Gas furnaces, boilers, and water heater vent systems should not interact with occupied spaces. They should be sealed-combustion power or power-vented devices.
- Leaky or disconnected ducts in forced heating and cooling systems can result in negative pressures to backdraft or spill combustion appliances. Avoid using building cavities, such as planned floor joists, as returns since they cannot be sealed airtight.
- Garages should not be connected to the home, if possible. If garages are connected to a home, they should be vented to the exterior with a passive vent stack. Air conditioners and furnaces should not be located in garages, nor should forced air ductwork. The door between the garage and the home should be weather-stripped and the common wall air sealed.

Radon

Radon is a cancer-causing natural radioactive gas that one cannot see, smell, or taste. Its presence in a home (including multi-occupant buildings) can pose a danger to the occupants' health. Radon is the leading cause of lung cancer in the U.S. and claims about 20,000 lives annually. For rehabilitation purposes, the EPA and the U.S. Surgeon General recommend that all homes (and multi-occupant buildings below three floors) be tested for radon. Some states have proficiency programs or requirements to test for radon and maintain lists of available contractors qualified to test for radon. If radon levels are above 4 pCi/L (picoCuries per liter of air) then EPA recommends that mitigation measures be undertaken, although EPA considers any level of radon a risk so mitigation measures may be appropriate for levels below 4 pCi/L.

There are several proven methods to reduce radon in a home, but the one primarily used is the active soil depressurization system (ASD), which pulls radon from beneath the home foundation and vents it (using a vent pipe and a fan) to the outside. The right system depends on the design of the home and other factors. Use a qualified contractor experienced in addressing radon when determining what mitigation measures to employ. For

[34] Building Science Corporation. *Read This: Before You Design, Build or Renovate.* Draft, May 2005, p. 28-29.

new construction, ensure that radon reduction features are used, including radon-resistant construction materials.[35] For more information on radon, contact a regional EPA office or the state radon office.

Operation and Management

Once a building incorporates green building practice into its design, construction, or rehabilitation, it is necessary to operate and maintain the building in an environmentally-friendly manner to maintain the benefits of green building. Using flooring material that has low or no VOC off-gassing but which is cleaned with toxic chemicals, will not achieve the full benefit of improved air quality for occupants. For multifamily buildings, encourage property mangers to develop environmentally friendly operations and maintenance procedures, which may include the following elements:

- Use non- or less- toxic cleaning materials and products and only use as much product as needed;
- Keep entryways clean and use walk-off mats to reduce the amount of dust, dirt, debris and pollen tracked into the building;
- Vacuum carpets frequently and use a high-efficiency particulate air filter (HEPA) vacuum if possible;
- Enforce non-smoking policies in common areas;
- Control moisture and repair plumbing leaks promptly;
- Develop an integrated pest management plan to control pests without using toxic chemical pesticides or insecticides; and
- Perform routine maintenance and replace filters on HVAC systems and duct work.[36]

[35] See U.S. Environmental Protection Agency. "Radon-resistant New Construction." Available online at: http://www.epa.gov/radon/construc.html. October 8, 2007.

[36] M. Landman Communications & Consulting Template. *Green Operations and Maintenance Manual.* 2006. Available online at: http://www.practitionerresources.org/showdoc.html?id=63995

Appendix 1: Resources

There are numerous resources available to PJs, CHDOs, and subrecipients to support efforts to incorporate energy efficiency and green building practices into affordable housing programs. Below is just a partial list of some valuable resources and organizations that can provide information.

The following is a list of Federal and non-federal energy efficiency and housing resources. Website links to main program pages are provided with references to applicable information that can be found within these sites. References include specific offices, fact sheets, manuals, and online tools. Websites can and often do change. If a website address is no longer active, contact the organization directly for more information.

Federal Resources

U.S. Department of Energy (DOE)

1000 Independence Avenue, S.W.
Washington, DC 20585

Phone: 1-800-dial-DOE
http://www.energy.gov/

- DOE Offices:
  - *Office of Energy Efficiency and Renewable Energy:* http://www.eere.energy.gov/
    This office has resources including information on the Solar Energy Technologies Program and the Building Technologies Program.
- Resources:
  - *Insulation Fact Sheet:* http://www.ornl.gov/sci/roofs+walls/insulation/
    The fact sheet offers helpful advice on insulating an existing or new home, including insulation levels recommended for different climates and installment tips.

U.S. Environmental Protection Agency (EPA)

Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

http://www.epa.gov

- EPA Resources:
  - *Indoor Air Quality:* http://www.epa.gov/iaq/homes/
    For information and resources related to indoor air quality in homes and activities to undertake during rehabilitation activities.
  - *Green Building:* http://www.epa.gov/greenbuilding/
    For information and links to resources related to green building practices.

