Existing Homes Program Guide

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1 Introduction

1.1 Purpose of this Program Guide

Existing homes in the US and Canada represent a large energy savings opportunity. To capture those energy savings, CEE member energy efficiency program administrators need to design effective programs. This requires solid information about the existing homes market, a sound technical understanding of the end uses and systems in existing homes, and an understanding of what program approaches and strategies have been tried before, in what circumstances, and with what level of success.

This Program Guide presents the above information based on the inputs from a working group of CEE members and industry representatives. Having these stakeholders participate in developing this document helps to ensure that: 1) efficiency programs are designed based on the best possible information and 2) approaches selected by efficiency program administrators have been vetted with those likely to be impacted by them, leading to greater buy-in and more participation in those programs.

1.1.1 Objectives

In preparing this information, the specific objectives of the Working Group are that:

- more existing homes programs will be rolled out across the US and Canada to assist consumers in lowering their energy bills;
- those programs will be more consistent and effective due to their use of the information in this Program Guide; and
- industry representatives will increase their participation in efficiency programs, bringing knowledge, expertise, and resources to the table.

1.1.2 Vision

This document enables efficiency programs to work with manufacturers, retailers, non-governmental organizations (NGOs), and other stakeholders to deliver programs that capture all cost effective, measurable energy savings opportunities in existing homes.

1.1.3 Audience

This Program Guide is organized from an energy efficiency program administrator perspective. The information is presented for program managers who are either developing new voluntary energy efficiency programs or modifying established voluntary energy efficiency programs. It does not address non-voluntary approaches to energy efficiency, e.g. increasing codes and standards. While energy efficiency program administrators are the target audience for the document, other audiences (contractors, manufacturers, retailers, government agencies, etc.) may also benefit by gaining a greater understanding of energy efficiency program planning considerations, the existing homes market, and technical opportunities to increase efficiency in existing homes.

1.2 Definitions

Existing Homes

- For the purposes of this document, the phrase “existing homes” refers to single family and small multifamily (4 units or less) homes in the US and Canada.

Existing Homes Program

- For the purposes of this document, “existing homes program” refers to energy efficiency programs offered by CEE members that have a goal of reducing energy usage in existing homes.

Whole Home Program

- For the purposes of this document, “whole home program” refers to a concept that incorporates building science principles to comprehensively assess existing conditions of a home’s energy usage, as well as how all the systems within the home interact. This assessment is then used to create a detailed work scope, or plan, to achieve the greatest energy savings for the home over a long period of time. A whole home program relies on properly trained and certified technicians to complete the installation of measures incorporating best practices to nationally recognized standards, typically followed up with third-party quality assurance inspections.

Home Performance with ENERGY STAR

- For the purposes of this document, “Home Performance with ENERGY STAR” is a program model of the whole home principle managed by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE). Under this program model, each home is assessed comprehensively by properly trained and certified contractors and/or consultants. Home Performance with ENERGY STAR takes a whole home approach to achieve not only energy efficiency, but also health, safety, and comfort. In other words, Home Performance is the whole home approach combined with health and safety measures, a trained and certified workforce, and quality assurance standards, to provide customer confidence in the marketplace.

Bundled Efficiency Program

- For the purposes of this document, a “bundled efficiency program” is an existing home program that targets consumers in existing homes by offering education and/or incentives on multiple end uses and/or systems in the home. A bundled efficiency program packages together program offerings into one touch-point with the customer and does not include a comprehensive assessment of a home’s energy usage.

2 Information for New Programs

2.1 Considerations in Developing an Existing Homes Program

2.1.1 Cost Effectiveness

Broadly speaking, when efficiency programs refer to cost effectiveness, they are considering whether the cost of running a particular program is justified by the energy savings that the program delivers. This is different from the way a consumer might consider cost effectiveness. To a consumer, the question is whether a price premium associated with a more efficient product or service is justified by the energy savings that product or service will provide to them over the product’s or service’s lifetime and whether the intangible benefits (comfort, prestige, safety) that the product or service provides offset those costs.

2.1.1.1 Types of Cost Effectiveness Tests

There are several different cost effectiveness tests being used by efficiency programs across the United States and Canada. The most widely used are described in Table 1 per Understanding Cost-Effectiveness of Energy Efficiency Programs, a publication of the National Action Plan for Energy Efficiency. The choice of test is determined by the regulatory body overseeing the efficiency program.

Table 1: Comparison of Cost Effectiveness Tests

Test	Key Question	Summary of Approach	Output of Test
Participant Cost Test	Will the participants benefit over the measure life?	Comparison of costs and benefits of the customer installing the measure	PCT >1 = Customer benefits over life of measure
Program Administrator Cost Test	Will utility bills increase?	Comparison of program administrator costs to supply-side resource costs	PACT >1 = Total costs to save energy are less than costs to deliver power
Ratepayer Impact Measure	Will utility rates increase?	Comparison of administrator costs and utility bill reductions to supply-side resource costs	Negative RIM (<0) = Rates would need to increase for utility to achieve same earnings in short term
Total Resource Cost Test	Will the total costs of energy in the utility service territory decrease?	Comparison of program administrator and customer costs to utility resource savings	TRC >1 = Net benefits outweigh the costs
Societal Cost Test	Is the utility, state, or nation better off as a whole?	Comparison of society's costs of energy efficiency to resource savings and non-cash costs and benefits	SCT >1 = Benefits beyond the immediate region and those not monetized in TRC outweigh the costs

In addition to using one or more of these tests, there are several different levels at which regulators may require energy efficiency programs to examine the cost effectiveness of their programs. These include the following:

- Measure Level – This screen analyzes the energy savings benefits over the life of a single measure divided by the costs. The measure level is typically the most difficult level at which to show the cost effectiveness of home performance programs.
- Project Level – This level of screening combines all of the costs and all of the benefits for all of the measures that will be installed at an individual home and looks at them as a package or "project" rather than as individual measures. This is especially relevant for programs that promote a comprehensive approach. While some individual measures may be highly cost effective and others may not be at all, in aggregate the project may be cost effective.
- Program Level – This is a more complex calculation that aggregates various measure level assumptions, multiplied by the number of assumed installations, and adds in program administration costs (marketing, education, evaluation, measurement, and verification, etc.). If the regulatory body allows it, technologies not passing the measure level screen may be included in the program if the overall program is highly cost effective.
- Portfolio Level – This calculation involves aggregating various programs and arriving at a single value. For instance, a program manager might aggregate three residential programs (lighting, whole house, and appliance recycling) to find a portfolio level value.

It can be difficult to show cost effectiveness for some measures in existing homes (e.g., air sealing) because the whole cost of the upgrade is typically included in the cost-effectiveness calculation. (This is different from the situation commonly encountered in appliance or lighting programs targeting new purchases where only the incremental price of the efficient product over a baseline standard product is typically counted in the cost effectiveness test.) If feasible under the program's regulatory guidelines, this can be addressed by using program or portfolio level screening, which enable less cost effective measures to be promoted by addressing them together with more cost effective ones through a more comprehensive program design.

2.1.1.2 Non Energy Effects

Non energy effects (societal benefits, greenhouse gas reductions, health, safety, comfort, etc.) are allowed in some service territories. For example, the regulatory environments in Missouri and Illinois do not allow for societal benefits, but do account for carbon savings because they are built into the avoided cost assumptions. These are typically somewhat nebulous and can be difficult to quantify and justify to stakeholders, depending on the regulatory environment and political situation.

2.1.2 Baseline Market Assessment

After existing homes program managers establish which cost effectiveness tests they will use and the level at which their program will be evaluated, they should determine the baseline or standard practice in their market. For example, a baseline market assessment can uncover the typical size and energy use of a single family home in the service territory and reveal the number of contractors offering efficiency upgrades and the number and type of improvements being made in the absence of the program. All of this information is valuable in program planning and accounting for program impacts after the fact.

The baseline market assessment is also valuable in identifying other local stakeholders that should be included in program planning discussions. For example, home performance, heating, cooling, and other skilled contractors and city or county building inspectors can provide valuable input on the feasibility of the program and on any hurdles to its success later on in the planning process.

2.1.3 Policy Context

Energy efficiency program administrators and industry groups need to evaluate the policy context—including federal, state, and local regulations—when they design program efforts to increase the efficiency of existing homes. Existing homes program managers should carefully assess the regulatory environment in which their program will take place. For example, several state regulators have already begun to work with their utilities to align progressive energy policy with utility financial stewardship. In addition, program managers should understand how federal and state programs (such as the Weatherization Assistance Program and the Home Star program under consideration by U.S. legislators) could impact their work. Appendix D includes information on the organizations that drive and seek to influence policy as well as several resources that track policy changes related to efficiency.

2.1.4 Program Goals and Objectives

The goals of a particular program can vary based on several dimensions and are critical to establish at the beginning of program development. For example, will the efficiency program seek high levels of customer participation or "deep" savings from each customer that participates? Will the efficiency program aim to support a home performance contractor infrastructure that delivers comprehensive efficiency improvements or use existing contractors to provide a bundled energy efficiency program? Is it important that the program

tie to an existing program model such as Home Performance with ENERGY STAR or develop a unique approach?[1]

2.2 Efficiency Program Elements

The challenge of designing effective energy efficiency programs can be daunting. The following definition, which was developed at the CEE 2009 Industry Partners Meeting, underscores the number of elements needed for a successful program:

- The energy efficiency program needs to build a network of contractors who employ trained and certified technicians to assess and complete the needed efficiency upgrades while simultaneously increasing consumer understanding of and willingness to pay for these services in a manner that motivates action and by reducing first cost barriers, all in a manner that leverages existing infrastructure and delivers energy savings cost effectively over both the short and long term.

This section of the Program Guide identifies the key elements of energy efficiency program efforts in existing homes and presents the Existing Homes Working Group's conclusions and recommendations about each.

2.2.1 Identifying Potential Customers

Due to the expense of widespread marketing campaigns, energy efficiency program administrators can benefit from identifying a subset of customers who will be most interested in upgrading the efficiency of their homes. Working Group participants have suggested that identifying consumers with high bills and moderate incomes is fruitful because these people will be motivated to act.

EPA's Home Energy Yardstick and other online audit tools can be used to identify consumers with high bills. Though more expensive, detailed in-home audits can also effectively identify customers that would benefit from comprehensive efficiency improvements. An important component of using in-home audits to identify customers is "conversion rate." The higher a program's conversion rate, the more successful it is in converting audits into full home performance jobs. Offering incentives for completing efficiency improvements, not just for having an audit done, is one way to increase the conversion rate.

One example of using audits to identify potential customers is occurring in Canada. A federal initiative, EcoEnergy, offers a full assessment of the home, including modeling. After modeling is completed, an EnerGuide rating is given for the home and recommendations are made for upgrades. This initiative helps the efficiency program identify promising customers; after the recommendations for improvements are made, the efficiency program can introduce applicable rebates.

The existing infrastructure of contractors and home performance service providers is another important way to identify customers. For example, when consumers are putting on new roofs, replacing furnaces, considering new windows, making additions to their homes, or remodeling their kitchens, they are already engaged in home improvements and may be interested in incorporating energy efficiency into the job.

[1] For more information on administering a Home Performance with ENERGY STAR program, see the Sponsor Guide, version 1.0, finalized September 2008. (Availalb e at http://www.energystar.gov/ia/home_improvement/HPwES_Sponsor_Guide.pdf.)

2.2.2 Ensuring Capacity and Capability of the Workforce

The Working Group has defined training and certification as working with contractors (the businesses) and technicians (the people doing the work) to enhance their skills and business practices to deliver efficiency and to improve the likelihood that they will do so on a regular basis. This element of program design is thought to be needed, at least initially, to help develop and identify knowledgeable contractors who can fulfill efficiency program requirements.

A robust training and certification effort includes a building science education component, an apprenticeship component, sales training, testing materials, an understanding of local program requirements including financing, and in-field training (like boot camp) to ensure technicians can perform the needed work well. Robust, ongoing participation in training and certification efforts requires management buy-in; to achieve this, efficiency programs should position training as a competitive advantage for contractors that participate since many programs require training and certification of their participating contractors.

Efficiency programs and industry groups have many options for training and certification, several of which are outlined in the appendix on workforce development. A few of these options are listed here:

- Rely on an external organization to certify technicians, e.g., Building Performance Institute (BPI) for whole house technicians, Residential Energy Services Network (RESNET) for auditors, and North American Technician Excellence (NATE) for HVAC technicians
  Note: See Appendix C for information on the accreditation of certification organizations.
- Conduct 100% Quality Control on every home participating in the program
- Offer specific training developed and implemented by the efficiency program
- Offer a tiered contractor accreditation based on expertise and other factors
- Offer training on skills that may be underrepresented in local markets, e.g., thermography certificates for infrared camera technicians

Many of the current whole home efficiency programs are taking the first approach and using BPI or RESNET certification in their programs. These are seen as valuable because they are standardized national programs that set clear expectations with contractors and technicians. In addition, Working Group members have noted that third party certification reduces the efficiency program's liability and enforcement tasks. To date, most efficiency program efforts have focused on technical training, though sales training is also critical to securing efficiency upgrades in homes. Some programs have chosen to develop their own certification methods, however if neighboring programs choose substantially different methods for certifying participating contractors, this creates a significant burden and hurdle for quality contractors serving multiple markets. If a national certification program is unable to meet a program's needs, it should consider working with those national certifying organizations to address its concerns first, or coordinate with its state energy office to produce state-wide certification programs instead of a patchwork of varying service territory certifications.

Additional needs in the area of training and certification include a certification for the insulation industry, because it is very different from the other trades addressed by BPI currently. (Though BPI has announced it will offer certifications for air sealing and insulation installers and supervisors.)

Training and certification is one area where partnerships with industry representatives can be particularly fruitful. For example, in the HVAC industry distributors are a key player in achieving trained and certified technicians because they are the delivery mechanism for training efforts to technicians working in homes. Efficiency program training that incorporates

HVAC components, therefore, should complement existing practices. In addition, efficiency program managers should work with industry groups to integrate efficiency into their established training courses and dealer events.

2.2.2.1 Questions to Ask in Developing a Workforce Program Element

- What type of workforce is needed to support the program? For example, are auditors, real estate agents, building performance contractors, insulation contractors, or HVAC technicians needed?
- What skills are required for each type of worker? Are there consistent job descriptions that the program can reference?
- Are there workforce sectors that are currently underutilized in the program's service territory that can be cross-trained in energy efficiency?
- How can the program ensure that the workforce is qualified to do the work? For example, are there training and certification requirements for each type of worker?
- What is the existing capacity in the service territory for each type of worker?
- How can capacity be increased over time?
- What funding sources (e.g. federal tax credits and/or other incentives) are available for companies adopting whole home energy efficiency into their business model?

2.2.2.2 Spotlight on Workforce Development Efforts

2.2.2.2.1 NYSERDA

NYSERDA currently has ten Centers for Energy Efficiency and Building Science (CEEBS) operating throughout New York State, to deliver workforce development training in several aspects of home energy efficiency. The curriculum for these training programs is designed to prepare participants for BPI certification exams, through both classroom education and in-field training. NYSERDA uses a network of community colleges and other adult training centers, which provides flexibility in scheduling classes to meet the needs of a diverse set of students. In addition, this allows for the incorporation of whole building energy efficiency topics (building analyst training, for example) into degree programs to develop an emerging workforce already trained in energy efficiency and enables a professional staff with expertise in adult education to deliver training, Distance learning is used to accommodate hard-to-reach markets. NYSERDA provides workforce development incentives for individuals that participate in CEEBS courses; they reimburse 75 to 100 percent of the cost of the course, depending on the status of the region's market development. Additional incentives are provided for certification costs, and specific auditor equipment.

2.2.2.2.2 California

In many states and provinces, energy offices are working to promote growth in the home performance industry. One example is the California Energy Commission, which has expanded its Home Energy Rating System regulations. These regulations are intended to foster a statewide industry that provides reliable information to differentiate the energy efficiency levels among California homes and to guide investment in cost effective home energy efficiency measures. Phase II of the program, approved in 2008, sets certifications for home energy auditors and home energy surveyors.

In addition, California activity on workforce development is supported by the California Building Performance Contractors Association (CBPCA), which trains contractors and lists those that participate in their verified contractor network.

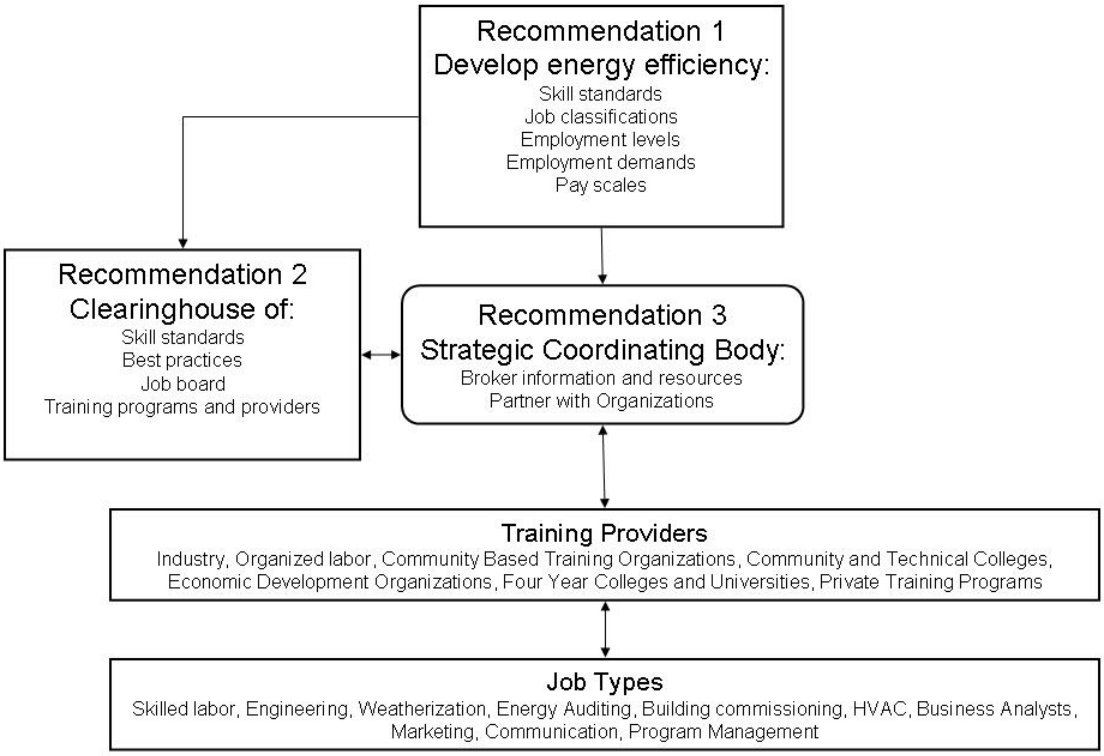
2.2.2.2.3 Wisconsin

Focus on Energy has partnered with Wisconsin's Department of Workforce Development and the North Central Wisconsin Workforce Development Board, for a limited offering of "Together We Save." This program is dedicated to helping residents in select communities save energy and money at home via an "Energy Advocate." Five cities throughout Wisconsin were chosen for the Energy Advocate project. In this project, Energy Advocates are employed to offer free energy inspections and free installation of energy-saving devices such as low-flow showerheads. The five cities were selected based on high unemployment, predominantly older homes, and many young people seeking jobs. The American Recovery and Reinvestment Act-funded project provides for five energy advocates in each community for the Together We Save effort. This prescriptive audit program helps educate homeowners about the benefits of comprehensive existing homes efficiency improvements and the advocates help the homeowners get involved in the established home performance program in the state.

2.2.2.2.4 Northwest

The Northwest Energy Efficiency Taskforce was formed to bring together a group of high level leaders to focus and improve the efficiency of electricity use throughout the Pacific Northwest. The Taskforce established six Work Groups, one of which focuses on developing the workforce of the future. In its May 2009 update to the Taskforce, the Workforce Group reported on a literature review and suggested a number of recommendations to improving the energy efficiency workforce in the Northwest, described in Figure 1.

Figure 1: Recommendations of NEET Workforce Group



Note the examples listed in the above diagram are intended to be a representational though not exhaustive list of involved organizations and job type.

2.2.3 Working with Trade Allies

From an efficiency program perspective, working with trade allies is an essential strategy in successfully launching and sustaining programs designed to improve whole house energy efficiency. The program manager needs to understand the supply and stakeholder channels for all of the industries with which it will engage. One method of building this knowledge base is to reach out to trade associations. Those with local and regional chapters are often the best resource for understanding the local market conditions.