ENERGY STAR

ENERGY STAR Hotline (6202J)
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

ENERGY STAR Hotline: (888) 782-7937
http:www.energystar.gov

The ENERGY STAR website offers a great deal of information on ENERGY STAR programs, including products to buy, how to find local partners and certified contractors advancing ENERGY STAR throughout the country, and tools for implementing ENERGY STAR systems and guidelines in a project. The types of tools on this site include:

- Manuals:
  - A Guide to Energy Efficient Heating and Cooling
  - Build ENERGY STAR Qualified Homes
- Brochures:
  - *Home Sealing Brochure*
  - *Duct Sealing Brochure*
  - *New Homes Brochure*
- Online Tools:
  - *Home Energy Cost Calculator:* http://hes.lbl.gov
    The Home Energy Saver's Energy Advisor calculates energy use and savings opportunities, based on a detailed description of the home.

U.S. Department of Housing and Urban Development (HUD)

451 7th Street, S.W.
Washington, DC 20410

Phone: (202) 708-1112
http://www.hud.gov/

- HUD Offices:
  - *Office of Community Planning and Development (CPD):* http://www.hud.gov/offices/cpd
    CPD environmental resources: http://www.hud.gov/offices/cpd/environment/index.cfm
    CPD energy resources: http://www.hud.gov/offices/cpd/library/energy/index.cfm

    These websites offer links and information on the HUD Energy Task Force, ENERGY STAR for Grantees, energy efficiency with CDBG and HOME, saving money and energy in HUD-assisted and HUD-financed housing, combined heat and power for multifamily housing, CPD energy initiatives, screening tools, including training for energy efficiency and affordable housing, and other related resources.
  - *Office of Healthy Homes and Lead Hazard Control:* www.hud.gov/offices/lead
    For information on addressing lead hazards in homes built before 1978 and information on health issues in housing.
  - *Office of Policy, Development, and Research (PD&R) – Partnership for Advancing Technology in Housing (PATH):* http://www.pathnet.org
    The PATH website contains articles, newsletters, publications, tools, and resources related to innovation and technology in housing.
  - *Energy Savers:* http://www.energysavers.gov
    This site contains information on Federal and state programs that promote energy efficiency. It is useful for consumers to learn about incentives, partnerships, and resources that can save energy in homes, businesses, vehicles, or industrial plants.
  - *HUD Energy Task Force*: http://www.hud.gov/energy/
  - *HUD energy training archives*: http://www.hud.gov/webcasts/archives/envirhealth.cfm

- Online Tools and Resources:
  - *"ENERGY STAR for Grantees"* PowerPoint Presentation. http://www.hud.gov/energystar/grantees.cfm
    This PowerPoint presentation provides an overview of ENERGY STAR with a focus on how HOME and CDBG grantees can adopt ENERGY STAR for their residential new construction projects.
  - *HUD Rehab Advisor:* http://rehabadvisor.pathnet.org
    HUD Rehab Advisor uses information about a project to estimate energy and cost savings that efficiency measures will achieve.
  - *Durability Doctor*: http://www.pathnet.org/durability_doctor/
    The Durability Doctor provides an analysis of the value that durable components add to a home by comparing the cost of the components and the cost savings of increased durability.
  - *Tech Sets:* http://www.pathnet.org/sp.asp?id=13675
    Tech Sets provide builders with systems-based packages that use complementary products and cost-effective technologies that can improve home quality. Each quarter a new Tech Set is released.

Non-Federal Resources

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

1791 Tullie Circle, N.E.
Atlanta, GA 30329

http://www.ashrae.org/

ASHRAE provides technical and educational information on heating, ventilating, air conditioning and refrigerating. Its website includes research, publications, newsletters, handbooks, online learning, satellite broadcasts, standards, and journals.

Canada Mortgage and Housing Corporation (CMHC)

700 Montreal Road
Ottawa, Ontario
K1A 0P7

Phone: (613) 748-2000
http://www.cmhc-schl.gc.ca/en/inpr/

CMHC provides a variety of case studies, resources, and other tools on building technology, green building, and affordable housing. It also offers an e-newsletter that provides the latest information on housing technology.

Enterprise Community Partners' Green Communities Initiative

10227 Wincopin Circle, Suite 500
Columbia, MD 21044

Phone: (410) 715-7433
http://www.greencommunitiesonline.org/

Green Communities provides funds and expertise to developers building and rehabilitating affordable homes in an energy efficient and environmentally sustainable manner. Green Communities also assists state and local governments to ensure their housing and economic development policies are smart and sustainable.

National Association of Home Builders (NAHB)

1201 15th Street, N.W.
Washington, DC 20005

Phone: (202) 266-8200 or (800) 368-5242
http://www.nahb.org

NAHB is a trade association that helps to promote policies that make housing a national priority. Its website offers economic and housing data, housing issues and policies, research, business management tools, publications, certifications, newsletters, reports, magazines, audio seminars, webcasts, and toolkits.

- **NAHB Research Center:** http://www.nahbrc.org/
  The NAHB Research Center offers technical information on building products, materials, new technologies, business management, and housing systems, and specialized material and structural systems testing. The Center also provides customized market research to help develop new products and markets and refine existing products and their production, certification programs, and green building research.
  - *Green Building Guidelines*: http://www.nahbrc.org/greenguidelines
    The NAHB Green Home Building Guidelines were created for home builders to highlight the ways a mainstream homebuilder can effectively weave environmental solutions holistically into a new home and to provide a tool that local associations can use to create their own green home building program.

Natural Resources Canada, Office of Energy Efficiency (OEE)

Office of Energy Efficiency
580 Booth St. 18th floor
Natural Resources Canada
Ottawa ON K1A 0E4

To order publications: 1 800 387-2000
http://oee.nrcan.gc.ca/english/index.cfm?attr=0

OEE offers publications and resources on improving energy efficiency in buildings and housing. While some information is specific to Canadian programs, many resources are broadly applicable.

Residential Energy Services Network (RESNET)

P.O. Box 4561
Oceanside, CA 92052-4561

Phone: (760) 806-3448
http://www.resnet.us

The Residential Services Network (RESNET) created training and certifying standards for the HERS program which prescribe minimum competencies for HERS certified trainers and raters. These standards apply to the third party raters of ENERGY STAR New Homes as well. The RESNET website includes information about HERS trainings, how to become certified as a rater, and descriptions of RESNET and the HERS index and thresholds.

U.S. Green Building Council (USGBC), Leadership in Energy and Environmental Design (LEED)

1800 Massachusetts Avenue, N.W.
Suite 300
Washington, DC 20036

Phone: (800) 795-1747
http://www.usgbc.org/

The USGBC website includes information resources about training, partnering, and facilitating efforts to create buildings that are environmentally responsible, profitable, and healthy places to live and work. It includes a description of, and information about, the LEED program and identifies opportunities to promote green building.

Appendix 2: Glossary

This glossary includes many relevant terms that a PJ/program manager may come across when incorporating ENERGY STAR into their HOME–funded activities. This glossary goes beyond the terms used in this guidebook, but is not intended to include every technical definition associated with energy efficiency. Unless noted, most of the definitions are from the ENERGY STAR program, EPA, or the Department of Energy, including three primary sources – ENERGY STAR's "Putting Energy into Profits: ENERGY STAR Guide for Small Business" and the "ENERGY STAR Building Manual," or the U.S. Department of Energy's "Consumer's Guide to Energy Efficiency and Renewable Energy."

Air Diffuser A device used to distribute heated or cooled air to a space.

Air Handling Unit (AHU) Equipment used to distribute conditioned air to a space, including heating and cooling coils, fans, ducts, and filters.

Air Side Systems Equipment used to heat, cool, and transport air within building HVAC systems.

Annual Fuel Utilization Efficiency (AFUE) The efficiency of a boiler is measured using AFUE. Specifically, the AFUE measures the amount of fuel converted to space heat in proportion to the amount of fuel entering the boiler. This is commonly expressed as a percentage.

ARI Air-Conditioning and Refrigeration Institute.

ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

ASME American Society of Mechanical Engineers.

Balancing Process of measuring and adjusting equipment to obtain desired flows. It applies to both air side and water side systems.

Blower Door Test A blower door test is a variable speed fan, mounted in a doorframe, used to pressurize and depressurize a house to measure air leakage.

Boiler A vessel designed to transfer heat produced by combustion or electric resistance to water. Boilers may provide hot water or steam, depending on design and settings.

British Thermal Unit (Btu) A unit of heat energy equal to the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit at sea level. This is roughly equivalent to the heat given off from burning a wooden match.

Builder Option Package (BOP) A set of construction specifications for a specific climate zone. The BOP specifies performance levels for the thermal envelope, insulation, windows, orientation, HVAC system and water heating efficiency for a specific climate zone that meet the ENERGY STAR standard.

Building Envelope The exterior surface of a building's construction—the walls, windows, doors, roof, and floor. Also called the building shell.

Building Performance Institute (BPI) The Building Performance Institute is a nationally recognized, not-for-profit, certification, and accreditation organization providing building performance credentialing services through a national network of affiliates. [i]

CABO Council of American Building Officials. Precursor organization of the International Code Council (ICC). [ii]

Calibration The process of adjusting equipment to ensure that operation is within design parameters.

Carbon Dioxide Colorless, odorless, incombustible gas formed during respiration, combustion, and organic decomposition. Increasing amounts of carbon dioxide in the atmosphere are believed to contribute to the global warming phenomenon.

Carbon Monoxide Colorless, odorless, poisonous gas formed during incomplete combustion of fuel.

Cellulose Insulation Insulation made of recycled wood fiber, primarily newsprint. The wood fiber is shredded and pulverized into small, fibrous particles that pack tightly into closed building cavities, inhibiting airflow. Types of cellulose insulation include: dry or loose fill, wet-spray, stabilized, and low-dust.

CFM Cubic Feet per Minute, a measure of air flow.

Chiller A mechanical device that generates a cold liquid that is circulated through an air-handling unit's cooling coil to cool the air supplied to the building.