Trade allies can be broken into two distinct groups: primary and secondary allies. Primary trade allies include home performance contractors, heating and cooling contractors, insulating, weatherization, and air sealing companies, residential building designers (which includes architects and engineers), and equipment manufacturers, distributors, and retailers. It is important to note that while many efficiency programs have worked extensively with manufacturers (e.g., on specifications) and retailers (e.g., on point of sale promotions), distributors play an important role in offering training and influencing retailer and contractor decisions.

It is important for program designers, managers, and implementers to understand that primary trade allies provide customers with the information they need to make decisions about energy efficiency. Engaging primary trade allies is a key component of a strong existing homes program. As the first point of contact for homeowners, these allies can serve as a catalyst for change.

Primary trade allies are generally eager to support energy efficiency programs in concept. To turn this general support into program participation, programs should be designed to be simple, fast (in terms of administration), and scalable. In other words, if a program requires twice as much administration as a neighboring program, its participation may suffer.

Because primary trade allies include the companies responsible for completing efficiency upgrades in homes, it is also important to engage them in discussions about quality assurance. Quality assurance includes delivery of energy savings (see section 2.2.6) and adherence to standards required by the program, such as combustion safety (see section 5.2.7). The long term viability of an efficiency program is bolstered when there is a strong quality assurance component developed with input from primary trade allies.

Energy saving programs need to be designed to be profitable for both primary trade allies and for their customers. One way to achieve this is to engage primary trade allies during the program design phase to understand what program elements will work with their business models and to ensure that the products needed to support the program will be readily available through distributors. In addition, efficiency programs can develop strong trade allies by keeping abreast of each industry related to their existing homes program (insulation, HVAC, etc.) and by recruiting champions within each to showcase the benefits of participation to their peers.

In order to generate the necessary base of primary trade ally delivery resources to satisfy existing residential housing market demand, secondary trade allies need to be nurtured and supported at the same time. Secondary trade allies include supportive organizations such training, certifying, and accrediting organizations. In addition, real estate professionals (realtors, appraisers, assessors, home inspectors, etc.) can be strong program allies. Other secondary organizations include the institutions that provide the necessary infrastructure for developing “green collar” workers, e.g., U.S. Green Building Council. Supportive secondary trade allies also include program design facilitators such as CEE, ACEEE, and regional energy efficiency partnerships who help raise market awareness for whole house energy efficiency programming, develop strategic objectives, and inform program designs.

Above all, successful programs are those that consider the needs of all of the organizations mentioned above and design programs that create an atmosphere where customers strongly demand efficiency upgrades.

2.2.4 Reducing Financial Barriers through Financing and Incentives

The Existing Homes Working Group defined financing and incentives as levers that can be used to remove a financial barrier and make implementation of comprehensive energy efficiency improvements possible. Of the two methods of reducing the financial barrier, they concluded that financing, not just incentives, is needed to achieve the number of jobs and the large scopes of work desired to maximize energy savings.

The Working Group developed the following list of nine different financing methods, though it notes that there are not data at this point to enable conclusions to be drawn about which methods are most effective. The Working Group plans to monitor financing program activity over time to narrow this list to the most successful approaches.

1. Energy efficiency programs and industry groups take advantage of existing tax credits and provide bridge financing to consumers. (This would be particularly useful for furnaces, central air conditioning and heat pumps, and water heaters).

2. Energy efficiency programs and industry groups form a coalition to communicate all types of available financing and incentives, such as tax credits, and market the total amount to consumers. (Avista is testing this model and HARDI has partnered with several programs to market HVAC programs using this approach.)

3. Energy efficiency programs and industry groups work with consumers so that when equipment breaks, a bridge loan to cover the repair is made and later, an audit of the entire house identifies how the recently repaired equipment could be addressed as part of a larger, more permanent efficiency upgrade.

4. Energy efficiency programs and industry groups redirect the funds set aside for incentives into hiring energy efficiency case workers who help consumers work through the process of making decisions. (Wisconsin is testing this model.)

5. Energy efficiency programs and industry groups work with local and state governments to enable financing through property tax bills. (There are no data available on this model yet, and one potential downside is inflating property tax.)

6. Energy efficiency programs offer on-bill financing. (Barriers to this include cost recovery considerations and older utility systems.)

7. Energy efficiency programs offer incentives to manufacturers, distributors, retailers, and contractors so that they help consumers with financing.

8. Energy efficiency programs and industry groups work with National Association of State Energy Officials (NASEO) on their nationwide financing model.

9. Energy efficiency programs and industry groups consider bundling in non-energy improvements (e.g., granite countertops) that motivate the homeowner to take action and secure their own financing. (This idea was based on early work with regulators in Vermont to acknowledge that consumers get non-energy benefits from home performance programs, such as increased comfort. Because consumers get this benefit from the home performance job and without paying extra for it, the logic is that some portion of the program costs are subtracted so overall program cost effectiveness increases.)

2.2.5 Motivating Consumer Action through Marketing

The Existing Homes Working Group has defined marketing as motivating consumers to take action to improve the efficiency of their homes. This subsection of the Program Guide sets forth general principles regarding marketing energy efficiency for existing homes; more specific information on how each program addresses marketing is included in the Program Summary appendix.

2.2.5.1 Segmenting the Consumer Market

Different marketing approaches are needed for different customers. Customer segmentation is important to identify appropriate solutions with unique challenges of that particular customer group. Efficiency programs can explore what consumer segments comprise their markets and which would be most receptive to various marketing messages by using the following resources as a starting point:

- Market segmentation presentations from past CEE meetings
  - PG&E presentation
  - BC Hydro presentation
  - Ontario Power Authority presentation
  - Harvard Center for Housing Studies
- Customer databases
- Customer surveys

2.2.5.2 Developing Effective Messages

To be effective, the Working Group has concluded that marketing should be simple, consistent, and persistent and should target the consumer segments that are most likely to take action. Of these, consistency is particularly important. As energy efficiency gains prominence and new players enter the market offering services, consumers are likely to hear multiple messages that could be confusing and even conflicting. Due to the fact that comprehensive existing homes programs can be complex, marketing should seek to alleviate any confusion (which leads to inaction). In addition, a clear pathway should be laid out for the consumer so they know what to do after they become aware of and engaged in the program.

The Working Group concluded that messages should not be limited to energy efficiency or energy savings. They note that emotional messages can motivate action and increased comfort is also important to consumers.

The Working Group identified several resources that new program managers can draw upon in developing marketing messages and deploying them. Highlights from these resources include the following information:

- 58 percent of consumers want to know how energy use in their home compares to other similar homes in their area.[2]
- Homeowners are willing to spend an average of $856 to optimize their home comfort and $720 to improve energy efficiency by 25 percent.[3]

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[2] 2006 Energy Conservation, Efficiency, and Demand Response, Schulman, Ronca & Bucuvalas, Inc. and Research into Action, Inc.

[3] 2006 American Home Comfort Study, Decision Analyst.

- In 2004 owners of homes built before 1970 spent an average of almost $500 on projects that promote greater energy efficiency.[4]

Coordination with other messages already in the market can be important, particularly with those that have high levels of consumer recognition and trust. According to a 2008 CEE survey,[5] ENERGY STAR is one such marketing platform. Highlights from the study are provided below.

- 76 percent of US national households recognized the ENERGY STAR label when shown the label.
- 78 percent of US national households had a high or general understanding of the label's purpose.
- 63 percent of US national households associated the ENERGY STAR label with "efficiency or energy savings."
- For 76 percent of US national households that recognized the ENERGY STAR label and knowingly purchased an ENERGY STAR-labeled product, the label influenced at least one of their purchase decisions "very much" or "somewhat."

2.2.5.3 Selecting Marketing Vehicles and Timing

The Working Group has concluded that consumers are savvy about marketing messages and therefore it is important for the agent delivering the messages to be seen as a trusted information source. To date, successful marketing actions have included community outreach (partnering with non-profits, senior centers, etc.), targeting schools (particularly high school since they can champion it at home), web advertising (Google search terms can be effective because they are "pay per click" and can be evaluated, as can banner ads), billboards, and event sponsorships. Less successful actions have included phone outreach (because the consumer may not trust the messenger) and paid ads in publications. Efficiency programs are considering newer methods of marketing, such as social media, though at this point, data to gauge their success are lacking.

One approach that has been used successfully by efficiency programs to date is cooperative marketing. Under this approach, programs set guidelines that ensure consistency in messaging and branding and set aside a pool of funds to support contractor marketing efforts. In exchange for the funds, the contractors agree to incorporate the program's messages, match program dollars with their own investments, and secure approval from the program before running the advertising. Some programs scale the available funds: the more jobs the contractor completes, the greater the marketing funds that are available to them. This approach magnifies the program's marketing dollars and, because the contractors themselves are involved in placing the ads, ensures that the marketing is targeted to areas where contractor infrastructure exists to meet the customer demand.

Program managers should consider capitalizing on the significant investments that all trade allies have already made in marketing the high efficiency products and services they sell to their customers. Providing utility program copy or collaterals that can be incorporated into brand-specific promotions will save time, money, and effort for program managers and primary trade allies.

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[4] Foundations for Future Growth in the Remodeling Industry: Improving America's Housing 2007, Joint Center for Housing Studies of Harvard University.

[5] Progress Towards Loyalty: Trends in ENERGY STAR Awareness and Brand Equity Among U.S. Households, 2000-2008 (Nevius, McNamara, Spielman & Barry 2008). Available at http://www.cee1.org/eval/nevius-08.pdf.

Efficiency program managers should also carefully consider the timing of their marketing efforts to ensure 1) they will be well received by consumers and 2) any consumer demand that is built can be addressed by contractors, manufacturers, and retailers. For example, broad-based HVAC marketing is typically done during the "shoulder" heating and cooling seasons because contractors need more business then and can respond to new leads that are generated by the marketing effort. More targeted marketing (such as arming contractors with collateral to use in upselling customers during service calls) can work well during peak heating and cooling seasons.

2.2.6 Verifying Savings

Evaluation of energy efficiency programs is a very broad area. It includes "formative" evaluation, which provides information to help in program design and implementation, such as market characterization and feasibility studies or process evaluation. It also includes "outcomes" evaluation, which focuses on the results of program activities, such as estimating net to gross impacts, or determining market transformation. This section of the Program Guide will primarily focus on measurement and verification (M&V) of project savings for use in impact evaluation, with a discussion of inspections. In this document, "evaluation" refers to the evaluation of an energy efficiency program. M&V refers to the measurement and verification of installed measures in a particular project or facility (or sample of these) carried out as part of an energy efficiency program. (For a general discussion of the different types and levels of evaluation referred to in this document and the relationships among them, including measurement and verification, see the CEE's Categories and Types of Evaluation.)

Measurement and verification of savings from existing homes efficiency programs is a significant component of the evaluation process, typically performed after project completion. Existing guidelines for energy savings estimates are found in International Performance Measurement and Verification Protocols (IPMVP)[6] as well as in the Federal Energy Management Program's (FEMP) Verification Protocols[7] and in American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guideline 14-2002.[8] These guidelines and protocols are narrow in scope in that they focus on the energy savings for a building or measure, not an entire program. Statistical sampling and analysis are required to scale savings estimates based on one energy efficiency measure or a single site analysis to the efficiency program level.

Before any verification is performed, energy efficiency programs should develop a measurement and verification (M&V) plan that explains the assumptions, methods, and responsibilities of all parties in performing an M&V study for use in program evaluation. Templates for M&V plans can be found on the Berkeley Lab Applications Team website. The details incorporated into a M&V plan should be sufficient to allow a third party to repeat the analysis and should include the verification protocols employed and statistical methods used for determination of facility or project savings that will be incorporated into program evaluation.

There are several options that efficiency programs have in developing their M&V plans. The five most common are described in detail below.

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[6] International Performance Measurement and Verification Protocol: Concepts and Options for Determining Energy and Water Savings Volume I, EVO-10000 -1.2007, Efficiency Valuation Organization. http://www.nrel.gov/docs/fy02osti/31505.pdf

[7] Federal Energy Management Program Measurement and Verification for Federal Energy Projects, Version 3.0, FEMP 2008. http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html

[8] ASHRAE Guideline 14-2002: Measurement of Energy and Demand Savings. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

1. Conduct a short term or instantaneous power measurement of the change in equipment load before and after the retrofit. This method is good for a lighting or refrigerator retrofit where the operational hours can be stipulated or estimated from short term monitoring. It is also preferable when savings relative to the entire electric bill are small, and a high confidence in estimated run time exists or when reliable studies on equipment run time can be cited. For comprehensive existing homes programs, this option is one of the protocols with the least cost but the lowest precision.

2. Conduct long term monitoring of an equipment retrofit. This verification path is much like the previous one, but requires more resources and time to monitor a specific end use. A good example is the monitoring of air conditioner use for a demand response program. Since air conditioner operation can vary due to occupant behavior and weather over an entire summer, an extended period of monitoring is required. Data would then be compiled to determine population impacts based on the demand reductions of a sample. This option is usually the most accurate method, but can be the costliest option to employ.

3. Employ building energy modeling software to estimate energy use of an entire building. This is generally used for new construction (where baseline energy use is not available) or when an existing building undergoes significant changes, making past billing data obsolete. Modeling can also be used to develop prototypical buildings, which can then be used to estimate program impacts associated with different energy conservation measures. Although simulating building energy use is useful for finding insightful information about the interaction of conservation measures, it is resource intensive and requires a specialist in building simulation.

4. Conduct billing analysis. This approach is particularly useful for efficiency programs administered by utilities, which have easy access to before- and after-treatment data. (It can prove more difficult for non-utility program administrators.) Provided that expected savings are at least 10 percent of the total bill, billing analysis is the most cost effective method for verification. (Savings less than 10 percent, e.g., a refrigerator upgrade, are too small to be distinguished from changes in other minor loads.) An existing home that has been through a comprehensive energy efficiency program should demonstrate sufficient savings to be realized on an energy bill.

   Billing analysis can be broken into two types: 1) control group and 2) regression. Control group analysis involves finding similar non-participant homes and comparing them to participating homes. This is a good method to account for energy use due to weather or even economic changes. The major challenge in using this method is developing a good, representative control group to match program participants. Of the many factors that should be considered, the size of the home and the applicable energy code for construction should be investigated. Depending on the sophistication of the efficiency program, use of a customer knowledge database and demographic data could also be introduced into the evaluation. Once complete, a simple comparison of energy bills can be performed to estimate savings due to the program.

   Regression entails developing a statistical model that relates energy use of a building to that of outdoor conditions, such as average temperature or degree day temperature over a billing period. Regression is an advantageous method if the analyst is confident that the behavior of the occupants, the household size, or who the occupants are, has not altered much over the duration of the study.[9] in which case any changes in energy use can be

[9] Studies have shown that the behavior of occupants in residential buildings can vary by up to 200 percent, when all else, including equipment, remains constant (Socolow 1978). For this reason, it is

related to the program. The disadvantage of this approach is if the behavior does alter as a result of the energy efficiency measure, e.g., snap back, or if the efficiency improvements were performed in conjunction with an addition to the home, an effective conservation measure could appear to lead to increases in energy use.

Despite the different drawbacks, either method of billing analysis has one distinct advantage: all, or a representative sample of, participant homes can undergo some rudimentary analysis. In addition, if the program retains contractor information, contractor performance can be evaluated by comparing energy impacts between companies. Those that do not seem to be performing up to program standards can then be addressed through additional training. Results can also be leveraged to justify a reduction in inspections for consistently high performing contractors, thereby offsetting the cost of analysis.

5. Conduct on-site verifications. This approach is often employed in conjunction with deemed or regulatory approved savings estimates. Third party inspections of post program work yield high quality data and provide assurances to the efficiency program administrator that efficiency money is effectively utilized. As with billing analysis, data from on-site inspections can also be mined for additional information to improve program or contractor performance. As stated above, an effective impact evaluation of the program can complement an inspection team to provide services where needed and potentially reduce the number of inspections depending on utility or commission requirements.

The Cadmus Group estimates that costs associated for program evaluation, not including on-site inspections, range from three to five percent of the total program costs depending on the depth of the evaluation.[10] For more in-depth reviews of types of evaluation processes, the *California Evaluation Framework* and *Model Energy Efficiency Program Impact Evaluation Guide* are available online. These manuals are excellent sources for understanding different approaches to EM&V and the human resource requirements and training to effectively complete each step of an evaluation.

3 Information for Established Programs

Established energy efficiency programs may consider changes to their programs for many reasons. A few examples of these changes are provided below.

- A changing policy environment can impact program cost effectiveness by providing tax incentives or other rebates for consumers or can impact the local workforce infrastructure by increasing dollars available for job training.
- The goals of a particular program may vary over time. As a program's initial goals are met, new goals are established. In addition, program goals can be influenced by external factors such as regulatory bodies and overarching trends in efficiency (e.g., toward "deep retrofits").

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important to look for changes in occupancy that could affect before- and after-treatment energy use, and try to remove facilities experiencing these from the sample if possible.

[10] EPA Webinar Series on EM&V, November 17, 2009, M. Sami Khawaja, Ph.D., The Cadmus Group.

- The local conditions under which the program is operated may change over time. If new incentive programs, market conditions, or unique market dynamics generate a sufficient contractor infrastructure that complies with all program requirements, the program administrator may shift emphasis from supporting development of a contractor infrastructure to building consumer demand.

Depending on the circumstances, energy efficiency program administrators may wish to make changes to any of the existing homes program elements identified in Section 2.2 (identifying potential customers, ensuring a qualified workforce is in place, reducing financial barriers through financing and incentives, motivating action through marketing, and verifying savings.)

To inform managers of established energy efficiency programs about how their counterparts' programs have changed over time, the Program Summary in Appendix E indicates how long each program has been in place and what major changes have been made in the past year.

4 Appendix A: Market Information

4.1 United States

As of 2005, the U.S. Residential Energy Consumption Survey (RECS) indicates that the number of existing housing units was 111,100,000. The American Housing Survey (AHS), administered by the US Census Bureau, indicates that in 2007 there were 128,203,000 existing housing units.

Information by region, climate zone, housing type, year of construction and foundation type is available in Table HC2.1 of the 2005 RECS. Additional state level information from the US Census is available through the US Census State Level Data website. To access this information, click on "Detailed Tables," which is then followed by a geography selection page. A useful way to scan available geographies is to select the "geo within geo" tab, and then set to select places within state, county subdivisions within state, etc. In the next screen where you select tables, use the "by keyword" option. Type in "fuel" or "housing" to narrow the choices.

According to the National Association of Home Builders, the average home size in the US was 2,330 square feet in 2004. 2005 RECS data indicates that the average US home was 2,033 square feet. The age of existing homes in the US is provided in Table HC5.1 of the 2005 RECS.

Energy use in US homes is measured as part of the RECS as well. Table US1 provides the total energy consumption, expenditures, and intensities for homes studied as part of the 2005 survey.

Consumer interest in home efficiency improvements is detailed in a 2007 ENERGY STAR Financing Guidebook.

4.2 Canada

According to Statistics Canada 2006 Census data, there were 7,920,410 homes in Canada. Of these, 6,871,315 are single-family detached homes. Statistics Canada 2006 Census data provides this information at the province level as well. These data indicate that there are 2.9 people per household in Canada.

4.3 Barriers

Several overarching barriers relevant to achieving greater efficiency in existing homes are provided in Table 2, courtesy of ENERGY STAR. (Barriers specific to particular end uses or systems in homes are addressed in Appendix B.)

Table 2: Barriers to Efficiency in Existing Homes

Barrier	Stakeholder
Unable to find qualified contractors to make improvements	Homeowners, Efficiency Programs
Absence of industry standards	Homeowners, Efficiency Programs, Contractors
Limited knowledge of building science and whole home solutions	Homeowners, Contractors
Lack of marketing and sales skills	Contractors
Service programs are costly	Efficiency Programs
Contractors reluctant to adopt new business approach	Contractors
Green message doesn't always focus on efficiency	Homeowners, Contractors

5 Appendix B: Technical Information

5.1 End Uses

While many efficiency programs focused on existing homes focus primarily on envelope improvements (covered in Section 5.2), adding end uses to the program can be an effective way to generate additional energy savings. In addition, including end use efficiency can also increase customer demand for the program. For example, some customers will be more motivated to upgrade the efficiency of end uses (e.g., newer appliances or more decorative lighting) than they will to invest in improvements that are "unseen" like air sealing. Including end uses in a comprehensive program offering helps the efficiency program to ensure that the customer upgrades their home's efficiency as much as possible.

5.1.1 Lighting

Lighting can be an important part of a comprehensive efficiency program. While it accounts for just over 6 percent of an average home's overall energy use, lighting accounts for approximately 17 percent of residential electricity use and costs consumers approximately $8 billion per year in electricity bills. It is estimated that the use of currently available energy efficient lighting technologies could reduce electricity use attributed to lighting by 50 to 75 percent.