Chlorofluorocarbons (CFCs) Chemical compounds consisting of carbon, hydrogen, chlorine, and fluorine, once used widely as aerosol propellants and refrigerants. Believed to deplete the atmospheric ozone layer.

Coefficient of Performance (COP) A measure of efficiency in which a higher value designates a more efficient system.

Coil, condenser A heat exchanger used to condense refrigerant from a gas to a liquid.

Coil, cooling A heat exchanger used to cool air under forced convection, with or without dehumidification. May consist of a single coil section or several coil sections assembled into a bank.

Coil, fan A device that combines a heat exchanger and a fan in a single unit that conditions air by forced convection.

Coil, heating A heat exchanger that heats air under forced convection. May consist of a single coil section or several coil sections assembled into a bank.

Combined Heat and Power (CHP) Also known as cogeneration, CHP is the simultaneous production of electricity and heat from a single fuel source, such as: natural gas, biomass, biogas, coal, waste heat, or oil. CHP is an integrated energy system that can be modified depending upon the needs of the energy end user. The two most common CHP system configurations are a gas turbine or engine with heat recovery unit or a steam boiler with steam turbine.

Combustion Air Air that supplies the oxygen required to burn fuel.

Combustion Spillage The unwanted flow of combustion gases into a home. [iii]

Commissioning The quality assurance process that ensures design intent is met for new facilities or major rehabilitation.

Compact Fluorescent Lamp (CFL) Small fluorescent lamps frequently used as more efficient alternatives to incandescent lighting. They typically have 10 times the rated life and three to four times the efficacy of incandescent lamps.

Condensate Return System A system of piping that returns the heated water condensing within steam piping to the boiler and thus saves energy.

Condenser A heat exchanger in a refrigeration system that expels building heat absorbed in the evaporator.

Conditioned Air Air that serves a space and that has had its temperature and/or humidity altered to meet design specifications.

Constant Volume (CAV, or constant air volume) Type of air-handling system that supplies the conditioned space at a constant air flow and modulates heating and cooling by varying the air temperature.

Controls An instrument or set of instructions for operating or regulating building systems.

Convector A heating unit that circulates heated air by means of natural convection. Normally consists of a heating element within an enclosure, with an air inlet below and an air outlet opening above.

Cooling Tower A device that dissipates the heat from water-cooled systems by spraying the water through streams of rapidly moving air.

Cycling The non-continuous operation of equipment.

Dampers Single- or multiple-blade devices, either manually or automatically opened or closed, that control the flow of air.

Damp proofing A process that slows water penetration into foundations. Damp proofing is usually performed by applying unmodified asphalt coatings to the foundation surfaces. [iv]

Degree-Day A rough measure used to estimate the amount of heating required in a given area. A degree-day is defined as the difference between the mean daily temperature and 65 degrees Fahrenheit (F). This is based upon the assumption that no heating is required when the temperature is above 65º F, and that proportionately more heating is required the further the average temperature drops below 65º F. Cooling degree-days may also be calculated to estimate cooling requirements.

Demand The average rate of electrical usage used over a specified period of time (typically a 15-minute, 30-minute, or 1-hour period). Measured in kilowatts (kWs).

Demand Charges Fees charged by a utility company for electric demand. These charges are often highest during weekdays in summer.

Demand, electric Electrical power delivered to a system at a given time or averaged over a designated period. Expressed in kilowatts.

Demand Ventilation Method of controlling the amount of outdoor air intake based on carbon dioxide levels in a space.

Depressurization Test This combustion safety test determines if any non-sealed combustion appliances will backdraft or spill combustion products into the living space.[v]

Desiccant A material that absorbs moisture from its surrounding environment.

Dilution Ventilation A form of exposure control that involves providing enough air in the workplace to dilute the concentration of airborne contaminants to acceptable levels.

Domestic Hot Water All hot water consumed in a building that is used for purposes other than heating a space.

Downsizing Process of reducing the size (capacity) of equipment so that it operates efficiently at design load conditions.

Dual Duct A type of heating, ventilating, and air-conditioning (HVAC) distribution system that involves simultaneous heating and cooling. Two supply ducts (a "hot deck" and a "cold deck") serve each space, and the hot and cold air from them are mixed in the appropriate proportions before being supplied to the space.

Duct Blaster Test A duct blaster test evaluates the leakiness of the duct system.

Ductwork The distribution system for air in HVAC systems. It is usually made of sheet metal or fiberglass.

Economizer A mode of HVAC operation using outdoor air for cooling when outdoor temperature and humidity levels are suitable.

Efficacy A measure of how efficiently a light source can produce light, expressed in lumens (of light output) per watt (of power input). For example, a 100-watt light source producing 9,000 lumens of light output has an efficacy of 90 lumens per watt.

Efficiency A measure of how much of a desired output is produced per unit of input; typically calculated as the amount of useful energy supplied divided by the energy consumed.

Electric Resistance Heat Heat produced by a flow of electricity through high-resistance wire, tape, or film.