Table 3: Lighting Energy Use Snapshot

	Amount Used (Quadrillion BTU)	Percent of Overall Home Use
Electricity	0.72	6.2%
Gas	-	-
Total	0.72	6.2%

Source: 2008 DOE Buildings Energy Data Book, 2010 Residential End Use Splits Data

According to a California study, an average of 26 fixtures using 2,076 kWh per year were installed in single family residences. Multifamily housing was slightly lower with 13 fixtures per household using 1,084 kWh per year. About 86 percent of residential lighting energy is used by an incandescent light source.

Shipments of CFLs have grown from 21 million lamps in 2000 to 397 million lamps in 2007. These lamps have captured 23 percent of the market for medium screw-based lamps in 2007. DOE estimates that 30 percent of households still own no CFLs, and 64 percent of households that own CFLs have five or fewer.

According to EPA, ENERGY STAR-qualified residential lighting fixtures had achieved market penetration of 11 percent in 2008, with indoor fixtures capturing 10 percent of the market and outdoor fixtures capturing 19 percent.

5.1.1.1 Barriers

CFL technology has evolved considerably over the past two decades. Many of the technical barriers that prevented consumer acceptance have been removed such as size, flicker, electrical interference, and light output. The remaining barriers for CFL products (both lamps and fixtures) include:

- Consumers of lighting are not well educated about efficiency and other lighting attributes, including different lamp types, configurations, and colors
- Consumers lack understanding of product value due to long-term subsidies

- General dislike of fluorescent lighting
- Limited availability of specialty lamps at retail outlets
- Few inexpensive dimming technologies
- Higher incremental cost as compared to baseline technologies

5.1.1.2 Emerging Lighting Technologies

Emerging technologies play an important role in lighting efficiency. One such promising technology is Light Emitting Diodes (LEDs), a type of Solid State Lighting (SSL). Rapid progress in SSL research and development (see the DOE SSL R&D Portfolio) has resulted in the advent of LED for general lighting applications. LEDs offer a number of advantages over current lighting technology. In addition to significant energy savings, high-quality LEDs have been shown to last longer and require less maintenance than incandescent and most fluorescent products. Most LEDs contain no mercury, lead, or other known disposal hazards. They excel in cold applications such as outdoor signs, street and area lighting, along with refrigerated display cases.

LED technology is developing very rapidly, with new generations of LED light engines being developed about every 6 to 9 months. White LEDs are expected to replace existing lighting technologies in the not so distant future, but in the near term this rapid evolution can lead to poor quality products entering the market, making quality assurance a key factor in efficiency program consideration of these products. To help address poor quality LED products, an ENERGY STAR specification for Integral LED Lamps was released on December 3, 2009. This specification becomes effective on August 31, 2010.

5.1.1.3 Legislation and Regulations

The Energy Independence and Security Act of 2007 set standards for several types of residential lighting in the United States. These standards are described below.

Standards were set for general service incandescent lamps. The first phase of the standard creates lumen bins around today's most popular medium screw base incandescent bulbs (e.g. 100, 75, 60 and 40W). In other words, today's 100W bulb may not use more than 72W as of January 1, 2012. Standards were also set for modified-spectrum general service incandescent lamps. These are provided in Tables 4 and 5.

Table 4: Standards for General Service Incandescent Lamps

Rated Lumen Ranges	Max. Rate Wattage	Lumen per Watt (LPW) Range	Minimum Rate Lifetime	Effective Date
1490-2600	72	20.7 – 36.1	1,000 hrs	1/1/2012
1050-1489	53	19.8 – 28.1	1,000 hrs	1/1/2013
750-1049	43	17.4 – 24.4	1,000 hrs	1/1/2014
310-749	29	10.7 – 25.8	1,000 hrs	1/1/2014

Table 5: Standards for Modified-Spectrum General Service Incandescent Lamps

Rated Lumen Ranges	Max. Rate Wattage	Lumen per Watt (LPW) Range	Minimum Rate Lifetime	Effective Date
1118-1950	72	15.5 – 27.1	1,000 hrs	1/1/2012

788-1117	53	14.9 – 21.1	1,000 hrs	1/1/2013
563-787	43	13.1 – 18.3	1,000 hrs	1/1/2014
232-562	29	8.0 – 19.4	1,000 hrs	1/1/2014

To further increase the efficiency of general service incandescent lamps, DOE must initiate a rulemaking no later than January 1, 2014 to establish a Tier 2 standard. This standard must deliver savings equal to or greater than a 45 LPW standard. This Tier 2 standard must be finalized by January 1, 2017 and have an effective date of January 1, 2020. If the final rule fails to meet the 2017 deadline or if it does not meet the above stringency target, then a minimum per bulb standard of 45 LPW automatically goes into effect on January 1, 2020. In addition, no later than January 1, 2020, DOE must initiate a second rulemaking to determine whether even more stringent standards are needed and whether exempt lamps should be covered. The final rule must be published by January 1, 2022 with an effective date no sooner than 3 years later.

In June 2009, DOE issued a final rule updating the minimum efficiency performance standards for general service fluorescent and incandescent reflector lamps. The effective date was July 14, 2009, and lamps must begin to comply on July 14, 2012.

Table 6: Standards for General Service Fluorescent Lamps

Lamp Type	Correlated Color Temperature	Energy Conservation Standard (lm/W)
4 ft. T8-T12 Med. Bi-pin ≥ 25W	≤4500K	89
	>4500K and ≤ 7000K	88
2-ft. T8-T12 Med. Bi-pin U-Shaped ≥ 25W	≤4500K	84
	>4500K and ≤ 7000K	81
8-ft. T8-T12 Single-pin Slimline ≥ 52W	≤4500K	97
	>4500K and ≤ 7000K	93
8-ft. T8-T12 High Output	≤4500K	92
	>4500K and ≤ 7000K	88
4-ft. T5 Miniature Bi-pin ≥ 26W	≤4500K	86
	>4500K and ≤ 7000K	81
4-ft. T5 Miniature Bi-pin High Output ≥ 49W	≤4500K	76
	>4500K and ≤ 7000K	72

Table 7: Standards for Incandescent Reflector Lamps

Lamp Wattage	Lamp Type	Diameter (inches)	Voltage	Energy Conservation Standard (lm/W)
40W-205W	Standard Spectrum	> 2.5	≥ 125 (130V)	$6.8xP^{*-0.27}$
			< 125 (120V)	$5.9xP^{*-0.27}$
		>2.25 ≤ 2.5	≥ 125 (130V)	$5.7xP^{*-0.27}$
			< 125 (120V)	$5.0xP^{*-0.27}$
40W-205W	Modified Spectrum	> 2.5	≥ 125 (130V)	$5.8xP^{*-0.27}$
			< 125 (120V)	$5.0xP^{*-0.27}$
		>2.25 ≤ 2.5	≥ 125 (130V)	$4.9xP^{*-0.27}$
			< 125 (120V)	$4.2xP^{*-0.27}$

Note: P is equal to the rated lamp wattage, in watts.

The 2009 DOE lamp rulemaking allowed the exemption for same incandescent reflector lamps created by the Energy Independence and Security Act of 2007 to continue. These exemptions are:

- BR30, ER30, BR40 and ER40 lamps of 50 watts or less
- BR30, BR40 and ER40 lamps of 65 watts
- R20 lamps of 45 watts or less.

Pending federal legislation is expected to require a rulemaking on the exempted reflector lamps in the near future.

5.1.1.4 Emerging Efficiency Program Strategies - Lighting Design

As the new U.S. federal standards listed above take effect, efficiency programs are beginning to offer advanced programs to capture energy savings (including SSL, controls, design and systems approaches). These more comprehensive program approaches no longer focus on one-for-one lamp and fixture replacements as has been done in the past. Instead, efficiency programs are beginning to work with lighting designers and architects to influence the layout and design of lighting toward greater efficiency. While this approach may hold more promise in the new construction market, results from early pilots will help educate stakeholders about its use in existing homes programs.

5.1.2 Appliances

Home appliances are defined in various ways. CEE's Super Efficient Home Appliances Initiative includes refrigerators, dishwashers, clothes washers, and room air conditioners. ENERGY STAR's appliance suite includes those four products, as well as freezers and dehumidifiers. Because the purpose of this Program Guide is to inform the existing homes program manager, information is provided below on four of the more "permanent" appliances: refrigerators, dishwashers, clothes washers, and clothes dryers.

Table 8: Appliance Energy Use Snapshot

	Amount Used (Quadrillion BTU)	Percent of Overall Home Use
Electricity	0.94	-
Gas	0.29	-
Total	1.23	10.8%

Source: 2008 DOE Buildings Energy Data Book, 2010 Residential End Use Splits Data

5.1.2.1 Product Information

5.1.2.1.1 Refrigerators

In most households, the refrigerator is the largest energy consuming kitchen appliance. New ENERGY STAR models use 20 percent less electricity than the federal standard and 40 percent less electricity than typical units sold in 2001.

CEE and ENERGY STAR specifications exist to define high efficiency refrigerators for both compact models (capacity smaller than 7.75 ft^3) and standard models (capacity greater than or equal to 7.75 ft^3). The CEE refrigerator specification is provided in Table 9.

Table 9: CEE Refrigerator Specification

Efficiency Level	Percent Above Federal Standard	
	Compact	Standard
ENERGY STAR	20%	20%
CEE Tier 1	20%	20%
CEE Tier 2	25%	25%
CEE Tier 3	30%	30%

5.1.2.1.2 Dishwashers

The average dishwasher shipped in 2008 was more than 43 percent more efficient than models shipped in the 1990's. Additional savings can be gained through the purchase of models meeting ENERGY STAR and CEE specifications, which are provided below in Table 10.

Table 10: CEE Dishwasher Specification

Level	Energy Factor (EF)	Maximum kWh Per Year	Maximum Gallons/Cycle
Standard Dishwashers			
Federal Minimum Standard	No requirement	355	6.5
ENERGY STAR	No requirement	324	5.80
CEE Tier 1	≥ 0.72	307	5.00
CEE Tier 2	≥ 0.75	295	4.25
Compact Dishwashers			
Federal Minimum Standard	No requirement	260	4.25
ENERGY STAR	-	234	4.00
CEE Tier 1	≥ 1.00	222	3.50

Approximately 80 percent of the energy used by dishwashers goes toward heating the water. Manufacturers have found ways to reduce the amount of water used and/or heat the water more efficiently to significantly improve the energy efficiency of a dishwasher. New dishwasher designs have reduced water use by including more efficient washing cycles, sensor technology and controls that allow you to tailor each wash to the specific characteristics of the load.

With higher efficiency models, payback periods that are less than the lifetime of a dishwasher (with a lifecycle cost lower than a baseline model) can be achieved. The expected life of a dishwasher is 9 to 12 years.

5.1.2.1.3 Clothes Washers

Clothes Washers account for nearly 13 percent of household water consumption per day. Merely switching to an ENERGY STAR qualified clothes washer from a conventional machine will result in lower operating and energy costs over the lifetime of the machine.

ENERGY STAR and CEE specifications for clothes washer are provided in Table 11.

Table 11: CEE Clothes Washer Specification

Level	Modified Energy Factor	Water Factor
Federal Minimum Standard	1.26	NA
ENERGY STAR	1.72	8.00
CEE Tier 1	1.80	7.50
CEE Tier 2	2.00	6.00
CEE Tier 3	2.20	4.50

The ENERGY STAR level will be increasing to be consistent with the CEE Tier 1 on July 1, 2009 and to be consistent with the CEE Tier 2 on January 1, 2011.

5.1.2.1.4 Clothes Dryers

Clothes dryers account for approximately 6 percent of total electricity usage. It typically costs 30 to 40 cents to dry a load of laundry in an electric dryer and approximately 15 to 20 cents in a gas dryer. Over its expected lifetime of 18 years, the average clothes dryer will cost approximately $1,530 to operate.

There are currently no ENERGY STAR or CEE specifications for clothes dryers. However, there is a Natural Resources Canada list of the energy use of gas and electric clothes dryers.

5.1.2.1.5 Smart Appliances

Peak load reduction is thought to be a significant future opportunity to save energy in appliances. “Smart” appliances are defined as those enabled to receive a signal from a local utility in order to appropriately shed load as requested by the utility and authorized by the homeowner. “Smart” appliances are designed to receive a control message and react based on internal programming, which shifts the energy load to other parts of the day. In future, it is thought that all types of home appliances will be enabled with this type of technology.

Additionally federal incentives through the ENERGY STAR program may be available for these products, as provided for in the pending federal energy legislation.

5.1.2.2 Market Information

According to the Association of Home Appliance Manufacturers (AHAM), shipments of major appliances through March 2009 are down 16 percent compared to same period in 2008. One reason for this is the state of the economy in the U.S. and Canada, which has impacted consumers’ willingness to make major discretionary purchases and new home starts. It should be noted that half of appliance demand is replacement demand which doesn’t fluctuate with the markets.

The full impact of the economy on the efficient appliance market is unknown. Several manufacturers and retailers have indicated an increase in demand for efficient models due to the rising cost of natural gas and electricity while the markets for conventional models are diminishing.

5.1.2.3 Program Design Considerations

Ideas submitted for program design were:

- Provide incentives above ENERGY STAR based on CEE tier levels, with higher funding offered for higher levels of efficiency.
- Increase level of integration and communication with manufacturers and retailers.

- Through CEE, discuss program planning parameters (like accepted useful life of products, typical kWh/therm savings, common program designs) and their likelihood for success.

5.1.3 Space Conditioning

Heating and cooling loads are critical to consider as part of a comprehensive efficiency program for existing homes due to the amount of energy they consume in the typical home. This section provides information on several of the technologies used for space conditioning, each of which should be understood by the existing homes program manager.

Table 12: Space Conditioning Energy Use Snapshot

	Amount Used (Quadrillion BTU)	Percent of Overall Home Use
Electricity	1.16	-
Gas	3.57	-
Total	4.73	52.8%

Source: 2008 DOE Buildings Energy Data Book, 2010 Residential End Use Splits Data

Note: The percent overall home use includes oil and propane space conditioning, at 0.66 and 0.24 quads, respectively

5.1.3.1 Air Conditioners and Air Source Heat Pumps

5.1.3.1.1 Technology

Space cooling systems increase comfort by not only removing heat from the space, but also decreasing humidity levels. New technology utilizing variable speed and communicating equipment can greatly enhance the control of both humidity and temperature. With increased humidity control, the space temperature set point can be adjusted resulting in equivalent comfort levels and less energy usage.

Heat pumps have typically experienced a bad reputation of delivering uncomfortable and drafty indoor conditions. However, many people do not realize that heat pump technology has evolved significantly over the last decade. Again utilizing variable speed and communicating equipment, heat pumps now provide much more comfortable environment.

A heat pump can be combined with a standard fan coil unit, or for higher efficiency ratings, a variable speed fan coil unit. Both fan coil units typically require backup electric heat when outdoor temperatures drop below the thermal balance point. The disadvantage is higher cost heating in cold conditions.

Using a gas furnace as backup heat for a heat pump system has gained popularity in the last several years. These systems are known as dual fuel, or more recently as hybrid heat systems. Some drivers of this popularity are lower cost of gas vs. electric backup heat, improving low-temperature heating capabilities of air-source heat pumps, and new thermostat and control technology that greatly simplifies the installation and operation of these systems. The newer controls allow flexibility of adjusting when the system will switch between gas and electric heat. So as energy prices fluctuate, the homeowner can select the fuel that allows for the most cost savings.

Improved indoor air quality (IAQ) can also be achieved when selecting indoor space conditioning equipment. Items such as UV lights, air cleaners, humidifiers, and ventilators can be tied to central cooling and heating systems. Simplified controls are now available allowing the control of all devices from one point.

Several standards and specifications are used by the HVAC industry and efficiency programs to define levels of equipment efficiency, as noted below. These specifications use the

following descriptors of efficiency: Seasonal Energy Efficiency Ratio (SEER), Energy Efficiency Ratio (EER), and Heating Seasonal Performance Factor (HSPF). In the U.S., tax incentives are available at the highest CEE tier as set on January 1, 2009. The "highest tier" is indicated in the shaded boxes below.

Table 13: CEE Specification for Central Air Conditioners – Split Systems

Level	SEER	EER
Federal Minimum Standard	13	NA
CEE Tier 1 and ENERGY STAR	14.5	12
CEE Tier 2	15	12.5
CEE Tier 3 (Advanced)	16 or higher	13 or higher

Table 14: CEE Specification for Central Air Conditioners – Packaged Systems

Level	SEER	EER
Federal Minimum Standard	13	NA
CEE Tier 1 and ENERGY STAR	14	11
CEE Tier 2	14 or higher	12 or higher

Table 15: CEE Specification for Air Source Heat Pumps – Split Systems

Level	SEER	EER	HSPF
Federal Minimum Standard	13	NA	7.7
ENERGY STAR	14.5	12	8.2
CEE Tier 1	14.5	12	8.5
CEE Tier 2	15 or higher	12.5 or higher	8.5 or higher

Table 16: CEE Specification for Air Source Heat Pumps – Packaged Systems

Level	SEER	EER	HSPF
Federal Minimum Standard	13	NA	7.7
CEE Tier 1 and ENERGY STAR	14	11	8
CEE Tier 2	14 or higher	12 or higher	8 or higher

There has been movement in the HVAC industry to incorporate new technologies and develop new types of systems to meet consumer needs and decrease energy use. For example, manufacturers are working on solar-assisted residential heat pump technology; Lennox recently introduced the first such model. In addition, IntelliChoice Energy manufacturers a natural gas-powered variable refrigerant flow heat pump. While currently available in only 8-ton and 11-ton sizes, this product may become available in sizes to meet typical smaller residential cooling loads in the future. Interest in regionally optimized HVAC systems, (e.g., the Energy-Efficient Ducted Evaporative Cooler), is growing as evidenced by work of the Western Cooling Efficiency Center.

5.1.3.1.2 Market Information

Market demand continues to increase for high efficiency heat pumps and central air conditioning. Higher levels of equipment performance is being considered as technical installers are becoming more familiar with high performance equipment, with manufacturers and retailers showing increased signs of inventory availability as the new energy economy continues to develop.

Air Conditioning Contractors of America recently finalized development of a Quality Installation specification, which became an ANSI standard. This standard has been adopted into the CEE Initiative and is incorporated in the ENERGY STAR Quality Installation program.

5.1.3.1.3 Barriers

The efficiency of traditional ducted air conditioners and air source heat pumps can be significantly impacted by improper installation, specifically, improper refrigerant charge, inadequate air flow across the coils, improper location of sensors and the difficulty of insuring that the unit is operating properly due to complexity setting "dip switches" or other required programming. In addition, poorly sealed ductwork, particularly when located in attics or crawl spaces, has been shown to reduce the net system efficiency by 10 to 20 percent.

5.1.3.2 Zoning

Zone control allows the home owner to indicate the area or areas that need cooling or heating. The whole home does not have to be cooled just to provide comfort in one area. As a result, the average energy use and emission of carbon dioxide should decrease because zoning only conditions the space that is indicated by the home owner. Multi-zoned structures that have diverse heating and cooling demands should benefit from zoning. This includes large homes with several living spaces and bedrooms and split-level homes.

To date, no large scale studies of efficiency gains from residential zoning systems have been published. Measurements from individual homes before and after installations of these systems suggest some applications where substantial benefits are possible, while other homes have actually shown negative savings.

5.1.3.3 Ductless Systems

5.1.3.3.1 Technology

Ductless heat pumps have three components: an indoor unit (the evaporator), an outdoor unit, and a controller (either wall-mounted or remote). The compressor, heat exchange coil, propeller fan, and circuit board are all contained in the outdoor unit. A ductless split system can have one or more wall-mounted indoor units that are driven by one compressor. High efficiency models typically use variable speed compressors (usually labeled "inverter" or "modulating" technology).

The units are connected by refrigerant lines that generally run through an opening in the ceiling or wall. No ducts to install means an easy and quick installation, also the building shell is not drastically compromised. Building durability may be a concern for buildings constructed with poor building materials or building that are old. Heat loss through leaky ducts is also avoided with a ductless system.

With the increased use and familiarity of ductless heat pumps in recent years, new options to efficient space conditioning. Substantial efficiency gains over traditional ducted air source heat pumps are possible since duct losses are avoided. Many ductless heat pumps can operate at temperatures near or below zero, therefore the likelihood of higher cost back up heat is reduced. Many units have inverter driven technology which allows them to dial into the correct operating speed rather than cycling on and off. Finally, the well-integrated design of the indoor and outdoor components simplifies the installation process and helps to ensure that systems operate at the rated efficiencies.

5.1.3.3.2 Health and Safety

Well insulated refrigerant lines will eliminate moisture issues by keeping the moisture confined. Excess moisture can negatively effect insulation and cause mold. A ductless system is able to control the amount of moisture vapor in the air through humidity control.