Emissions Emissions are gases and particles put into the air or emitted by various sources.

Energy Audit An energy audit assesses how much energy is being used in a home and evaluates what measures can be taken to improve efficiency.

Energy Efficiency Mortgages (EEM) An Energy Efficient Mortgage is a mortgage that credits a home's energy efficiency in the mortgage itself. EEMs give borrowers the opportunity to finance cost-effective, energy-saving measures as part of a single mortgage and stretch debt-to-income qualifying ratios on loans thereby allowing borrowers to qualify for a larger loan amount and a better, more energy-efficient home.

To get an EEM a borrower typically has to have a home energy rater conduct a home energy rating before financing is approved. This rating verifies for the lender that the home is energy-efficient. EEMs are sponsored by federally insured mortgage programs and the conventional secondary mortgage market.

Energy Efficiency Ratio (EER) Energy Efficiency Ratio is a measure of how efficiently a cooling system will operate when the outdoor temperature is at a specific level (95°F). In technical terms, EER is the steady-state rate of heat energy removal (i.e., cooling capacity) by the product measured in Btuh divided by the steady-state rate of energy input to the product measured in watts. This ratio is expressed in Btuh/watt. The higher the EER, the more efficient the air conditioner.

Energy Management System (EMS) A control system capable of monitoring environmental and system loads and adjusting HVAC operations accordingly in order to conserve energy while maintaining occupant comfort. It may also be used for other control and monitoring, such as lighting and security.

ENERGY STAR Home Performance A national program from the U.S. EPA and U.S. DOE, is a comprehensive, whole-house approach to improving energy efficiency and comfort at home, while helping to protect the environment. Specially-trained contractors evaluate homes using state-of-the-art equipment and recommend comprehensive improvements that will yield the best results.

Evaporator A heat exchanger in a refrigeration system that absorbs heat from chilled water or building air, thus reducing the supply temperature.

Exfiltration Refers to conditioned air entering an unconditioned area.

Exhaust Air Air removed from a building and not reused.

Fan, Cooling Tower Fans that are used to draw air through the cooling tower to carry away water vapor.

Fiberglass Insulation An insulation that is spun from molten sand and recycled glass into fibers. Types of fiberglass insulation are blanket (batts and rolls) and loose-fill. [vi]

Filter A device that removes fine particles from the air stream in an air-handling system.

Geothermal Heat Pump See Ground Source Heat Pump.

GPM Gallons per Minute, a measure of flow rate for water or other liquids.

Green building Green or sustainable building is the practice of creating healthier and more resource-efficient models of construction, renovation, operation, maintenance, and demolition.

Green Communities Initiative Green Communities, a program funded by Enterprise, provides funds and expertise to enable developers to build and rehabilitate affordable homes that are healthier, more energy efficient and better for the environment. Green Communities homes are built according to the Green Communities Criteria, which contains detailed information that addresses aspects of design, development and operations, such as integrated design, site, location and neighborhood fabric, site improvements, water conservation, energy efficiency, materials beneficial to the environment, healthy living environment, and operations and maintenance. [vii]

Green Home Building Guidelines Published in 2005, the voluntary Green Home Building Guidelines developed by the National Association of Home Builders cover seven areas, including lot preparation and design, resource efficiency, energy efficiency, water efficiency and conservation, occupancy comfort and indoor environmental quality, and operation, maintenance, and homeowner education. [viii]

Ground Source Heat Pump Also called "Earth Coupled" and "Geothermal," these heat pumps use underground coils to transfer heat from the ground to the inside of a building. Compared with conventional heat pumps, ground source heat pumps can have 40-percent higher efficiency, but cost more to install. See also Water Source Heat Pump.

Gypsum board Gypsum board is an interior wall covering made of layers of gypsum and paper. Gypsum is a white mineral made of hydrous calcium sulphate. It is used to make plaster. [ix]

Halogen A type of incandescent lamp with higher efficiency than standard incandescent lamps. Halogen produces a bright white light ideal for retail applications.

HealthyBuilt Homes The HealthyBuilt Homes Program provides a certificate for homes that were built with sustainable, high-performance building strategies and meet green home guidelines. Built by residential builders, these homes are comfortable, healthy, and affordable places that reduce energy and water usage, promote renewable energy use and help protect the land where the home is built. [x]

Heat Exchanger A device that transfers heat from one fluid to another.

Heat Gain The rate at which heat enters or is generated within a space at a given point in time.

Heating Seasonal Performance Factor (HSPF) Rates both the efficiency of the compressor and the electric-resistance elements in heat pumps. It is the ratio of the seasonal heating output in Btu divided by the seasonal power consumption in watts. The most efficient heat pumps have an HSPF of between 8 and 10.

Heat Pump An electric device with both heating and cooling capabilities. It extracts heat from one medium at a lower temperature (the heat source) and transfers it to another medium at a higher temperature (the heat sink), thereby cooling the first and warming the second.

HEPA filter A High Efficiency Particulate Absorbing filter. A HEPA filter removes particles from the air by trapping them as air flows through. [xi]

HERS Home Energy Rating System. A home energy rating that involves an analysis of a home's construction plans and on-site inspections. Based on the home's plans, the Home Energy Rater uses an energy efficiency software package to perform an energy analysis of the home's design. This analysis yields a projected, pre-construction HERS Index. Upon completion of the plan review, the rater works with the builder to identify the energy efficiency improvements needed to ensure the house meets ENERGY STAR performance guidelines. During and upon completion of construction, the rater conducts on-site inspections. Results of these tests, along with inputs derived from the plan review, are used to generate the HERS Index score for the home.

HERS Index The HERS Index is a scoring system established by the Residential Energy Services Network (RESNET). On this index, a home built to the specifications of the HERS Reference Home (based on the 2006 International Energy Conservation Code) scores a HERS Index of 100, while a net zero energy home scores a HERS Index of 0. The lower a home's HERS Index, the more energy efficient it is in comparison to the HERS Reference Home.

Home Energy Affordability Gap: The gap between "affordable" home energy bills and "actual" home energy bills. [xii]

Humidifier A device that adds moisture to air.

Humidistat A device that responds to humidity changes and controls equipment by seeking a setpoint.

HVAC Heating, Ventilating, and Air Conditioning.

Hydronic A ventilation system that uses heated or cooled water circulated by pumps throughout the building.

IAQ Indoor air quality.

Incandescent light bulb Incandescent lighting is the most common type of lighting used in homes. Traditionally, it delivers about 85 percent of household illumination. Incandescent lamps operate without a ballast. It lights up instantly, providing a warm light and excellent color rendition; it can be dimmed. However, incandescent lamps have a low efficacy compared to other lighting options (10–17 lumens per watt) and a short average operating life (750–2500 hours).

Infiltration Air that leaks into a building through the building shell.

Insulated Concrete Forms (ICFs) Rigid plastic foam forms that hold concrete in place during curing and remain in place afterwards to serve as thermal insulation for concrete walls. ICFs consist of insulating foam, commonly expanded polystyrene or extruded polystyrene. [xiii]

Intergovernmental Panel on Climate Change (IPCC) The Intergovernmental Panel on Climate Change is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP) to provide decision-makers and others interested in climate change with an objective source of information about climate change. [xiv]

Internal Rate of Return (IRR) The Internal Rate of Return is the interest rate that is equivalent to the present value of expected future cash flows after considering the initial cost of the project.

International Residential Code (IRC) The International Residential Code is a comprehensive, stand-alone residential code that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy, and electrical provisions for one- and two-family residences.

Kilowatt (kW) Unit of power (demand) equal to 1,000 watts.

Kilowatt-hour (kWh) A unit of electric energy equal to the energy consumed by a 1-kilowatt load operated for one hour.

LEED Leadership in Energy and Environmental Design. LEED is a third-party certification program and a nationally accepted benchmark for the design, construction, and operation of high performance green buildings. [xv]

Light-Emitting Diode (LED) An illumination technology that requires very little power and has a rated life greater than 80 years. It is often used for exit signs.

Load The demand upon the operating resources of a system. In the case of energy loads in buildings, the word generally refers to heating, cooling, and electrical (or demand) loads.

Low-Emissivity (low-E) Windows A new window technology that lowers the amount of energy loss through windows by inhibiting the transmission of radiant heat while allowing plenty of light to pass through.

Low-Voltage Halogen An incandescent lamp that produces bright white light at a higher efficiency than standard incandescent lamps. The high "sparkle" from low-voltage halogen lamps makes them well suited for retail spot lighting.

Lumen A unit of measurement of the rate at which a light source produces light per unit time.

Megawatt One million watts.

Maintenance An ongoing process to ensure equipment operates at peak performance.

Meter A device used to measure and display or record data.

Microturbine Small combustion turbines that produce between 25 kW and 500 kW of power. [xvi]

Mixing Box A component of an air-handling system in which air streams from two different sources and are combined to form a uniform air stream.

Model Energy Code (MEC) The Model Energy Code is a national minimum standard for energy efficient residential construction developed by the Council of American Building Officials. The International Energy Conservation Code has replaced the MEC as the energy performance standard of ENERGY STAR qualified homes.

Multi-zone A type of HVAC distribution system that involves simultaneous heating and cooling. Hot and cold air are supplied at the multi-zone unit and mixed in appropriate proportions to provide the supply-air temperatures needed in each zone.

National Association of Home Builders (NAHB) A trade association that promotes policies to make housing a national priority. Chief among NAHB's goals is to provide and expand opportunities for all consumers to have safe, decent, and affordable housing. [xvii]

National Fenestration Rating Council (NFRC) The National Fenestration Rating Council is a nonprofit organization that administers uniform, independent rating and labeling system for the energy performance of windows, doors, skylights, and attachment products. [xviii]

Nitrogen Oxides (NOx) Chemical compounds that contain nitrogen and oxygen. They react with volatile organic compounds in the presence of heat and sunlight to form ozone and are a major precursor to acid rain.