As homes are becoming more tightly sealed as an energy conservation measure, IAQ becomes more important. The right amount of ventilation directly impacts IAQ. Some ductless systems can work in conjunction with ventilation systems. Airborne contaminants that contribute to allergies can be controlled by a ductless system through anti-allergen filters. Additionally, electric ductless systems can be installed as an additional heat source to augment furnaces. This could help to eliminate combustion and carbon monoxide issues.

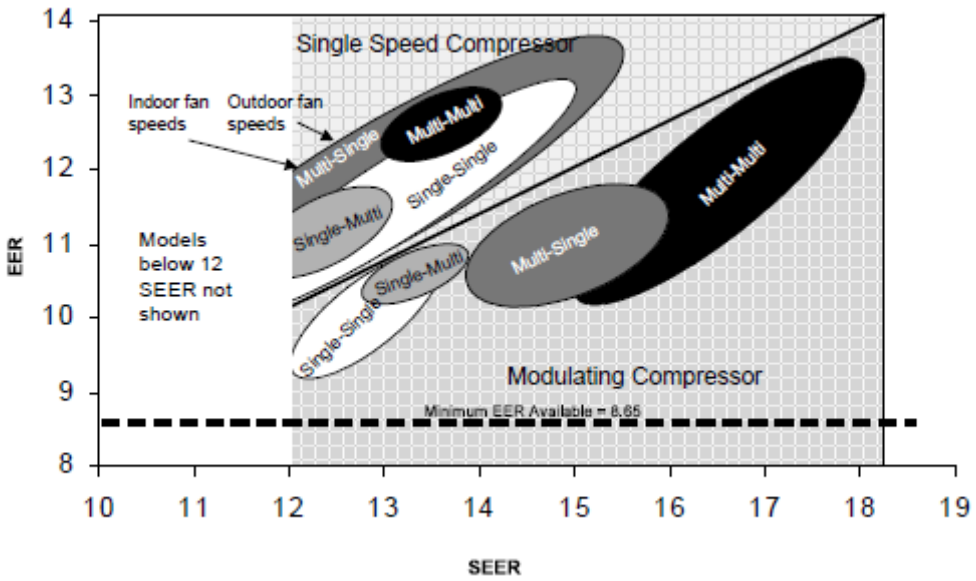
5.1.3.3.3 Energy Efficiency Program Activity

From 2006 through 2008 the Bonneville Power Administration conducted a Ductless Heat Pump pilot in 14 single family homes with zonal electric heat. This pilot project helped to validate the savings opportunity for customers with baseboard electric heat, which the Northwest Energy Efficiency Alliance (NEEA) estimates to be in excess of 200 average megawatts in their four state area in the Pacific Northwest of the US. To tap this potential, NEEA is now managing a pilot project as a market transformation effort on behalf of the electric utilities in the region. They are working with manufacturers, distributors, and contractors and to develop marketing materials and project infrastructure that will enable installation of up to 2500 units. In addition, NEEA is leading an evaluation and measurement effort to document the costs, energy savings and non-energy benefits, as well as identify consumer and market delivery barriers.

5.1.3.4 Inverter or Modulating Systems

The graphic below, taken from a DOE Technical Support Document, demonstrates how SEER and EER are affected by adding variable-speed fans and modulating compressors. Systems with modulating compressors are typically optimized for low capacity operation to boost SEER. This can reduce the performance of the system at high capacity. Sensible heat ratios (dehumidification) and sound levels can also suffer.

Figure 2: Relationship Between SEER and EER in Modulating Systems



Many models with high SEER ratings have modulating compressors. All else equal, a system with a modulating compressor will achieve a SEER boost of two to four points, but may suffer an EER loss of up to two points. Since the efficiency standards and the market are tied to SEER ratings, manufacturers have an incentive to boost SEER at the expense of EER. However, totally modulating systems can attain the same EER ratings as their single speed counterparts. This indicates that manufacturers can design and produce higher efficiency, totally modulating systems that boost both EER and SEER.

The problem with setting EER standards higher than the minimum ratings available today is that they could discourage the development and sale of modulating capacity and variable speed equipment, which realize a benefit in the SEER test and allow manufacturers to reduce the cost of the core components compared to non-modulating equipment. This cost reduction, makes modulating equipment more affordable for consumers. Being required to meet the same EER standards as non-modulating equipment would negate this cost benefit.

Modulating equipment is important because it mitigates the inefficiencies caused by over-sizing the system during installation (including frequent equipment cycling, and increased energy consumption. The argument could be made that over-sizing contributes more to peak power demand than does any reduction in EER associated with modulating equipment.

5.1.3.5 Ground Source Heat Pumps

5.1.3.5.1 Technology

Like other heat pumps, ground source heat pumps (GSHPs) have an indoor portion and an outdoor portion. In a GSHP, the outdoor portion of the system is installed underground in one or many trenches, bore holes or water wells. The advantage to this configuration is that unlike ambient air, the ground often has a more stable and favorable temperature (warmer than air in the winter, cooler than air in the summer).

When a building requires cooling, the ground temperature is often lower than the temperature of the building, a situation that can lead to very high cooling efficiency when compared to cooling with a traditional air conditioner or air source heat pump where heat is rejected into outdoor air that is often warmer than the indoor air. When supplying heating, the ground is often warmer than the outdoor (ambient) air, theoretically allowing the heat pump to operate at a higher effective efficiency than an air sourced heat pump would. While GSHPs are sometimes referred to as a type of “renewable” energy in marketing materials and other non-technical documents, like other space conditioning technologies, they consume energy to do work and it is important to consider that a nontrivial amount of electricity is required to operate a GSHP.

In the ground connected portion, the system may circulate water or less often, refrigerant through pipes in open (ground water or standing column) or closed loop (ground coupled) circuits using electric pumps.

5.1.3.5.2 Market

GSHPs have received much attention recently due in part to federal tax credits and support from state energy offices and energy efficiency program administrators. Homeowners who invest in GSHP systems typically have a strong interest in reducing their reliance of fossil fuels and tend to belong to a higher-than-median income bracket.

5.1.3.5.3 Barriers

Price: Due to the effort required to install the ground connected heat exchanger, GSHP systems can cost significantly more than a comparably sized traditional HVAC or air source system. Although the technology is maturing and the cost of the system components is

declining, the cost of excavation or drilling dominates the economics of GSHPs. (In addition, the excavation and drilling can be particularly challenging in existing homes given the fact that driveways, fences, etc. are already in place and may need to be moved during installation.)

Test Procedures: Program managers should be aware that one critique of the existing test procedures is that they may not adequately account for the pumping energy required to overcome the resistance or head of the ground connection portion of the system. As a result, two small field studies in New England have shown that in-field performance is not as high as the nameplate efficiency.[11]

It can also be difficult to predict the thermal capacitance of the ground at a given installation, although proper system design can help to alleviate this issue (see below). This is a dynamic issue. For example, after a heating season of drawing heat from the ground, the soil or water around the system may have cooled to the point where heat can no longer be extracted efficiently. On the other hand, due to the cycle of heating and cooling seasons, the cooler ground at the end of heating season can boost the cooling efficiency of a GSHP system once cooling season arrives.

System design and commissioning: Because the ground connection is the source of the inherent strength of GSHP technology, it is important to ensure that the system is designed properly and commissioned after installation. Careful design consideration must be given to ensure that:

1. Site soil conductivity is measured and calculated so that the system can operate efficiently late in a season of dumping/removing heat energy to/from the ground.
2. Pumping energy is accurately accounted for on the ground loop side when estimating the operating efficiency of a complete system.
3. The ground connection is sized to accommodate peak load after most of a season of heating or cooling has taken place, plus accommodate any future expansion in capacity. Unfortunately, because the ground connection is the most expensive and resource intensive portion of a GSHP system, it is an attractive target of "value engineering" exercised to reduce project costs. In retrofit situations, it may be disruptive to install a properly sized ground connection.

Regional performance: The in-field performance of GSHP systems depend on the ground properties and on the cooling and heating load of the home, which both need to be accounted for in system design. Two field studies from New England referenced above indicate that GSHP systems may supply heat at lower temperatures than other types of heating systems. These studies found that in cold climates, GSHP heating can work well in homes with very large ducts or radiant hydronic elements, while they perform less well in homes with ducts sized for conventional HVAC systems, fin-tube convectors, and cast iron radiators. However, these results may not be indicative of GSHP performance in other regions, as CEE members promoting the technology in the Midwest report no such problems.

Additional field data would be helpful in enabling efficiency program managers to better understand the regional issues associated with GSHP performance. National Renewable Energy Laboratory, supporting the Building America program, is finalizing plans to evaluate the performance of ground-source heat pumps installed in efficient homes. Specific objectives of their research include: 1) characterizing performance of different ground source heat pump systems, including various distribution methods and ground field configurations,

[11] "Myths and Realities of Ground Source Heat Pumps." Presented by Bruce Harley, Technical Director at Conservation Services Group at the Northeast Home Energy Rating System Alliance Meeting on January 10, 2009. "Ground Source Heat Pumps – Performance Data." Andy Shapiro, Energy Balance, Inc.

2) characterizing performance in different climates, and 3) quantifying installed costs including all components (loop, equipment, installation labor, excavation labor) to determine cost-benefit and regional pricing differences.

5.1.3.6 Furnaces and Boilers

5.1.3.6.1 Technology

Furnaces are the most commonly used residential heating system in the U.S., with 41 percent of households relying on natural gas furnaces for primary space heating.[12] The average equipment life is 15 years, meaning that savings from efficiency persist for quite some time after installation.[13]

Standard efficiency furnace technology uses a natural draft venting process to eliminate the combustion products through a vertical vent such as a chimney. The open vent design allows a substantial amount of heat to be lost through the chimney, contributing to fairly low efficiencies. High efficiency equipment removes extra heat from the combustion materials, recovering an estimated 10 to 20 percent of the heat energy from flue gases formed during the combustion of the natural gas. As the heat is removed, the water vapor in the flue gases condenses, yielding a corrosive condensate that requires a corrosive resistant drainage system. In addition to the drain, condensing furnaces, as they are known, typically incorporate a fan to power vent the exhaust. The drain and venting are the primary sources of higher equipment and installation costs.

The annual energy savings for condensing (90 percent Annual Fuel Utilization Efficiency, or AFUE) gas-fired furnaces are 15 percent when compared to equipment meeting the minimum standard. Using a more conservative energy savings factor of 12 percent (based on replacement of the most commonly sold 80 percent AFUE furnace), the energy saving potential remains significant. Increasing the penetration of high efficiency furnaces from 24 percent to 60 percent, using 12 percent savings, would save approximately 9.35 million cubic feet of natural gas annually within the United States, or enough gas to supply approximately 140,000 residences with gas heating for one year. Currently, there are products manufactured with efficiencies of more than 96 percent AFUE.[14]

Estimates of electric savings for a furnace meeting the CEE specification for electrical efficiency indicate that on average these units save 500 kWh during the heating season and 200 kWh during the cooling season if the central air conditioning system uses the same air handler.[15] These estimates are for the average U.S. household; actual savings depend on many factors, including climate, equipment sizing, and duct pressure. Savings analyses should acknowledge the slight increase in gas used in systems with efficient motors that is necessary to make up for lost heat generated from an inefficient motor.

Boilers represent a smaller percentage of national heating equipment than furnaces, with only 7 percent of U.S. households and 11 percent of Canadian households relying on natural gas boilers for primary space heating. This national average, however, belies the regional variations and potential due to long equipment life. In the Northeast census region, approximately 24 percent of households have boilers.

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[12] 2005 Residential Energy Consumption Survey, US DOE Energy Information Agency.

[13] 29th Annual Portrait of the U.S. Appliance Industry, September 2006. Appliance Magazine

[14] Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, Air-Conditioning Heating, and Refrigeration Institute.

[15] Sachs, H.M. and Smith, S., April 2003. Saving Energy with Efficient Residential Furnace Air Handlers: A Status Report and Program Recommendations.

Most boilers are made with cast iron heat exchangers and have efficiencies between 80 and 82 percent AFUE. Energy efficient boilers (85 percent AFUE) provide 6 percent annual energy savings compared to the minimally compliant unit. Condensing boilers (90 percent AFUE) are considered to be highly efficient, and units are available with efficiencies up to 98 percent AFUE. [16] Like furnaces, condensing boilers use a technology that removes additional heat from the flue gases and condenses hot water vapor from those gases, which increases the installation cost of these units. Due to the significant increase in equipment and installation costs, the payback for a condensing unit can range from approximately six to nine years.[17] It should be noted, however, that the average lifespan for boilers is 21 years, which allows ample opportunity for operating savings to accumulate and pay for any increased first cost.[18]

Table 17. CEE Fuel Efficiency Specifications for Furnaces and Boilers

Level	Furnaces (percent AFUE)	Boilers (percent AFUE)
Federal Minimum Standard	78	80
ENERGY STAR	90	85
CEE Tier 1	90	85
CEE Tier 2	92	90
CEE Tier 3	94	--

Table 18. CEE Air Handling (Electricity Use) Specification

Gas Furnaces with a minimum of 90% AFUE	$\frac{3.412*E_{AE}}{3.412*E_{AE} + 1000*E_F}$	≤ 2.0%

5.1.3.6.2 Market

Following the typical market channel, furnaces and boilers go from manufacturer to wholesale distributor to HVAC contractor to consumer. Alternative paths may include a retailer or a builder or bypass one of the above market actors, however it is important to note that retail channels for these products still rely on traditional distributors and contractors in that market. While there are more than 40 gas furnace brand names, six manufacturers produce over 80 percent of equipment.[19] The top three manufacturers, by sales, of gas furnace equipment are Carrier, Goodman, and Lennox.[20] The three manufacturers that produce the bulk of residential boilers are: Slant/Fin Corporation, Burnham, and ECR International (as Dunkirk Radiator Corporation, Pennco Boilers, and Utica Boilers).[21]

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[16] Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, Air-Conditioning, Heating, and Refrigeration Institute.

[17] Ibid. Paybacks are calculated based on estimated incremental costs of $900 to $1,800.

[18] 29th Annual Portrait of the U.S. Appliance Industry, September 2006. Appliance Magazine.

[19] Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, Air-Conditioning, Heating, and Refrigeration Institute.

[20] 29th Annual Portrait of the U.S. Appliance Industry, September 2006. Appliance Magazine.

[21] Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, Air-Conditioning, Heating, and Refrigeration Institute. Last searched March 2009.

In terms of market trends, the availability of high efficiency equipment has increased significantly in recent years. As of January 2009, 29 percent of all available gas furnace models qualified for the CEE fuel efficiency specification, up from just 12 percent of models in 1998 and 22 percent in 2002. Of these, 20 percent meet the CEE Tier 2 specification or higher.[22] Increased availability of efficient equipment certainly increases the likelihood that contractors will market these products and that consumers will ask for them. Despite this increased availability, high efficiency models continue to be more expensive. This may be due to the fact that high efficiency is commonly marketed as a premium product with additional costly features that may enhance quality or performance but not the core efficiency of the unit.

5.1.3.6.3 Barriers

Upgrading to a condensing furnace or boiler requires additional equipment and installation costs. The additional equipment costs result from increased costs of materials necessary to deal with the corrosive nature of the condensation. Additionally, there are increased installation costs due to the need to ensure proper disposal of the condensate and to incorporate power venting. Since the furnace and boiler markets are strongly driven by lowest bid quotes, these increased equipment and installation costs create a key barrier to increasing market penetration of efficient, gas-fired heating equipment.

Improper installation also can impact the efficiency of furnace and boiler systems and can lead to safety issues and consumer dissatisfaction, e.g., if the system is noisy or they do not see their energy bills decrease. Furthermore many consumers are unaware of what constitutes a quality installation and contractors have limited incentives to provide quality installations. To address this, CEE adopted the ACCA/ANSI Quality Installation Standard, which also addresses furnaces and boilers. Existing homes program mangers wishing to address installation can make inroads by talking with local distributors and HVAC contractors to uncover the specific barriers (e.g., whether the housing stock is conducive to condensing appliances) and develop a plan to address those in their programs.

5.1.3.7 Program Design Considerations

The following are program design concepts that are currently being used by HVAC program administrators. They represent a starting point for incorporating space conditioning into comprehensive existing homes programs.

- Ensure quality installation (QI) by taking advantage of the ENERGY STAR Quality Installation Program and the CEE Residential Air Conditioning and Air-Source Heat Pump Initiative, both of which reference the ANSI/ACCA 5 QI 2007 HVAC Quality Installation Specification.
- Conduct contractor outreach and focus on highlighting “Champions” in the marketplace.
- Design training on technology and business opportunities.
- Increase level of integration and communication with distributors and contractors.
- Through CEE, discuss program planning parameters (like accepted useful life of products, typical kWh/therm savings, common program designs) and their likelihood for success.
- Monitor work of ASHRAE, AHRI, ACCA, and DOE to support the highest level of equipment performance.

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[22] Consumers’ Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, Air-Conditioning Heating, and Refrigeration Institute.

5.1.4 Water Heating

Water heating represents a major use of energy in North American homes with the potential for significant natural gas savings. In the U.S., water heating accounts for approximately 15 percent of residential energy consumption, making it the third largest energy end-use in homes behind space heating (47 percent) and lighting and appliances (24 percent). It is estimated that 54 percent of U.S. water heaters are heated with natural gas, 38 percent are heated with electricity, 4 percent are heated with oil and less than 3 percent are heated with LPG. Gas-fired storage water heaters are installed in approximately 58.2 million homes in North America. In Canada, water heating is estimated to be the second largest residential energy end-use behind space heating, accounting for nearly 22 percent of household energy consumption. It is estimated that 35 percent of Canadian water heaters are fueled by electricity and 59 percent are fueled by natural gas, with oil and propane accounting for the remaining 6 percent.

Table 19: Water Heating Energy Use Snapshot

	Amount Used (Quadrillion BTU)	Percent of Overall Home Use
Electricity	0.38	-
Gas	1.08	-
Total	1.50	13.9%

Source: 2008 DOE Buildings Energy Data Book, 2010 Residential End Use Splits Data

Note: The percent overall home use includes oil and propane water heating, at 0.09 and 0.05 quads, respectively.

5.1.4.1 Technologies and Systems Covered in the CEE Initiative

The CEE High Efficiency Residential Gas Water Heating Initiative covers two technologies: storage water heaters and tankless water heaters.

Storage (or Tank) Water Heaters

Storage water heaters are also commonly referred to as tank-type water heaters. Storage water heaters with higher levels of efficiency often have increased insulation, advanced valves, or direct vent technologies which control drafts and minimize airflow through the use of a draft inducer fan. High efficiency units can also come equipped with power venting technologies that use a small fan to exhaust flue gases. Anti-convection valves, flue baffling, heat traps or sealed combustion designs are other technology improvements that can increase the efficiency of the water heater by improving combustion efficiency or limiting standby heat losses. On average, high efficiency tank-type water heaters can save between 7 percent and 14 percent in energy used per year in comparison to minimum efficiency tank-type water heaters.

Tankless Water Heaters

Tankless water heaters are also commonly referred to as demand or instantaneous units. Tankless models are based on the same principles as a traditional storage water heater, but do not store water in a tank. The burner in tankless water heaters is activated when a minimum water draw occurs. Once a hot water tap is turned on and a flow sensor is triggered, the burner begins to heat a heat exchanger. Cold water enters the unit and ascends through the heat exchanger where heat is transferred to the water. Once the water reaches its set point temperature, it exits the unit ready for consumption.

The efficiency rating of tankless water heaters is typically higher than the rating for tank-type water heaters. The efficiency improvements occur in part because there are no standby losses of heat to the surrounding environment as would typically be found with a tank-type water heater. The reduction in standby losses and other efficiency improvements translate into a

potential yearly energy savings of about 30 percent in comparison to minimum efficiency tank-type water heaters.

5.1.4.2 Emerging Technologies

The following technologies, not included in the CEE Initiative, are being explored by members to evaluate their readiness for energy efficiency program promotion.

Condensing Tankless Water Heaters

This type of tankless water heater uses exhaust heat and passes it across an additional heat exchanger surface area to transfer the remaining heat into the water, resulting in a higher efficiency than a traditional tankless unit.

Hybrid Tankless Water Heaters

The hybrid pairs tankless technology with a traditional holding tank delivers the performance of a tankless water heater, with ease of installation that makes it as simple to install as an old tank-style water heater. Tankless units require special venting and ¾ gas and water lines. The hybrid product can use type B vent and ½ gas and water lines. The efficiency of these units is in between high efficiency tank units and tankless units.