Off-peak Refers to a utility rate schedule that designates the time of day when energy and demand costs are typically less expensive.

On-peak Refers to a utility rate schedule that designates the time of day when energy and demand costs are typically more expensive.

Optimum Value Engineering (OVE) The National Association of Home Builders (NAHB) developed Optimum Value Engineering (OVE) techniques to streamline framing and reduce the amount of wood wasted in construction. OVE increases the energy efficiency of the home, since greater spacing between framing members and the elimination of excess framing allows more insulation to be added. [xix]

Packaged Unit A self-contained HVAC unit that provides heating and/or cooling to a building space.

Part-load Condition when equipment operates at less than full capacity to meet the demand placed upon it.

Part-load Performance Equipment efficiency at less than full capacity.

Payback, simple A traditional measure of the economic viability of a project, generally defined as the length of time it takes for savings from an investment to equal the cost. Although frequently used because of its ease of calculation, payback frequently does not give an accurate representation of the total lifecycle value of an investment.

Peak (cooling) Load Maximum cooling required to maintain an indoor design temperature under the most adverse summertime outdoor air conditions.

Photocell A light-sensing device used to control light fixtures and dimmers in response to detected levels.

Photovoltaic See Solar Photovoltaic.

Pressure Drop The loss in pressure experienced by flowing water or air due to friction and obstructions.

Programmable Thermostat A control device for HVAC systems that allows the user to program in various temperature and fan settings for various times of day.

Quad An amount of energy equal to 10^{15} Btu. This unit of measure is used by the U.S. Department of Energy in discussing world and national energy budgets. [xx]

Radiant Heaters A technology that heats building occupants by radiating heat from an electric or combustion source. Because radiant heaters use radiation instead of convection to transfer heat, they are very efficient in areas where high ceilings or high infiltration make heating the air costly.

Radiator Device that provides warmth to a space through radiant or convective heat provided by either steam or hot water.

Radon Radon is a cancer-causing natural radioactive gas that cannot be seen, smelled, or tasted. Radon is the leading cause of lung cancer among non-smokers.

Recommissioning Recommissioning ensures system functionality. It is an inclusive and systematic process intended not only to optimize how equipment and systems operate, but also to optimize how the systems function together.

Reflective insulation Reflective insulation, also called a radiant barrier, is a metallic foil material (usually aluminum) designed to block radiant heat transfer across open spaces. Reflective insulation is most effective at reducing cooling bills in hot, sunny climates.

Refrigerant A substance used to provide cooling, either as the working substance of a refrigerator or by the direct absorption of heat. Examples: CFCs, HCFCs, HFCs, air, ammonia, water, or carbon dioxide.

Reheat A type of HVAC air distribution system in which air maintains comfort in a building by cooling the air to a low temperature (typically 55 degrees F) at the air handler and then reheats it near its point of use. This system provides good temperature and humidity control but wastes considerable energy.

RESNET The Residential Energy Services Network is a membership-based, charitable nonprofit organization that develops national standards for building energy efficiency rating systems, including HERS Index. [xxi]

Retrofit: Upgrading a fixture, room, or building by installing new parts or equipment.

Return on Investment (ROI) The ratio of money gained or lost on an investment relative to the amount of money invested. [xxii]

Rigid Foam Board Insulation Used to insulate almost any part of the home and provides thermal resistance and adds structural strength. The most common types of materials used in making foam board include polystyrene, polyisocyanurate or polyiso, and polyurethane.

Rightsizing The process of correctly sizing equipment to the peak load.

Rooftop unit Air-handling equipment such as packaged units located on the roof.

R-Value A measure of thermal resistance or the ability of a material or group of materials to retard heat flow.

Seasonal Energy-Efficiency Ratio (SEER) SEER is a measure of equipment the total cooling of a central air conditioner or heat pump (in Btu) during the normal cooling season as compared to the total electric energy input (in watt-hours) consumed during the same period. Typically used to measure the efficiency of a central air conditioner, it measures how efficiently a cooling system operates over an entire season. The higher the SEER, the more efficient the air conditioner.

Setback Setting a thermostat to a lower temperature when the building is unoccupied to reduce heating energy consumption. This may also refer to setting the thermostat to higher temperatures ("setup") during unoccupied periods in the cooling season and operating the fan in "auto" mode (rather than constant operation) during unoccupied periods.

Setpoint Desired temperature, humidity, pressure in a space, duct, etc.

Solar Photovoltaic (PV) A solid-state electrical device that converts light directly into direct current electricity of voltage-current characteristics that are a function of the characteristics of the light source and the materials in and design of the device. Solar photovoltaic devices are made of various semiconductor materials including silicon, cadmium sulfide, cadmium telluride, and gallium arsenide, and in single crystalline, multicrystalline, or amorphous forms. Photovoltaics pertain to the direct conversion of light into electricity.

Space The distinct area to which conditioned air is delivered.