Heat Pump Water Heater

Heat pumps transfer energy from the surrounding air to water in a storage tank. These water heaters can be much more efficient than electric resistance water heaters and most effective in warm climates with long cooling seasons.

Solar Water Heaters

While the initial purchase price of solar water heaters is high compared to standard models, they can be cost effective. That is because the sun's energy is harnessed to reduce operating costs up to 90 percent. Solar water heating systems require a conventional water heater as a backup water heating source to ensure hot water is available when solar energy is not.

5.1.4.3 Efficiency Specifications

CEE specifications for storage and tankless water heaters are provided below. In addition, a voluntary NOx requirement has been included in the initiative for both storage and tankless units. These optional NOx emissions criteria are mandatory where required by law.

Table 20: CEE Specifications Residential Storage Water Heaters <75,000 Btu/h

Tier 0	≥ 0.62 EF
Tier 1	≥ 0.67 EF
Tier 2	≥ 0.80 EF

Table 21: CEE Specifications for Residential Tankless Water Heaters >50,000 and <200,000 Btu/h

Tier 1	≥ 0.82 EF (w/ electronic ignition)

Table 22: CEE Specifications Optional NOx Emissions

Residential Storage <75,000 Btu/h	10 ng per joule of heat output or 15 ppm at 3% O2
Residential Tankless >50,000 and <200,000 Btu/h	40 ng per joule of heat output or 55 ppm at 3% O2

ENERGY STAR has also developed specifications for water heaters, which include more technologies than the CEE specifications. They are provided below.

Table 23: ENERGY STAR Specifications for Gas Storage Water Heaters

ENERGY STAR Criteria	Energy Factor	First-Hour Rating	Warranty	Safety
GAS STORAGE (ENDING 8/31/2010)	EF ≥ 0.62	FHR ≥ 67 gallons per hour	Warranty ≥ 6 years on sealed system	ANSI Z21.10.1/CSA 4.1
GAS STORAGE (BEGINNING 9/1/2010)	EF ≥ 0.67	FHR ≥ 67 gallons per hour	Warranty ≥ 6 years on sealed system	ANSI Z21.10.1/CSA 4.1

Table 24: ENERGY STAR Specifications for Tankless Water Heaters

ENERGY STAR Criteria	Energy Factor	Gallons-Per- Minute	Warranty	Safety
WHOLE-HOME GAS TANKLESS	EF ≥ 0.82	GPM ≥ 2.5 over a 77°F rise	Warranty ≥ 10 years on heat exchanger and 5 years on parts	ANSI Z21.10.1/CSA 4.1 or ANSI Z21.10.3/CSA 4.3, depending on burner size

Table 25: ENERGY STAR Specifications for Gas Condensing Water Heaters

ENERGY STAR Criteria	Energy Factor	First-Hour Rating	Warranty	Safety
GAS CONDENSING	EF ≥ 0.8	FHR ≥ 67 gallons per hour	Warranty ≥ 8 years on sealed system	ANSI Z21.10.1/CSA 4.1

Table 26: ENERGY STAR Specifications for Solar Water Heaters

ENERGY STAR Criteria	Solar Fraction	Warranty	Safety
SOLAR WATER HEATERS	SF ≥ 0.5	Warranty ≥ 10 years on solar collector, 6 years on storage tank, 2 years on controls and 1 year for piping and parts.	OG-300 Certification from the SRCC

Table 27: ENERGY STAR Specifications for Heat Pump Water Heaters

ENERGY STAR Criteria	Energy Factor	First-Hour Rating	Warranty	Safety
HEAT PUMP WATER HEATER	EF ≥ 2.0	FHR ≥ 50 gallons per hour	Warranty ≥ 6 years on sealed system	UL 174 and UL 1995

5.1.4.4 Market Information

Storage units dominate both the gas-fired and electric water heater markets, with shipments of over 8.8 million units for gas and electric units combined in the U.S in 2007. The percentage of gas-fired and electric resistance storage water heater shipments was nearly equal, with electric resistance units having slightly more market share than gas-fired units (4.38 million units and 4.47 million units, respectively). Storage water heaters account for over 95 percent of the market share for water heaters in North America. Tankless water heaters accounted for approximately 2.6 percent of the total market. Solar and heat pump water heaters account for a small minority of annual sales. There is indication that the percentage shipments of tankless water heaters may be growing quickly. Unit sales of gas tankless water heaters are reported to be 254,600 in 2006.

Currently, the majority of residential gas-fired water heater sales in both the U.S. and Canada are for minimum-efficiency tank-type models with Energy Factors of 0.58 and 0.59. Sales and availability of high-efficiency units are in the minority, but major manufacturers are slowly beginning to produce these units in larger quantities and retailers and plumbers are offering these units on a more frequent basis.

5.1.4.5 Barriers

The following is list of the key barriers to the adoption of more efficient water heating, taken from the CEE High Efficiency Residential Gas Water Heating Initiative:

- Plumbers, contractors, builders, developers and retailers often do not have the appropriate marketing tools or do not see the value in selling high efficiency equipment.
- Consumers are unaware of the benefits of investing in high efficiency equipment.
- High-efficiency water heaters can be more expensive initially in comparison to traditional tank-type water heaters.
- Split incentives – builders and developers versus homebuyers.
- Lack of reliable and objective sources of information regarding water heating options.

5.1.5 Electronics and Miscellaneous Electric Loads

Electronics and other miscellaneous electric loads ("MELs," defined as electrical uses that do not fall under the other major end uses) are an end use that includes a large number of products, which in the aggregate use a substantial amount of electricity in the home. While electronics and MELs have not been a major part of comprehensive efficiency programs for existing homes in the past, they represent an untapped savings opportunity and should be considered for inclusion in programs in the future.

Table 28: Electronics and MELs Energy Use Snapshot

	Amount Used (Quadrillion BTU)	Percent of Overall Home Use
Electric	1.75	-
Gas	-	-
Total	1.75	16.4%

Source: 2008 DOE Buildings Energy Data Book, 2010 Residential End Use Splits Data

The electricity use of electronics and MELs is growing. EPA forecasts that the electronics electricity use will continue to grow in the future, and a study by the Electric Power Research Institute from 2009 forecasts the savings opportunity for electronics will be the greatest of all residential end uses in both 2020 and 2030 (in which the cumulative energy savings is estimated to be almost 45 TWh vs. approximately 29 TWh for the next highest end use: cooling).

The following devices are generally considered to fall in the Electronics and MELs category:

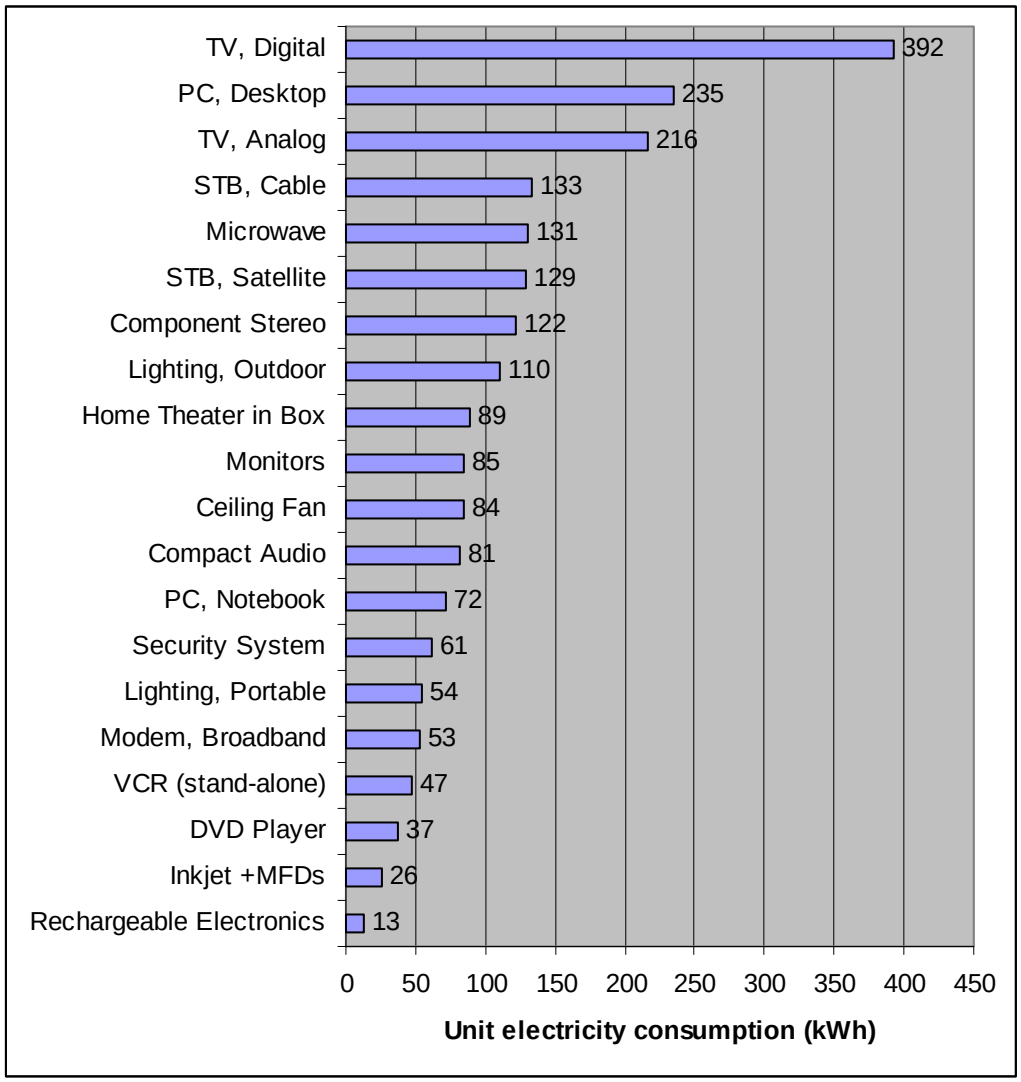
Table 29: Electronics and MEL Devices

Home Entertainment	Home Office	Components	Other MELS
Televisions	Telephony	Internal Power Supplies	Microwaves
Video Playback (DVD, VCR, DVR)	Computers (desktop and notebook)	External Power Supplies	Outdoor and portable lighting
Set-Top Boxes (cable and satellite)	Monitors	Battery Charging Systems	Ceiling fans
Home Audio Equipment (component systems, home theater in a box)	Printers and multi-function devices		Security systems
Rechargeable electronics	Modems		Coffee machines
	Advanced power strips		Toasters and toaster ovens

Energy efficiency programs started focusing on the savings opportunity for electronics at CEE in 2006. MELs have not been a major focus to date, so the majority of information in this Program Guide is related to electronics. While electronics represent an important savings opportunity for efficiency programs, the product category also presents a unique challenge due to its fast changing nature and the dispersion of end-uses in the home each representing an often small share of total electronics energy end-use.

Figure 3 provides the average annual electricity consumption of several major electronics products and other MELs from a 2008 study conducted for the U.S. Department of Energy.

Figure 3: Unit Electricity Consumption of Electronics and Other MELs

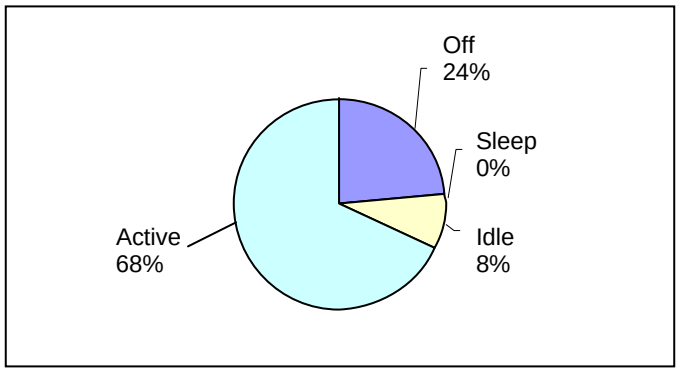


Source: TIAX LLC for the U.S. Department of Energy 2008

Program managers should note that given the rapid technological advances in this category, Figure 4 is most useful as a relative indicator of electricity consumption. Accessing the most recent information available through CEE and other sources will be important if electronics are to be a major focus in an existing homes program.

Electronics and other MELs are also unique among end uses in that they use a substantial amount of energy when not in active use, as indicated in Figure 4.

Figure 4: Residential Consumer Electronics Annual Energy Consumption by Mode



Data Source: TIAX LLC for the Consumer Electronics Association 2007

Consumer electronics products—whether they are considered energy efficient or not—vary substantially in their electricity use by mode. Successfully influencing consumer behavior to save energy in the day-to-day operation of their electronics products could result in additional energy savings for energy efficiency programs for existing homes.

5.1.5.1 Specifications

There are ENERGY STAR specifications for numerous electronics products, including televisions, set-top boxes, computers, monitors/displays, digital-to-analog converter boxes, imaging equipment, external power supplies, consumer audio and DVD products, and telephony. The specifications have been set with a goal of identifying the most efficient products in a given category. The most current specifications and lists of qualifying products may be found on the ENERGY STAR website.

In addition, CEE maintains a high efficiency specification for televisions to identify televisions with higher levels of efficiency than the minimum ENERGY STAR efficiency level. The most current version may be found on CEE's website.

5.1.5.2 Market

Generally, through its research and conversations with members, industry, and other experts, CEE has observed a few major trends in consumer electronics. First, technologies are converging as consumers move towards a fully networked home and manufacturers continue to introduce devices that perform multiple functions. Second, consumer electronics are proliferating in the home, and are increasing in variety and in market penetration, though some of these products are portable, battery-operated devices. Often older products are kept plugged in the house, e.g., an older TV/VCR in a spare bedroom. Finally, all of this change is occurring rapidly.

In addition, home energy monitors, home automation systems, and home area networks may be of interest to existing homes program managers. Although they have not been a major focus for the Consumer Electronics Committee or the Existing Homes Working Group, CEE is tracking market and technical developments with these will make additional information available as appropriate.

5.1.5.3 Barriers

While consumer electronics present an important prospect for electricity savings, the product category also presents a unique challenge due to its fast changing nature and the dispersion of end-uses in the home, each often representing a small share of total electronics energy end

use. These additional barriers have been noted by managers of consumer electronics programs:

- Lack of consumer demand for efficient products
- Difficulty in identifying and differentiating energy efficient products (e.g., no EnergyGuide label or comparable information)
- Lack of a focused message to consumers about what to do
- Consumer desire to have at least one each of the latest and greatest gadget
- Relatively small per-unit energy savings
- Lack of understanding about product power use across various modes (e.g., some products are drawing power all of the time)
- User interfaces that may be available to help consumers manage energy consumption (e.g., screen brightness in televisions, power management for computers and monitors) are challenging for many consumers and/or are not supported by additional information
- Interconnectedness of products, which limits a consumer's ability to turn off products
- Lack of information sources about efficiency (e.g., sales staff)

5.1.5.4 Program Design Considerations

A comprehensive efficiency program to decrease the electricity use of consumer electronics products in existing homes includes two focuses: product purchase and product use. The CEE Consumer Electronics Program Guide should be consulted for additional information on upstream/manufacturer, midstream/retailers, and downstream/consumer program approaches.

Efficiency program administrators should also be mindful of evaluation, measurement and verification (EM&V) considerations at the outset of a program design that includes electronics. EM&V is a complicated field, and consumer electronics are a complicated product area. Developing an early understanding of all of the potential forces that could affect the outcome of the program—such as through preparation of a logic model—may increase the likelihood of a more robust outcome.

5.2 Envelope

A comprehensive approach to energy efficiency in existing homes requires a systems model that takes into account all measures listed within this section to achieve long lasting, deep energy savings.

5.2.1 Air Sealing

5.2.1.1 Why Seal Homes?

Air sealing describes the process of sealing cracks and holes in the building envelope that result in the escaping of interior air, which has been heated or cooled, with outside air. This "natural ventilation" of this leakage is referred to as the air exchange rate. It is recognized that a certain amount of fresh air is needed for occupant health – assuming, of course that the air outside a home is cleaner than inside the home.

Ventilation also assures that indoor humidity will not cause mold problems in homes. The increased use of manufactured building products and home furnishings, with increased use of

chemicals in the manufacturing, has resulted in far more potentially hazardous chemical being released in homes, further increasing the importance of fresh air for occupants.

Air exchange is the result of the complex interaction of several “driving forces" of air exchange:

- Convection: Warm air rises and escapes outside through cracks and holes in the upper areas of the home; with cooler outside air coming in through cracks and holes around the foundation. (This is sometimes called the “stack effect” because traditional venting of furnaces and water heaters depends on the warm temperature of the flue gases to carry them up the chimney.) This effect is reversed in air conditioned homes with hot air entering at the top of the home (often from attics that are 30-40°F hotter than outside) and exiting through cracks and holes lower on the home.
- Wind: Creates air pressure on one side of a home and negative pressure on the opposite side induces air exchange.
- Forced air ducts and exhaust fans: Creates differential air pressures inside the home which cause air exchange.

How much air will move as a result of these driving forces depends on how tight the building envelope has been constructed. Traditionally, carpenters have used trim to cover cracks and holes into building cavities such as walls, attics and foundation areas. Large volumes of air can pass through these holes. In addition, forced air ducts and differential pressures from unbalanced air flows between supply and return sides of the system have been shown to cause high rates of air exchange, as well as temporary, but dangerous, depressurization of chimneys during furnace, water heater, fireplace, and woodstove operation.

The exact rate of air exchange in a home with “natural ventilation” is constantly changing. During very cold weather, the air exchange rate of a home from convection may be quite high, often resulting in cold floors and warm ceilings. At other times of the year, when the inside and outside temperatures are close to each other, this “natural air exchange” can be very low and indoor humidity problems can result. In most cases this natural ventilation is sufficient for occupant health and safety although it will almost certainly be less than optimum for energy savings. The belief that homes can be sealed to some optimum air tightness level that provides adequate fresh air while conserving energy is a myth.

As a result, in new construction where mechanical systems can be installed at less financial cost and air leaks can be sealed during the entire construction process, the adage has become: “build tight, ventilate right.” In existing homes the ability to seal and ventilate homes has been more of an art and less of a science until the advent of “blower door” air testing and sealing. In addition, retrofitting of whole home ventilation systems is not always practical or financially viable.

In hot humid climates the issues of ventilation and air exchange are the same, only because the temperatures differential may be reversed — with warmer air, higher humidity, outside and cooler air inside.

It has long been understood that office and commercial buildings need to have mechanical ventilation to provide fresh air, but because homes have traditionally been relatively leaky and the number of occupants per square foot in single family detached homes is relatively low, it was felt there was no need for such mechanical ventilation in single family homes. It has also been understood (but not always practiced) that apartment buildings and, more recently, manufactured housing, might require mechanical ventilation, as well, to avoid humidity problems, given the tighter building envelope and higher density of people living there. ASHRAE 62.2 provides guidance on Ventilation and Acceptable Indoor Air Quality in Low Rise Residential Buildings.

Until the past 20 years, the ability to quantify the actual air exchange rate of a home required specialized measurement procedures using the release of small amount of a 'tracer gas" in the structure and measuring the concentration of the gas over time. Thanks to the contributions building science researchers and many people in the federally funded low-income weatherization program, techniques using a large, calibrated fan in a doorway to pressurize or depressurize a building have resulted in a set of widely accepted procedures for quantifying the air leakage rate of homes. These "blower door tests" typically take about 30 to 45 minutes and provide a skilled technician with valuable clues about where to find the leaks in a home and, in particular, which leaks are most important to seal. (See Diagnostic Equipment Section for more information on blower doors.)

5.2.1.2 Benefits of Air Sealing

Significant energy savings are possible from reducing excessive air leakage in homes — both in heating and cooling dominated climates. The problem has been that without a process for identifying which homes were leaky and which were tight there was no good way to quantify the possible energy savings. Other barriers will be described below.

In addition to energy savings, reducing air leakage can result in improved "health and safety" for occupants. These benefits include:

- Proper combustion system venting — gases from naturally vented furnaces, water heaters and woodstoves leave the home
- Reduced moisture/humidity/mold problems – creating better indoor air quality and, in extreme situations, improved durability of the structure
- Greater thermal comfort – excessive air exchange rates cause the "cold floor/warm ceiling" situation in homes, allowing residents to keep thermostats set a few degrees lower, further saving energy

5.2.1.3 Energy Savings Opportunity

While studies have shown certain building types, such as those with forced air ducts or complex form (i.e. with many corners) and certain vintages of homes tend to have greater rates of air exchange, it's not possible, nor necessary, to generalize. With the advent of the blower door test and a growing number of trainers and trained operators, the process of identifying the "big leakers" is a more straightforward process.

Various studies report considerable opportunity to reduce excess air leakage in homes without compromising the home's "natural ventilation" capability. Reductions in air leakage by 25 to 35 percent are typical, with some homes having reductions as high as 80 percent. (A comprehensive overview can be found in *Measured Air Leakage of Buildings*, by Heinz R. Trechsel and Peter L. Lagus.)

Typically, air sealing is integrated as part of a package of measures, including insulation and other building envelop measures. A good example is the Home Performance with ENERGY STAR program. EPA estimates show that homeowners can typically save up to 20 percent of heating and cooling costs (or up to 10 percent of total energy costs) by air sealing their homes and adding insulation in attics, floors over crawl spaces, and accessible basement rim joists.

5.2.1.4 Barriers

Air sealing has been adopted as a very common measure in DOE's Weatherization Assistance Program (WAP) where measures are government funded and selected based on cost effectiveness. For years, building scientists have recognized that an effective air barrier, in

conjunction with insulation, is a critical component of an energy efficient home. This is why many above code new construction programs like ENERGY STAR have adopted air infiltration requirements. However, the adoption of air sealing requirements in many efficiency programs, federal tax credits, and building codes has been less successful.

There are four reasons why adoption of air sealing has been slow. First, the network of contractors that deliver this service and the manufacturers or the products have not organized a strong trade association to promote the benefits of air sealing. Most of the contractors selling air sealing work in WAP or above code new construction programs. For years manufactures of insulation and other products like windows and HVAC have marketed the energy efficient benefits of their products. They have also successfully lobbied for tax credits and other incentives for their products. However, air sealing (and air sealing products) is typically excluded even though it is often the most cost effective energy efficiency measure.

Homeowners have been well educated about the benefits of insulation to reduce heating and cooling bills, but they are mostly unaware of the importance of reducing air infiltration. Homeowners are often able to see obvious leaks around doors and windows that can be corrected with weather stripping, but they are unaware of the larger leaks in their attic and basement. They often times associate drafty cold rooms with inefficient windows, though air leakage may be the cause. Even if they are educated about air leakage, through government publications like ENERGY STAR's DIY Guide to Sealing and Insulation, they don't necessarily know who to call to fix their home's air leaks. Window, HVAC, and insulation contractors are all recognized in the yellow pages. Air sealing contractors are not.

Second, a perception exists that the effectiveness of air sealing can not be easily measured like insulation, windows, or HVAC. Measuring the effectiveness of air sealing requires an air leakage test using a blower door. This perception is important because it is actually easier to measure the installed effectiveness of air sealing than the installed effectiveness of insulation, windows or HVAC. These products are lab tested. The metrics are easily specified in codes and standards and the cost of measurement is commoditized. This is not possible for air sealing.

Third, homeowners are confused about the benefits of air sealing and the fear of indoor air quality (IAQ) problems from a home being "too tight." Many homeowners have heard about radon and other indoor air pollutants, and have become concerned that sealing air leaks could contribute to poor IAQ.

Fourth, contractors that want to add air sealing to their business must find a way to estimate and price the work. Air sealing is labor intensive work. Some homes are very leaky with complicated thermal and air bypasses. It takes an experienced technician to identify where the largest air leaks are located and estimate a reasonable amount of time and materials to achieve substantial improvement. Unfortunately, the profit margins for air sealing work are typically less than HVAC or window replacement.

5.2.1.5 Program Design Considerations

Though some variation exists, the majority of air sealing programs fall into two overlapping categories (each described below):

- Educate consumers and offer promotions and incentives.
- Educate and train contractors to be able to deliver the service effectively.

Some energy efficiency programs include air sealing as a prescriptive measure, though this can present challenges because a pretest is needed to identify what level of opportunity a specific house provides. In some cases a house may already be tight (particularly slab on

grade and homes without ductwork) and in a few cases, may already have significant indoor mold and mildew problems due to the lack of air exchange.

Training must emphasize ways for the contractor or technician to determine that they have achieved the most cost effective air sealing, as opposed to continuing work for minimal gains. Identifying these thresholds has been the subject of much discussion in *Home Energy Magazine* and a good procedure is outlined in John Krigger and Chris Dorsi's book Residential Energy: Cost Savings and Comfort for Existing Buildings.

One challenge for efficiency programs in setting up and running any air sealing program is to provide the appropriate incentive. Energy Trust of Oregon provides an incentive of $1 per CFM@50 Pascal for air leakage reduction, as well as a separate testing incentive (to compensate contractors for "dry hole" houses with no or low air leakage reduction potential). In Canada, several provinces and the federal government have extensive air sealing incentives ranging from $300 to over $800, as indicated at www.homeperformance.com.

5.2.1.5.1 Consumer Education/Promotion/Incentives

"Seal and Insulate with ENERGY STAR" is a marketing platform to promote air sealing and insulation. There are marketing graphics for retail signage and insulation products, a consumer brochure and a Do-it-Yourself Guide to Sealing and Insulation with ENERGY STAR. The Guide is available in English and Spanish. Home Performance with ENERGY STAR integrates air leakage testing and building envelope air sealing with insulation and other measures. Energy Trust of Oregon and other organizations administering the programs have done internal evaluations of their cost effectiveness.

5.2.1.5.2 Contractor Education and Training

States and agencies working under the federally funded Weatherization Assistance Program have long experience developing guidelines for air sealing homes. Training resources include:

- Building Performance Institute has a certification program that includes whole house air sealing and duct sealing.
- Several regional building science training centers, such as those in Pennsylvania, Kansas and California, have considerable expertise training contractors in cost effective air sealing.
- ACI sponsors an annual national conference and several regional conferences that include extensive presentations on residential building science topics, including whole house air and duct sealing.
- Although not delivering blower door training, per se, Building Science Corporation is an excellent resource for air leakage reduction information.

5.2.2 Indoor Air Quality

Increasing insulation levels in homes generally does not cause indoor air problems by adding new pollutants to the air. However, measures such as installing storm windows, weather stripping, caulking, and blown-in wall insulation can reduce the amount of outdoor air infiltrating into a home. Consequently, after weatherization, concentrations of indoor air pollutants from sources inside the home can increase. In fact, homeowners in general are increasingly concerned about mold, radon, carbon monoxide, and toxic chemicals in their homes.

As homes are made more "tight" via added insulation and air sealing, the chances of creating an environment for poor indoor air quality (IAQ) increases. That is, if too little outdoor air enters a home, pollutants can accumulate to levels that can pose health and comfort

problems. Most home heating and cooling systems, including forced air heating systems, do not mechanically bring fresh air into the house. Local bathroom or kitchen fans can be helpful in controlling IAQ because they are located in rooms with high moisture content and because they exhaust outdoors, thereby removing contaminants directly from the room where the fan is located and also increase the outdoor air ventilation rate. Some weather conditions can drastically reduce the amount of outdoor air that enters a home, allowing pollutants to build up even in well-ventilated homes.

Home energy audit programs should include strict standards and guidelines when it comes to IAQ. Where moisture problems exist, moisture sources must be mitigated through elimination of the source, isolation of the source, or ventilation of the space around the source before proceeding with other shell-related measures. As well, these programs should include a focus on decreasing the risk of poor IAQ by including careful selection and installation of moisture control systems, HVAC systems, combustion-venting systems, and building materials.

Most programs around the country follow the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE) 62.2-2007 standard. This standard defines the roles of and minimum requirements for mechanical and natural ventilation systems and the building envelope with the goal of providing acceptable indoor air quality in low-rise residential buildings. Additionally, the EPA's Indoor airPLUS program is a good source of information for IAQ standards and guidelines.

Examples for how to deal with potential IAQ issues as part of an existing homes efficiency program include:

- Conduct blower door tests before and after the installation of air sealing, enclosed cavity insulation, or sealing of ductwork located outside the building envelope.
- To ensure building occupant safety, it is necessary to conduct diagnostic testing on all combustion appliances any time the building envelope is altered (i.e. with insulation and air sealing), mechanical ventilation is added, or when new combustion appliances are installed. These tests must be conducted to verify that post-installation conditions meet the minimum safety requirements for spillage, drafting and carbon monoxide during both the Combustion Appliance Zone (CAZ) and Worst Case Depressurization (WCD) tests.
- Air sealing measures must be prioritized to reduce the stack effect and inhibit moisture migration into attics or other interstitial spaces.
- Appropriate inspection and diagnostic tests must be performed before and after installation of attic insulation and/or ventilation to ensure an effective air barrier exists between the attic and living space.

5.2.3 Insulation

Insulation has always been an important tool in keeping people warm during cold winter months and cool during hot summer months. Insulation provides various benefits to the building and its occupants that include:

- Providing resistance to heat flow, which naturally moves from warmer spaces to cooler spaces.
- Reducing the amount of heat flow from the warm side to the cool side of a building.
- Providing other benefits such as controlling sound and, depending upon the type of insulation, controlling moisture.

Heating and cooling account for 50 to 70 percent of the energy used in the average American home,[23] thus, inadequate insulation and air leakage are leading causes of energy waste in most homes. Insulation:

- saves money and limited energy resources,
- makes homes more comfortable by helping to maintain a uniform temperature, and
- makes walls, ceilings, and floors warmer in the winter and cooler in the summer.

The amount of insulation needed depends on several factors: local climate, the size, shape, and construction of the home, the type and efficiency of the heating and cooling systems, and the fuel used for space conditioning. (ENERGY STAR's estimated savings combines insulation with air sealing.)

When comparing insulation products, it is critical that the comparison be based on equal R-values. Insulation is rated in terms of thermal resistance, called R-value, which indicates the resistance to heat flow. The higher the R-value, the greater the insulating effectiveness. The R-value of thermal insulation depends on the type of material, its thickness, and its density. In calculating the R-value of a multi-layered installation, the R-values of the individual layers are added. R-values given in labels, fact sheets, ads, or other promotional materials must be in accordance with the Federal Trade Commission's Home Insulation Rule (16CFR460).

5.2.3.1 The Importance of a System

Insulation is most effective when integrated with air sealing practices. Insulation is not a substitute for proper air sealing and the prevention of air infiltration. The energy performance of a home reaches its highest potential when the home is thought of as a combination of separate but integrated systems that include insulation, moisture control, ventilation, and air sealing. Combined, these make up the full thermal performance of the home. All materials used in building construction combine to deliver the overall performance and no cavity insulation alone is capable of providing a continuous air barrier. Resistance to air flow through walls is primarily done by gypsum board (77 percent) and sheathing, siding or housewrap (12 percent). The rest comes from proper sealing of the building envelope and the numerous gaps and penetrations to the outside such as wiring, pipes, ducts, and flues. Studies done by the National Association of Home Builders and others confirm that with proper air sealing, various insulations perform equally.

5.2.3.2 The Importance of Best Practices

Insulation must be installed to the manufacturer's instructions. Where manufacturer instructions are not available, the installer should then follow the trade association installation instructions for the specific type of insulation. When insulation is not installed properly, effectively the building and its occupants pay the price for the life of the building through higher utility costs and a home that is potentially less durable.

5.2.3.3 Environmental Benefits

Environmental benefits have a variety of meanings, most of which center around three areas: social, economic and environmental. The insulation industry is in line with renowned organizations such as the United Nations and others in its view on environmental development. The insulation industry aims its product development efforts in ways that promote sustainable building practices, renewable resources, whole life costs of its

[23] Department of Energy Insulation Fact Sheet DOE/CE-0180

products—from manufacture and product development through transportation to the job site, lifetime performance of the product and waste.

5.2.3.4 Types of Insulation

When choosing an insulation product, the consumer should consider climate, the ease of application, thermal performance, resistance to settling, resistance to moisture, permanence, safety, and value. According to DOE, the "best" type of insulation depends on:

- how much insulation is needed,
- the accessibility of the insulation location,
- the space available for the insulation,
- local availability and price of insulation, and
- other considerations unique to each purchaser.

Fiberglass and cellulose are the two most common types of insulation. The North American Insulation Manufacturers Association (NAIMA) compares fiberglass and cellulose insulation in a recent publication. They review the areas of thermal resistance R-value, settling and loss of R-value, water vapor sorption, convection, impact of weight, fire safety, resistance to corrosion, air infiltration, sound control, use of recycled materials, and safety.

Although fiberglass and cellulose are the most common types of insulation, there are many other types available. Spray polyurethane foam, commonly referred to as SPF, is a spray-applied insulating foam plastic that is installed as a liquid and then expands many times its original size. SPF can be adjusted and have many different physical properties depending on the use desired. Extruded Polystyrene (XPS), Expanded Polystyrene (EPS), and Polyisocyanurate are foam insulating sheathing products that can be applied to the exterior of homes when there is not an option to fill a cavity with fiberglass or cellulose. These foam boards are available by insulation contractors or by home improvement retailers. Cotton insulation has recently become available in fixed widths and thicknesses for installation in open cavities. Spray foam has been available for many years in commercial and industrial applications and is now being used in the residential market. Spray foam is typically applied on the outside of building walls and then a secondary wall is constructed to protect the insulation and provide a mounting mechanism for the exterior siding material.

The following trade associations focus on various insulation technologies:

- North American Insulation Manufacturers Association
- Extruded Polystyrene Foam Association
- Reflective Insulation Manufacturers Association International
- Cellulose Insulation Manufacturers Association
- Polyisocyanurate Insulation Manufacturers Association

5.2.3.5 Market Information

DOE recently released their new R-value recommendations for new and existing homes based on pre-determined climate zones. (See Figure 5.) The insulation recommendations for attics, cathedral ceilings, walls, and floors have been increased overall and generally exceed those required by most building codes. The DOE's new range of recommendations is based on comparing future energy savings to the current cost of installing insulation. According to the DOE, providing a range of recommendations is shown for these reasons:

- Energy costs vary greatly over each zone
- Installed insulation costs vary greatly over each zone
- Heating and cooling equipment efficiency varies from home to home

Figure 5: DOE R-value Recommendations by Climate Zone

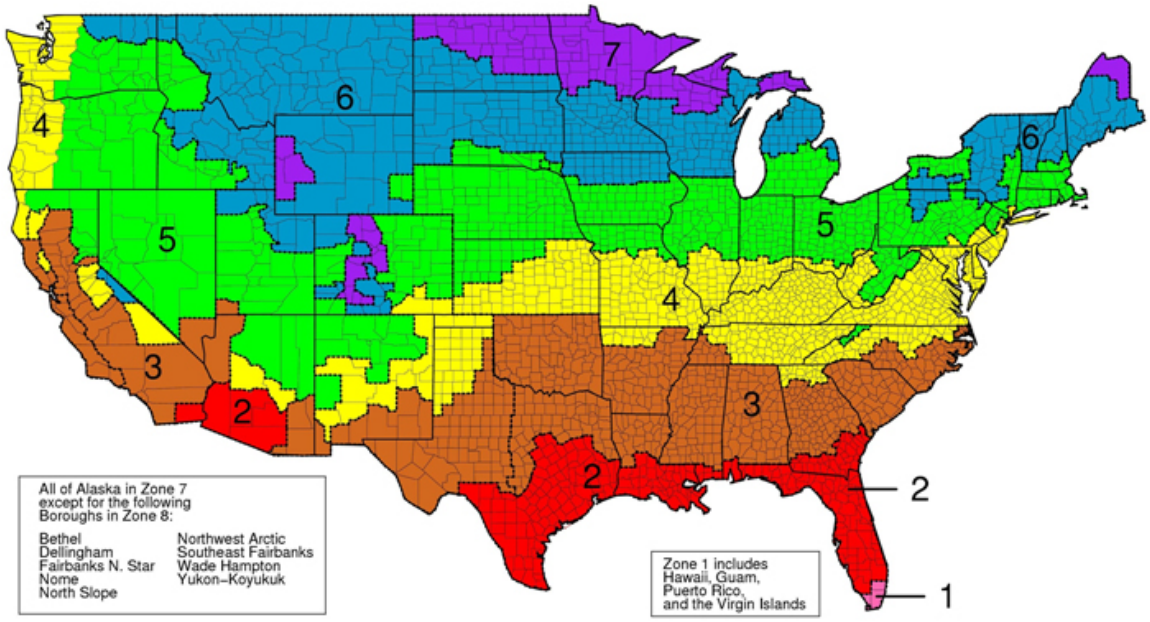


Table 30 below, developed by Oak Ridge National Lab for DOE, shows which levels of insulation are recommended for both different climates and various locations within the home. Recommended insulation levels from the Seal and Insulate with ENERGY STAR Program provided guidance for retrofitting existing wood-framed buildings.

Table 30: Levels of Insulation by Climate Zone

Zone	Add Insulation to Attic		Floor
	Uninsulated Attic	Existing 3–4 Inches of Insulation	
1	R30 to R49	R25 to R30	R13
2	R30 to R60	R25 to R38	R13 to R19
3	R30 to R60	R25 to R38	R19 to R25
4	R38 to R60	R38	R25 to R30
5 to 8	R49 to R60	R38 to R49	R25 to R30
Wall Insulation Whenever exterior siding is removed on an Uninsulated wood-frame wall: Drill holes in the sheathing and blow insulation into the empty wall cavity before installing the new siding, and Zones 3–4: Add R5 insulation wall sheathing beneath the new siding Zones 5–8: Add R5 to R6 insulation wall sheathing beneath the new siding Insulated wood-frame wall: For Zones 4 to 8: Add R5 insulation wall sheathing before installing the new siding			

The Federal Trade Commission's Home Insulation Rule requires installers to provide each customer (builder or consumer) with a signed and dated contract or receipt for the insulation installed. The receipt for loose-fill must show the type of insulation, coverage area, thickness, R-value, and number of bags installed. The manufacturer must also provide a manufacturer's fact sheet. The fact sheet for loose-fill insulation must contain the manufacturer's name, address, type of insulation, and a chart containing the R-value. Installers must have this information and show it to the customer before they agree to buy the insulation.

5.2.3.6 Barriers

Proper installation is essential for insulation to perform properly. Knowledge of vapor retarders, air infiltration, ventilation, recessed lighting, and water pipes are just a few of the areas critical to proper insulation installation. The Insulation Contractors Association of America (ICAA) provides a checklist for inspection of insulation installations.

5.2.3.7 Program Design Considerations

Energy efficiency programs promoting the upgrade of insulation levels are operating in many areas of the U.S. The DSIRE database is one source of information for these programs. Anecdotal evidence indicates that financial incentives, such as those offered by energy efficiency programs and tax credits, appear to positively affect market penetration. One approach energy efficiency program administrators can consider is to establish higher performance tiers that encourage homeowners to evaluate and upgrade the insulation that was originally installed in their home.

5.2.4 Windows

In U.S. homes, windows on average account for more than 20 percent of the heating and 40 percent of the cooling load.[24] Windows also have a large impact on peak energy demand and occupant comfort.

The role of windows in the energy equation of buildings is larger than their share of the building envelope area would suggest. This is due to the low insulating value of typical windows in the building stock, the transparency of windows to the sun's light and heat, and air leakage through older windows. The impact of windows on heating and cooling loads would be even higher if some of this impact was not offset by solar heat gain in the heating season and natural ventilation in the cooling season.

5.2.4.1 Primary Factors of Window Energy Performance

- Heat Loss: The largest impact of windows on energy use. Multiple glazing layers and low-E coatings and can reduce heat loss to a fraction of conventional window heat loss.
- Solar Heat Gain: Can offset heating needs but has a strong potential to cause overheating. Low-E coatings can control solar heat gain without rejecting visible light. External shading devices such as awnings or overhangs can provide very effective solar control depending on orientation and sun angles.
- Daylighting: Has the potential to improve the indoor environment and reduce lighting energy use. In homes, tinted glass is uncommon, so that daylight access is usually more a matter of window placement than of the window properties.

[24] Arasteh et al. 2006.

5.2.4.2 Technology and Performance Metrics

Over the past three decades, dramatic improvements have been achieved in the energy efficiency of windows and related components (such as internal and external shading devices, skylights, and window film).

A large portion of the U.S. building stock remains equipped with only single-pane windows with an insulation value of R-1, while modern window design can achieve up to R-5 or R-6. Codes and standards express the insulation value of windows by the U-factor, which is the inverse of the R-value. Low U-factors (high insulation values) are achieved with multiple glazing layers (double or triple pane) low-emissivity (low-E) coatings, low-conductance spacers, and gas fills. In addition to their insulating properties, low-E coatings can also reflect solar infrared radiation, thereby reducing cooling loads. The solar heat gain coefficient (SHGC) indicates a window's resistance to solar heat gain (the lower the SHGC, the less solar heat gain).