Spot Ventilation Spot ventilation improves the effectiveness of other ventilation strategies by removing indoor air pollutants and/or moisture at their source. Spot ventilation includes the use of localized exhaust fans, such as those used above kitchen ranges and in bathrooms.

Spray Foam Insulation Used as an insulating and air sealing product for residential wall and ceiling cavities. The insulation is sprayed into wall cavities and expands to fill all its nooks and crannies. Excess foam is scraped off the studs to form a uniform wall cavity. The two types of spray foam are open-cell (isocyanurate) and closed cell (polyurethane).[xxiii]

Static Pressure The condition that exists when an equal amount of air is being supplied to and removed from a space.

Steam Trap A valve that allows condensed water to flow out of a steam supply line without allowing any of the steam to escape.

Strainer Screen Filtering device used in water side systems to protect equipment from dirt, rust, and other particles.

Structurally Insulated Panel (SIP) Prefabricated insulated structural elements used in building walls, ceilings, floors, and roofs. They provide superior and uniform insulation compared to more traditional construction methods, offering energy savings of 12 percent–14 percent. Common types of SIPS use insulation made from expanded polystyrene or polyisocyanurate, a polyurethane derivative.

Sulfur Dioxide (SO_2) A heavy, colorless, pungent air pollutant formed primarily by the combustion of fossil fuels such as coal. It is a respiratory irritant and a precursor to the formation of acid rain.

Sulfur Oxides (So_x) Refers to one or more of the following: lower sulfur oxides, sulfur monoxide, sulfur dioxide, and sulfur trioxide. They are pungent, colorless gases formed primarily by the combustion of fossil fuels.

Supply-Air Diffuser A device used to evenly distribute supply air to a space.

Systems-built homes Homes that are built in a factory and then carefully transported in sections to home sites where local builders put them together. Systems-built homes include modular homes, panelized homes, and log homes. [xxiv]

Testing, Adjusting, and Balancing (TAB) The process of adjusting HVAC system components to supply air and water flows at design or revised specifications.

Thermal Bypass Checklist A comprehensive visual inspection of building details to identify where thermal bypass, or the movement of heat around or through insulation, occurs due to missing air barriers or gaps between the air barriers and the insulation. For a home to be qualified as ENERGY STAR, a Thermal Bypass Checklist must be completed by a certified Home Energy Rater.

Thermostat A device that responds to temperature changes and controls equipment by seeking a setpoint accordingly. Typically contained in heating, cooling, and refrigeration systems.

Ton A unit of measure of cooling capacity equal to 12,000 Btu/hour.

Transformer A device that reduces the incoming line voltage, usually to a standard level, so that it may be used to operate electrical equipment in a building.

T-12 Lamp Industry standard nomenclature for a fluorescent lamp which is twelve 1/8 of an inch (1 1/2 inch) in diameter. Other standard lamp sizes include T-8 (1 inch), T-10 (1 1/4 inch), and T-5 (5/8 inch).

U.S. Green Building Council (USGBC) A nonprofit organization committed to expanding sustainable building practices. USGBC is composed of more than 15,000 organizations from across the building industry that are working to advance structures that are environmentally responsible, profitable, and healthy places to live and work. [xxv]

Volatile Organic Chemicals (VOC) Gaseous emissions from certain solids or liquids, some of which may have short- and long-term adverse health effects. Examples include: paints, paint strippers, cleaning supplies, pesticides, building materials, copiers, correction fluids, glues, and permanent markers.

Voltage, volts International system unit of electric potential or the amount of electrical flow, also referred to as electromotive force.

Waste Heat Recovery Recovering heat that is discharged as a byproduct of one process to provide heat required by a second process. For example, recovering heat going up the flue of a boiler to be used to preheat boiler feedwater.

WaterSense An EPA-sponsored program that labels products that are water efficient and provide information on products and programs that save water without sacrificing performance.

Water-Side Systems HVAC systems in which water is used to provide heating or cooling, including pumps, chillers, boilers, and other equipment.

Water Source Heat Pump Heat pumps that use wells or heat exchangers to transfer heat from water to the inside of a building. Although most of these units use ground water, a small number of installations use surface water, such as ponds or streams. Compared with conventional heat pumps, water source heat pumps can have 50-percent higher efficiency, but cost more to install. See also Ground Source Heat Pump.

Watt (W) A unit of electric power. It defines the rate at which electric energy is consumed.

Weather stripping The process of sealing air leaks around movable joints, such as doors or windows.

Whole House Approach A whole-house systems approach considers the interaction between the occupants, the building site, climate, and other elements or components of the home: appliances and home electronics, insulation and air sealing, lighting, heating and cooling, water heating, windows, doors, and skylights. Builders and designers who use this approach recognize that the features of one component in the house can greatly affect other components, which ultimately affects the overall energy efficiency of the house.

Wind Turbines Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity.

Zone A distinct area to which heating or air conditioning is supplied.

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HUD-2008-09-Building Energy Star Qualified Homes
October 2008