5.2.4.2.1 Typical Properties of Common Window Assemblies

	U-factor	SHGC
Single glazing, non-insulated wood/vinyl frame	0.84	0.63
Double glazing, non-insulated wood/vinyl frame	0.49	0.56
Double glazing, non-insulated wood/vinyl frame, high-solar-gain low-E, argon gas	0.37	0.53
Double glazing, non-insulated wood/vinyl frame, low-solar-gain low-E, argon gas	0.34	0.30
Triple glazing, insulated vinyl frame, high-solar-gain low-E, argon gas	0.18	0.40
Triple glazing, insulated vinyl frame, low-solar-gain low-E, argon gas	0.18	0.26

Notes: The data presented here is an average of similar (but not identical) products from several manufacturers. Specific products will have performance properties slightly higher or lower. Users are encouraged to check with specific manufacturers for exact performance properties. Source: Carmody et al. 2007. Residential Windows. 3rd edition. Norton, New York.

5.2.4.3 Installation

Similar to most other energy efficiency measures, the best window technologies are only effective if the windows are installed correctly. Improper installation can contribute to air leakage, unnecessary heat loss, condensation, and water leakage. This leads to diminished energy performance as well as deterioration of walls, insulation, and the window unit itself.

Given the importance of proper installation, the American Society for Testing and Materials (ASTM International) has developed E 2112, Standard Practice of the Installation of Exterior Windows, Doors and Skylights and the American Architectural Manufacturers Association (AAMA) has developed InstallationMasters, an installer training and registration program. The Energy and Environmental Building Association's (EEBA) Water Management Guide is another excellent resource.

5.2.4.4 Impact on HVAC System Sizing

Another important factor to be considered when windows are installed is the impact of window performance on heating and cooling loads and thus on the demand placed on HVAC systems. This is important when determining the adequate HVAC system size for homes. Oversized HVAC systems should be avoided to prevent system short cycling, thus minimizing energy waste and providing for proper dehumidification in climates with humidity issues. Last but not least, smaller HVAC systems cost less.

In addition to the potential for HVAC downsizing, energy efficient windows may allow for compact HVAC distribution systems. Significantly smaller distribution systems are possible with highly insulating windows, which may provide for occupants to be comfortable with registers or baseboards located closer to the center of the building, rather than the standard practice of delivering heating and cooling near exterior windows.

5.2.4.5 Market

In 2005, an estimated 46 percent of homes still featured single-pane windows and less than 8 percent of residential buildings had windows with low-E coatings, despite the fact that low-E glazing is essentially required to meet ENERGY STAR criteria and modern code requirements. This picture is changing steadily, as more and more ENERGY STAR windows are being installed in existing and new homes. In 2008, DOE reported that the market share of ENERGY STAR windows, doors, and skylights was at 59 percent nationally, and close to 90 percent in the replacement market.

The large market share of ENERGY STAR windows led DOE to conclude that ENERGY STAR no longer differentiated energy efficient windows, doors, and skylights from standard products. Therefore, DOE released new more stringent ENERGY STAR criteria that became effective in January 2010. As before, these criteria differ by climate zone, but in general they encourage windows with a U-factor of no more than 0.30 in the north and a SHGC of no more than 0.30 in the south. The specific criteria for each climate zone can be viewed on the ENERGY STAR Web site. Previously, the maximum northern U-factor was 0.35 and the maximum southern SHGC 0.40.

The American Reinvestment and Recovery Act includes a tax credit for replacement windows (up to $1,500) with a maximum U-factor and SHGC of 0.30. As opposed to ENERGY STAR, this tax credit does not differentiate between climate zones. It applies through 2009 and 2010.

5.2.4.6 Barriers to Greater Efficiency

Although building energy codes and ENERGY STAR have been successful in transforming the windows market so that double-pane, low-E windows have become standard practice, a vast demand for upgrades of existing windows (often single-pane) remains. The cost of window replacement is a barrier, which means that in many cases alternatives to replacement need to be considered, including window repairs, storm windows, weather stripping, and window film.

When windows are replaced, some barriers to optimum energy efficiency persist:

- Highly-insulating windows with U-factors close to 0.20 exist and could increase savings in cold climates significantly although incremental cost for these products is high due to lacking economies of scale. One reason is that neither the ENERGY STAR program nor common building energy codes such as the International Energy Conservation Code (IECC) provide higher performance tiers that reward highly-insulating options such as triple glazing.

- Quality control for installation is not universally provided. Although ASTM International 2112 provides a standard for window installation, training according to this standard and verification of proper installation are nowhere near universal.
- Coordination between window and HVAC contractors is often non-existent. As window energy performance increases, the excess capacity of oversized HVAC systems and resulting short-cycling becomes even more of an issue, especially regarding the need for proper dehumidification.

5.2.4.7 Program Design Considerations

Many energy efficiency programs promoting window energy efficiency are focusing on incentives for ENERGY STAR windows. The effectiveness of such incentives has diminished as the high market penetration of ENERGY STAR windows has led to substantial free ridership, although the more stringent ENERGY STAR criteria that will take effect in January 2010 will reduce market share and free ridership to some extent.

Ideas submitted for program design (each described in detail below) were:

- market transformation
- low-income solutions
- installation quality control
- systems approach

5.2.4.7.1 Market Transformation

ENERGY STAR, building energy codes, and the federal tax credit only provide pass/fail criteria, leading the windows market to aim for performance that just meets these criteria. Utility programs, however, can establish higher performance tiers that encourage energy performance beyond business as usual. Higher performance tiers help minimize free ridership and may lead to lasting market transformation. Initially, products meeting such higher tiers would cost significantly more than more common products, but increasing awareness and economies of scale can bring down cost in the long run.

A good example for a higher performance tier would be a U-factor of about 0.20 for heating-driven climates, which can be achieved by the best triple-pane windows in high performance frames. DOE is currently soliciting bids from window manufacturers and their distributors to provide high performance windows that meet a U-factor of 0.22 to 0.20 (R-5). The window products from qualified vendors will be available directly from the vendors listed on the volume purchase web site. DOE is also working with potential purchasers to make them aware of the windows and with utilities to consider customer incentives for these high performance windows to reduce the cost of these products.

5.2.4.7.2 Low Income

Window replacement is often cost-prohibitive for low-income customers. To allow low-income customers to improve the performance of their windows, most state and utility programs offer weather-stripping and caulking services. While these measures reduce air leakage, they do not reduce heat transfer through the glass, which can instead be achieved by storm windows (less heat loss) and window films (less solar heat gain). The cost effectiveness of storm windows can be increased if low-E glass is used. Low-E storm windows reduce heat loss far more than conventional storm windows.

5.2.4.7.3 Installation Quality

An effective program that addresses windows will focus on installation procedures. This effort may be best focused on identifying an industry accepted standard for the proper installation of windows, and ensuring that quality control is applied to actual jobs.

5.2.4.7.4 Systems Approach

Any improvement in window energy performance – including replacement, repairs, re-glazing, solar control films, secondary glazing, and shading devices – may reduce the demand on the HVAC system. In most cases, this affects the optimal sizing of HVAC units, but in the case of highly-insulating windows, improved surface temperatures may even warrant a radically simplified system without perimeter heating. A key barrier is that window and HVAC contractors do not typically coordinate their work. Utility companies could play a role in establishing such coordination so that maximum comfort, energy savings, and cost reduction opportunities are realized.

5.2.5 Duct Sealing

5.2.5.1 Overview

In 1989, Cummings and Tooley (ASHRAE 1989) broke ground into the interactions duct work has with the entire home and its effect on comfort and energy use. For the following 20 years, research and insights into the substantial effect substandard duct installation has on energy led to a broad range of studies and remediation techniques to improve the performance of a forced air delivery system.

Because the majority of today's residential ductwork is flex duct, constructed of a wire helix, fiberglass insulation and a vapor barrier as a wrap, many of the remediation techniques are presented with this material in mind. Metal ductwork, a far less common installation, could also be a good candidate for some remediation, but repair is usually limited to insulation or duct leakage.

The main remediation issues with ductwork are: 1) duct leaks, 2) undersized ductwork, 3) compressed, crimped or restricted ductwork, and 4) failed or inadequate duct insulation. Each is addressed below.

5.2.5.1.1 Duct Leaks

Sealing existing ductwork has been shown to improve the energy efficiency of homes in the south by decreasing air conditioner energy use by 18 percent (Cummings et al, 1990) when reducing leaks from 16 down to 4 percent. Duct leaks compound energy use by increasing infiltration in a home (ibid). Sealed ductwork should be, at a minimum, compliant with the IECC 2006 which requires all joints in low pressure duct systems to be sealed with UL 181B listed heat sensitive tape or mastic.

5.2.5.1.2 Undersized Ductwork

Duct work too small to convey air at the rated capacity of the air handling unit creates issues with low evaporator temperatures and heaters running too hot. Both conditions cause degradation of performance resulting in an energy penalty as compared to a system with sufficient air flow. The easiest remedy for increasing air flow is to add to the return duct system or increase the size of the main return. In the case of restricted air flow for supply, an additional register or larger duct work may be required. Either method, properly applied, will aid in alleviating restricted airflow, improve comfort, system performance, and prolong equipment life.

5.2.5.1.3 Compressed, Crimped or Restricted Ductwork

Compressed ductwork is common when a run of flex duct is longer than needed. The additional length is either compressed or snaked across the ceiling. In either case, the additional duct friction increases the static pressure, reduces the air flow degrading the efficacy of the system. This scenario is easily remediated by cutting the duct to the proper length and stretching it between the two connection points. When looking for crimped duct runs, it is common practice to hang flex duct with cloth strips which, if not supported by an appropriate saddle, will cause the duct to crimp and restrict airflow. Tight turns altered for a larger sweep, ducts laid in between roof supports supported with a saddle and/or protected from physical damage are practices that will improve the efficiency of the air delivery system.

5.2.5.1.4 Failed or Inadequate Duct Insulation

Flexible ductwork with failed insulation may be a better candidate for complete replacement. When the installed equipment can be salvaged, duct insulation should be brought up to the standards of IECC 2006. All replaced ductwork should be sized to Manual D calculations and in compliance with IECC 2006.

5.2.5.2 Testing

Ductwork should be tested by one of two methods: duct pressurization or envelope air flow difference. These test methods are described in detail in ASTM E 1554.[25]

Duct pressurization testing is performed with all the duct work sealed at the registers and an external fan is used to pressurize the duct system. Alternative versions of duct pressurization testing allow for separation of supply and return leakage. Combining with a whole house pressurization fan (blower door) allows air leakage to outside only to be measured. The envelope air flow difference test uses a blower door to pressurize and depressurize the home with the central air handling system on and off. The difference in envelope air leakage due to system operation is used to calculate the duct leakage to outside at operating conditions separately for supply and return.

5.2.5.3 Barriers

5.2.5.3.1 Cost

Testing the ductwork for leaks is the only reliable method for determining the efficacy of a forced air system. Duct blower or envelope air flow difference testing require a skilled technician and properly calibrated equipment to obtain reliable results. Costs for such a test could range between $250 and $500 for a moderately sized home. Costs and time are reduced for the envelope air flow difference method if coupled with envelope air leakage testing because the test also provides the envelope air leakage and if the blower door apparatus is installed for envelope leakage testing, the additional time and cost for duct leak testing is reduced.

5.2.5.3.2 Trained and Certified Testers

As stated above and emphasized in the testing section, skilled technicians are needed for a successful program. Thought must be given to how the program will identify and track personnel or companies that are committed to energy efficiency and those who are less than legitimate. A comprehensive and standardized training program should be identified for all contractors to complete.

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[25] Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization, ASTM, 2007.

Testing for proper air flow has issues of its own. Attempting to evaluate total air flow through the system requires flow hood measurements at the registers or measurements at the air handler. These additional tasks, as with blower duct testing, require skilled professionals and test equipment properly maintained and calibrated to National Institute of Standards and Technology (NIST) traceable testing stands. Both requirements would have addition costs and burdens on the overseeing agency for compliance.

5.2.6 Assessing Envelope Energy Efficiency

Diagnostic equipment can reduce the amount of time needed to find the flaws in the home envelope. This section details diagnostic equipment, software packages, and standards/certification programs that can be integrated into efficiency program efforts. (Some aspects of diagnostic equipment are relevant to combustion safety testing, and those are included in that section of the document.)

5.2.6.1 Diagnostic Equipment

5.2.6.1.1 Blower Doors

Blower doors are pressure testing devices for the air barrier of a home. Blower door testing is a practical and cost effective technique for measuring air leakage in a home, by providing a way to quantify air flow and the resulting heat loss, along with a way to pinpoint specific leaks.

In existing homes, blower doors are effective learning tools in understanding the unique conditions of the home. Blower door testing can also be a powerful tool to educate consumers, even people who understand almost nothing about their home's thermal performance can easily tell the difference between small and large leaks when they feel them with their own hands. They allow both instantaneous feedback and quantitative inspections, as well as provide customers piece of mind that installed energy improvements will perform as prescribed when blower door testing is used as a test-out procedure.

The blower door is equipped with an expandable frame, a panel, and a built-in fan, and fits in an open doorway. The fan pressurizes the home to a standard pressure, and gauges are used to identify and measure the air leakage. Blower door testing helps energy professionals determine the air tightness of a home. Measurements are taken by increasing the speed of the fan until the pressure difference between the home and the outside is at the desired level, the airflow out of the home at that pressure is then recorded.

The amount of air that flows through a hole(s) is dependent on characteristics of the hole(s) and the pressure driving the flow. These three variables (hole, pressure, and flow) work together. Thus, given any two of these variables, one can calculate the third. A blower door generates and measures pressure and airflow, so that an energy auditor can characterize a group of holes in the home.

If the building needs air tightening, a blower door helps locate specific areas of the home that allow air leakage, to recommend targeted air sealing measures. Because the blower door provides control over the air flow in the building, leaks can be forced to become more apparent. Leaks directly into the living space can be felt with the back of the hand form inside the home during depressurization. Leaks from unconditioned spaces can also be checked from those spaces with chemical smoke.

5.2.6.1.2 Pressure Pan

The pressure pan is a diagnostic tool used along with a blower door to identify duct leakage in forced air duct systems. Pressure pans do not directly measure leakage rates, rather a pressure pan is used to measure differences in pressure between the home and a duct run

during a blower door test. Thus, pressure pan readings should not be used as an absolute pass/fail standard, only as a screening tool for technicians.

A pressure pan test involves placing a gasketed plastic pan over each register or grille, one at a time, with air handler fan(s) off and the blower door depressurizing (or pressurizing) the home to a standard reference pressure. The pattern of pressure readings often allows for quick identification of major leakage sites. If the duct system has no connections to the outside, then the air inside the duct system will be at the same pressure as the interior of the home during a blower door test. However, if the duct system is connected to the outside through leaks, the air inside a duct system will be at a different pressure compared to the interior of the home during a blower door test. The larger the pressure difference, between the inside of the home and the duct system, the more leaky the duct system is.

Pressure pan readings can also be used as a quality control tool to assess the air sealing measures of the duct system. The Energy Conservatory warns that sealing duct leaks can significantly affect operation of the air handler and duct system. Duct leakage should repairs should always be a part of a larger total system diagnostic procedure examining total system air flow, airflow balancing, and proper operation of combustion appliances.

5.2.6.1.3 Duct Leakage Testing System

A duct leakage testing system, e.g., Duct Blaster®, measures the flow through the ducts to leaks both inside and outside the home (total duct leakage). Measurements are taken with the duct blaster attached at the blower compartment of the air handler or attached to the return grille. During these tests all registers are covered and duct blaster flow is adjusted to create a reference pressure in the supply plenum or the nearest connected supply grille.

Potential errors using this method are more limited than with other duct leakage diagnostic tools. The duct blaster measures the total duct leakage, both to the inside and to the outside of the home. In order to determine the leakage from the ducts to the outside only, a home pressurization test has to be performed. The home is first brought to a reference pressure with the blower door, then the duct blaster flow is adjusted to zero with reference to the home.

5.2.6.1.4 Thermographic Inspections

Energy auditors may use thermography—or infrared scanning—to detect thermal defects and air leakage in building envelopes. Thermography measures surface temperatures by using infrared video and still cameras. These tools see light that is in the heat spectrum. Images on the video or film record the temperature variations of the building's skin, ranging from white for warm regions to black for cooler areas. The resulting images help the auditor determine whether and where insulation is needed. They also serve as a quality control tool, to ensure that insulation has been installed correctly.

A thermographic inspection is either an interior or exterior survey. The energy auditor decides which method would give the best results under certain weather conditions. Interior scans are more common, because warm air escaping from a building does not always move through the walls in a straight line. Heat loss detected in one area of the outside wall might originate at some other location on the inside of the wall. Also, it is harder to detect temperature differences on the outside surface of the building during windy weather. Because of this difficulty, interior surveys are generally more accurate because they benefit from reduced air movement.

Thermographic scans are also commonly used with a blower door test running. The blower door helps exaggerate air leaking through defects in the building shell. Such air leaks appear as black streaks in the infrared camera's viewfinder.

5.2.6.1.5 Air Flow Meter

Within the context of existing homes efficiency programs, an air flow meter is a device used to measure the speed of air flowing through a duct system, typically measured in cubic feet per minute (CFM).

5.2.6.1.6 Manometer

A manometer is a tube filled with liquid that is used to measure pressures within an HVAC system. Mercury manometers measure vacuum in inches of mercury, while water manometers measure pressure in inches of water.

5.2.6.2 Diagnostic Software

DOE is sponsoring a project entitled BESTEST-EX, the goal of which is to test the ability of current software analysis methods with utility bill true up to predict energy savings for existing homes programs. Participants in the project include Architectural Energy Corporation, Apogee, Conservation Services Group, Florida Solar Energy Center, ICF, Oak Ridge National Laboratory, and Performance Systems Development. The software represented by the group includes RemRate, EnergyInsights, HomeCheck, EnergyGauge (DOE2), BEACON HEA, NEAT, and TREAT (SUNREL). This multiyear project will include case studies, community evaluations, technologies, simulation, support to deployment, and standards and codes support.

5.2.6.3 Standards

5.2.6.3.1 Building Performance Institute

The Building Performance Institute, Inc. (BPI) is a national organization whose mission is to enhance the health, safety, comfort, durability, and energy efficiency of residential buildings by providing skills verification and promoting best practices in the building trades. BPI has established technical standards for organizational and individual credentialing and quality assurance. These standards include Building Analyst and Shell Specialist. (BPI has announced plans for new certifications for sealing and insulation installers and their supervisors in 2010.)

In addition to health and safety minimum requirements, BPI technical standards for Building Analysts require a building airflow standard calculation according to exchange requirements, heat loss and savings calculations of building components, area and volume calculations, combustion safety testing, carbon monoxide protection, and work scope requirements.

Shell Specialists are required to support BPI's technical standards for airflow and mechanical ventilation, and installation requirements for air sealing, duct sealing, insulation, and windows.

Each of the above BPI technical standards requires technicians to utilize measurement and verification procedures involving diagnostic tools such as a blower door, duct system analyzer, combustion safety testing, and Carbon Monoxide (CO) meters.

5.2.6.3.2 Residential Energy Services Network

The Residential Energy Services Network (RESNET) has developed national standards for home energy audits. Included in the RESNET home energy audit standard is the comprehensive home energy audit, which involves evaluation, diagnosis, and proposed treatment of an existing home. The comprehensive home energy audit may be based on a home performance assessment or a home energy rating.

RESNET ratings provides a relative energy use index called the HERS® Index. A HERS Index of 100 represents the energy use of a standard building and an Index of 0 (zero) indicates that the proposed building uses no net purchased energy (a.k.a. a Zero Energy Building). A set of

rater recommendations for cost effective improvements that can be achieved by the rated building is also produced.

RESNET standards encompass three areas:

- Software accreditation achieved by passing a battery of software verification tests developed by U.S. national laboratories and RESNET.
- Definition of knowledge base and skill sets that a rater must demonstrate through passing an online exam.
- A quality assurance evaluation that features each rating provider employing a certified Quality Assurance Designee. The Quality Assurance Designee must annually independently verify internal consistency of a minimum 10 percent of all building input files and independently field verify the accuracy of a minimum of 1 percent of each certified rater's homes.

5.2.7 Combustion Safety Testing

5.2.7.1 Introduction

Spillage is a temporary flow of combustion byproducts through the dilution device when a furnace or boiler starts. Weak draft during the first moments after ignition cause spillage, however this situation usually corrects itself after the chimney warms up. Backdrafting is continuous spillage – a reversal of the chimney's airflow.

Any analysis of a home's airflow should include a check of all combustion equipment. Any device that uses room air for combustion must have an adequate air supply. Backdrafting tends to be the result of excessive negative pressure caused by air moving appliances. If the negative pressure in a combustion appliance's space is greater than the its flue system's draw, the airflow in the flue will be reversed and the flue gasses will be dumped inside.

Although backdrafting tends to be more common in tight homes, it is also affected by the specific equipment involved, locations, compartmentalization created by interior doors, and high winds. Thus it is especially important to test all combustion appliances during both the initial energy audit, as well as test-out procedures, putting the home in worst case conditions.

5.2.7.2 Worst-Case Depressurization, Carbon Monoxide, and Draft[26]

The main purpose of measuring draft is to ensure that the combustion gases are being vented out of a home. Draft is also an indicator of the effectiveness of the venting system and the stability of the combustion process. Draft is measured in inches of water column (IWC) or pascals.

A Worst Case Draft (WCD) test must be completed whenever a dwelling has atmospheric combustion appliances, including gas or wood fireplaces or space heaters. Pre-testing is done to determine if there are any serious safety concerns that should be corrected before improvements are completed, if improvements—such as air sealing—may create a safety problem, and to ensure that there are no imminent serious health risks that may endanger homeowner's lives. Post-installation combustion safety testing is performed to ensure that participating homes are in a safe and healthy operating condition after having participated in a whole home efficiency program.

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[26] Note that the majority of what is included in this section has been replicated from the Wisconsin Weatherization Field Guide, dated 7/1/2007.

5.2.7.3 Measuring Draft

Most existing combustion appliances exhaust their gases into an atmospheric chimney. An atmospheric chimney produces negative draft—a slight vacuum. The strength of this draft is determined by the chimney's height, its cross-sectional area, and the temperature difference between the flue gases and outdoor air. Atmospheric chimney draft should always be negative.

Atmospheric chimneys transport combustion gases using the flame's heat and gases' buoyancy. Atmospheric gas appliances are designed to operate at a chimney draft of around negative 0.02 inches of IWC or –5 pascals. Tall chimneys located indoors typically produce stronger drafts, and short chimneys or outdoor chimneys produce weaker drafts. Wind and home pressures have a strong influence on draft in atmospheric chimneys.

Fan assisted appliances employ a small fan near the exhaust of their heat exchanger. This draft inducing fan regulates the overfire draft but has little or no effect on draft in their atmospheric chimneys.

Positive draft appliances, like condensing furnaces, have a strong positive draft and an airtight venting system. The positive draft of these appliances is created by a draft fan and is strong enough to resist the influence most indoor and outdoor pressures.

5.2.7.4 Depressurization and Worst Case Draft Testing

Depressurization is the leading cause of backdrafting and flame roll out. WCD testing uses the home's exhaust fans, air handler, and chimneys to create worst case depressurization in the combustion appliance zone (CAZ). The CAZ is an area containing one or more combustion appliances. During this worst case testing, the efficiency program administrator can measure the chimney draft and indoor-outdoor pressure difference or just chimney draft. Refer to BPI's Combustion Safety Test Procedure for Vented Appliances for directions on how to perform this test.

There are two test instruments commonly used in combustion safety testing. The first is a carbon monoxide analyzer and the second is a combustion analyzer. Carbon monoxide is a byproduct of combustion when either the ratio of fuel to oxygen is too high to permit the complete formation of CO2 or the temperature is too low to permit oxidation to occur. A CO analyzer is used to measure ambient CO during combustion safety testing. CO analyzers measure carbon monoxide in parts per million (ppm). A combustion analyzer is used to measure combustion gases in the draft pipe during combustion safety testing.

6 Appendix C: Workforce Development Information

6.1 Current Efforts to Expand the Workforce

Whole home programs commonly include a workforce development component because in most markets, there are few contractors that can deliver (either independently or working in teams across the trades) comprehensive whole home energy efficiency improvements and meet program requirements, particularly in the areas of air sealing, duct sealing, and diagnostics. Contractors need to be trained in diagnostic testing, energy modeling, selling and implementing comprehensive improvements, and program quality assurance requirements.

Ongoing training of trade allies in program requirements is part and parcel of an existing home program's responsibility to ensure customer savings. Quality Assurance testing can help identify where additional training is needed among the local contractor infrastructure and most likely to contribute to the success of the program.

In addition to the organizations whose primary mission is training (listed in Section 6.4.1), manufacturers, community colleges, training centers, and other industry groups also engage in training and certification efforts. For example, HVAC manufacturers and distributors work to train their contractor base on efficiency upgrades. For example, one HVAC manufacturer alone offers classroom training and over 400 e-learning titles and the average HARDI distributor has 1,200 contractor customers and holds over 50 training classes per year.

Work has begun to leverage the efforts of efficiency programs and industry representatives in the area of training. One example of this is a curriculum being developed by the California Investor Owned Utilities (SCE, Sempra, and PG&E), the California Energy Commission, the California Lighting Technology Center, the California Community Colleges, and the National Electrical Contractors Association/International Brotherhood of Electrical Workers.

The 2009 American Recovery and Reinvestment Act (ARRA) in the U.S. has also spurred efforts to expand the workforce for comprehensive energy efficiency work in existing homes. Of the total $787 billion provided by ARRA, $32.7 billion went to programs funded by DOE, including $3.2 billion for Energy Efficiency Conservation Block Grants and $3.1 billion for the State Energy Program (SEP). Some recipients of these funds are focusing on energy efficiency workforce development. One example is California, which set aside $20 million from its State Energy Program funds for a Green Jobs Training Program, in which almost half the SEP funds allocated support the residential energy efficiency industry.

6.2 Growing Interest in Workforce Development

Workforce development has received significant attention recently, and several reports have been issued that discuss the opportunities and challenges and that provide resources for efficiency programs and industry stakeholders.

- Center for American Progress – Green Recovery
- Apollo Alliance – Green-Collar Jobs in America's Cities
- American Solar Energy Society – Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century
- EPA – Background paper for Technical Forum on Clean Energy Workforce Development

- EPA – Clean Energy Workforce Development Resources for States

In addition to the above resources, Efficiency First (the national trade association representing the home performance industry) will be releasing a report in mid-2010 that details the industry perspective on the workforce needs of residential energy efficiency employers. The report, along with other resources, will be posted on the Home Performance Resource Center website.

6.3 Challenges in Workforce Development

Several challenges have been noted by Existing Homes Working Group participants regarding training efforts. These include the timing of training events (because some trades are seasonal, training must be timed to accommodate their schedules), flexibility in scheduling classes to meet the needs of a diverse set of students, and accommodation of distance learning for hard-to-reach markets. Another challenge in training is providing technicians who receive training with a pathway to make use of their skills; this is particularly important in a down economy.

Further, training is ineffective if the business model and business owner aren't fully committed to it. When a company is committed to delivering a high level of service or unique services, it must have qualified technicians to be effective; it trains its workforce because it is essential. Without this motivation many training efforts tend to be put on the back burner or not fully implemented.

In addition, anecdotal evidence from the HVAC industry in particular shows that trained technicians are more likely to leave the business and either work for other companies or start their own businesses. This may also be a barrier to the home performance contractor, which may not want to invest in training for its technicians.

Lastly, it can be difficult and expensive to develop the hands-on training needed for basic skills for entry level workers such as air sealing, duct sealing, etc. These skills require hands-on training and mentoring over time that may be difficult for traditional training groups to provide.

To address these challenges, the Working Group concluded that strong connections between training and certification organizations and efficiency program efforts are needed to ensure that technicians who have the needed skills actively participate.

6.4 Workforce Development Market Actors

6.4.1 Organizations that Train

The following is a list of training organizations that have been nominated for inclusion by Working Group participants. A more comprehensive list of training organizations is available on the BPI web site.

GreenCollarEdu.net offers training in HVAC and building performance. Their course entitled "Performing the Comprehensive Building Assessment" is designed for those seeking BPI certification as a Building Analyst professional. The course integrates the BPI Building Analyst as well as various industry codes and standards in including the ANSI/ACCA Quality Installation & Maintenance Standards.

Green Builder College is the an online training program that offers certification and continuing education to professionals who work in residential buildings. Their offerings include the Green Builder® Certification program, and will also offer continuing education credits, providing an ongoing source of professional development.

Laborers' International Union of North America (LiUNA) is a third-party accredited curriculum development and workforce training organization with a national network of affiliated training schools capable of delivering fixed site and mobile training throughout North America. LiUNA offers training primarily for weatherization contractors and currently has 60 credentialed weatherization trainers nationwide who can certify workers for all three levels of weatherization work (installer/technician, supervisor and energy, and auditor). They have certified over 200 workers as weatherization installer/technicians.

CleanEdison serves federal, state and local governments, building design and construction firms, owners, operators, and real estate investors. They offer both customized training and open enrollment green training programs. CleanEdison offers courses to prepare students for the BPI certification exams, as well as energy auditing.

Energy Center of Wisconsin (ECW) is an independent nonprofit that trains the workforce responsible for improving the performance of homes and workplaces. ECW is an authorized provider for the American Institute of Architects, the International Association for Continuing Education and Training, and the U.S. Green Building Council. Part of ECW's offerings includes the Energy Center University which offers live event and online energy efficiency and renewable energy continuing education programs geared towards commercial, industrial, and residential building professionals. Additionally, ECW partners with Focus on Energy to deliver training to those individuals and contractors desiring to partner with and deliver services for Focus on Energy residential and business programs. The curriculum for these training programs is designed to prepare participants for BPI certification exams, through both classroom education and in-field training. Focus on Energy provides training incentives and equipment loans for individuals successfully completing this training.

6.4.2 Organizations that Certify Technicians

BPI, as stated above, is a national organization whose mission is to enhance the health, safety, comfort, durability, and energy efficiency of residential buildings by providing skills verification and promoting best practices in the building trades. BPI has established technical standards for individual credentialing and quality assurance. These standards include Building Analyst and Shell Specialist. (Though BPI does not offer training itself, it does list other organizations whose training aligns closely with the BPI National Standards and Knowledge Areas on its Web site.)

The Residential Energy Services Network (RESNET), as described in section 3.2.6.3.2, has developed national standards for home energy audits. Included in the RESNET home energy audit standard is the comprehensive home energy audit, which involves evaluation, diagnosis, and proposed treatment of an existing home. The comprehensive home energy audit may be based on a home performance assessment or a home energy rating.

North American Technician Excellence (NATE), is a certification program for technicians in the heating, ventilation, air conditioning, and refrigeration (HVAC/R) industry. NATE certification is supported by the entire industry, and includes a senior level exam called the "HVAC Efficiency Analyst" that covers items related to system design, sizing, and installation to ensure maximum efficiency is delivered.

6.4.3 Organizations that Accredit Contractors

BPI has established technical standards for organizational credentialing (in addition to their standards for certifying technicians. Their contractor accreditation involves standards for quality management systems, customer dispute resolution procedures, and employment of BPI certified technicians.

6.4.4 Organizations that Accredit Training and Certification Programs

Accreditation organizations exist to ensure that organizations offering certification administer quality programs. As such, efficiency programs would benefit from monitoring the progress of the following accreditation efforts.

American National Standards Institute (ANSI) is a standards setting organization used in a wide variety of industries. ANSI currently administers ANSI/ISO/IEC standard 17024, which is available for use by organizations that certify personnel. The process ANSI uses to accredit certification bodies is based on an international standard (ISO/IEC 17011), which helps to ensure that the ANSI process represents best practices. ANSI is the only personnel certification accreditation body in the United States to meet nationally accepted practices for accreditation bodies. Becoming certified by ANSI requires both a paper review and an on-site visit. Of the certifications most widely used by efficiency programs, neither BPI nor RESNET have begun the process of becoming accredited under ANSI/ISO/IEC 17024, while NATE has begun—but not completed—the accreditation process.

Distance Education and Training Council (DETC) is defines, maintains, and promotes educational excellence in distance education institution by offering accreditations to organizations educating and certifying students. DETC has accredited the HARDI Independent Study Institute, which is an HVAC education and training program.

International Association for Continuing Education and Training (IACET) offers the ANSI/IACET 1-2007 standard, which covers the processes used to design, develop, and deliver continuing education and training. Because this standard focuses on processes, not content, it applies across all disciplines. One example of an organization in the efficiency field that has been accredited by IACET is the Energy Center of Wisconsin.

Bureau de Normalisation du Québec (BNQ) verifies the conformity of products, processes, services and persons and develops certification programs in a number of fields. Founded in 1961, the BNQ operates in the fields of standards development and product certification.

Canadian General Standards Board (CGSB) is a federal government organization that offers standards development and certification of products and services for government, industry and consumers. The Canadian General Standards Board is best known for the conformity assessment and testing services related to buildings materials and products.

7 Appendix D: The Policy Context

7.1 Federal Policies

The DOE Office of Energy Efficiency and Renewable Energy has a stated mission of strengthening the United States' energy security, environmental quality, and economic vitality in public-private partnerships. In the policy arena, it is responsible for promulgating federal minimum efficiency performance standards for many of the end uses in existing homes.

Other federal agencies, such as the Department of Housing and Urban Development (HUD) are also involved in policy related to existing homes. For example, in February 2009, DOE and HUD announced a partnership on existing homes efficiency, which was followed by an October 2009 strategy entitled Recovery through Retrofit, that outlined their planned work together with other federal agencies. This strategy is being led by Vice President Biden and implemented by the Department of Energy and several other agencies.[27]

The National Action Plan for Energy Efficiency is a private-public initiative begun in the fall of 2005 to create a sustainable, aggressive national commitment to energy efficiency through the collaborative efforts of gas and electric utilities, utility regulators, and other partner organizations.

The State Energy Efficiency Action Network (SEE Action) was launched by DOE and EPA in February 2010 to help states achieve maximum cost-effective energy efficiency by 2020. SEE Action exists to further the energy efficiency goals developed in the National Action Plan for Energy Efficiency. To do this, SEE Action focuses on four priorities: 1) residential program models; 2) financing; 3) evaluation, measurement, and verification topics; and 4) the impact of information on customer decisions.

7.2 Regional, State/Provincial, and Local Policies

Many regions, states, provinces, and local jurisdictions set policies that influence energy efficiency programming. Two such organizations are provided (one regional and one state level) as examples below.

The California Energy Commission is the state agency responsible for setting residential building codes and energy performance standards for selected products in the state of California. In addition, it conducts research on energy efficiency technologies through the Public Interest Energy Research (PIER) Program.

The Northwest Power and Conservation Council develops and maintains a regional power plan a fish and wildlife program for Oregon, Washington, Idaho, and Montana and to balance the region's environment and energy needs. Its three tasks are to 1) develop a 20 year electric power plan that will guarantee adequate and reliable energy at the lowest economic and environmental cost to the Northwest, 2) develop a program to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River Basin, and 3) educate and involve the public in the Council's decision making processes.

7.3 Organizations that Work to Inform and Influence Policy

Many organizations and groups inform and influence policy decisions, whether at the national, state/provincial, or local level. These include both the trade associations for the industries

[27] More information on DOE's work on the Recovery through Retrofit strategy was presented on a December 17, 2009 Webinar. Slides are available online.

that serve the existing homes market and efficiency-focused organizations. A comprehensive listing of all organizations working to inform and influence policy is beyond the scope of this document, however, a few of the organizations working in this realm are listed below with the goal providing a starting point for efficiency program managers to begin their own research on this topic.

Industry associations working to inform and influence policy include organizations such as Efficiency First, the Air-Conditioning, Heating, and Refrigeration Institute, the Air Conditioning Contractors of America, the Heating, Airconditioning, & Refrigeration Distributors International, the Plumbing-Heating-Cooling Contractors National Association, the North American Insulation Manufacturers Association, the Insulation Contractors Association of America, the National and Building Materials Dealers Association, the National Electrical Manufacturers Association, the Association of Home Appliance Manufacturers, the American Lighting Association, and many others.

Efficiency-focused organizations working to inform and influence policy include (but are not limited to) groups such as the Alliance to Save Energy, the American Council for an Energy Efficient Economy, the Regulatory Assistance Project, and National Association of Regulatory Utility Commissioners.

Many of the above organizations publish newsletters and other publications related to policy changes that can be helpful sources of information for efficiency program managers working in existing homes. Another source of information on policies that have been finalized and implemented is the Database of State Incentives for Renewables and Efficiency, or DSIRE. This searchable Web based database provides information on state and federal incentives, rules, regulations, and policies.

8 Appendix E: Program Summary

The following information was collected in February and March of 2010 and represents CEE's best efforts at reporting on the existing homes programs offered by its members. However, it is not an exhaustive summary of member programs; for information about programs that are offered locally, please contact your local efficiency program administrator. The information in this Program Summary will be updated on an approximately annual basis and posted on the CEE Web site.

Based on the information collected, there appears to be a significant amount of commonality among all member existing homes programs. For example, all programs are working to offset the financial barriers to whole house retrofits. Each program featured here offers customer incentives, while a third of programs offer financing. Commonality also exists in terms of marketing messages. All programs include energy and money savings, comfort, health and safety. In addition, all programs are emphasizing contractor training and certification, with over half of the programs who responded specifically referencing BPI.

Despite this commonality, the programs appear to vary around four dimensions. First, in terms of the degree to which they are performance or prescriptive, the majority of programs included in this summary are taking a comprehensive performance approach, such as Home Performance with ENERGY STAR. Others, however, are offering prescriptive incentives for a menu of efficiency upgrades. Second, programs vary in terms of whether they cover all fuels. For example, Commonwealth Edison is offering a program that covers only electric savings, while the California Investor Owned Utilities are partnering to offer a program that includes electric and gas. Third, programs vary in terms of their history in a market; some are pilots and others have nearly 10 years of experience. Lastly, the programs included in this summary vary in terms of their annual budgets. The Commonwealth Edison program is approximately $250,000 annually, while Public Service Electric & Gas, New York State Energy Research & Development Authority, and the Energy Trust of Oregon are all in the $10-15 million range.

Program Administrator Information	
Organization Name	Ameren Illinois Utilities
Program Manager	Nick Lovier, 309-677-5245, nlovier@ameren.com
Organization Type	Electric Utility
Geographic Scope of Program	Lower 2/3 of the state of Illinois, approximately 44,000 square miles of territory
Web site	www.actonenergy.com
General Program Information	
Program Name	Home Energy Performance Program
Duration of Program	Program launched June 1, 2008. Program will run indefinitely until the legislation changes.
Annual Budget	Legislation mandated a phase-in of spending to mitigate rate impacts, therefore annual budgets will vary and gradually increase over time.
Funding Source	Cost recovery tariffs
General Approach	The program includes an initial visual walk-through audit with direct install measures. This is followed by a report suggesting follow-up measures such as attic and wall insulation, air sealing, etc. Incentives are offered to customers if they proceed with the follow-up measures.
Goals & Objectives	The program has energy and demand savings goals with an overall objective being to offer comprehensive retrofit packages for customers considering energy efficiency improvements for existing single family homes.
Cost Effectiveness Test Used	Total Resource Cost must be greater than 1 at the measure level.
Detailed Program Information	
Target Audience	Existing single-family homes in the Ameren Illinois Utilities territory.
Identifying Customers	Specific homeowners are identified through on consumption data and other demographic information.
Ensuring Capacity and Capability of the Workforce	The program actively recruits insulation contractors to sign up as Program Allies. All Program Allies must be BPI certified.
Working with Trade Allies	Trade allies include Illinois Central College, Earthways Center, Brian Kumer Thermal Imaging, Heartland Community College, and the Illinois Association of Energy Raters.
Reducing Financial Barriers	The program offers incentives for follow-up measures to reduce the investment required to make energy efficiency improvements.
Motivating Action through Marketing	The audit portion of the program is marketed by highly targeted direct mail piece in order to control the geographic focus. Follow up measures are marketed through our website (www.actonenergy.com) and contractor driven efforts.
Verifying Savings	The program uses deemed savings, which are established based on building science and market research.
Implementation Strategies	A Prime Contractor is used to implement the program and manage Program Allies.
Evaluation	The program is being evaluated by a third party contractor; no results are available at this time.
Major Changes in the Past Year	The program has been in operation for approximately one year, so the only major change has been its continual growth.

Program Administrator Information	
Organization Name	Avista Utilities
Program Manager Contact	Chris Drake, 509-495-8624, Chris.Drake@AvistaCorp.com
Organization Type	Electric and Natural Gas Utility (Natural Gas only in Oregon)
Geographic Scope of Program	Eastern Washington, Northern Idaho, and Southwestern Oregon
Web site	www.avistautilities.com
General Program Information	
Program Name	Home Improvement Incentives
Duration of Program	Avista has continuously offered residential incentives for energy efficiency improvements since the fall of 2001. Avista has offered other residential programs for existing homes on and off since 1978.
Annual Budget	Not provided
Funding Source	Energy Efficiency Tariff Rider (Customer Rates)
General Approach	The program provides incentives for individual energy efficiency measures that meet established high efficiency ratings. These measures include space conditioning, water heating, insulation, windows, and programmable thermostats.
Goals & Objectives	Residential incentive programs have goals of several million kWh and hundreds of thousands of therms, annually based on integrated resource planning and regional power and conversation council goals.
Cost Effectiveness Test Used	Total Resource Cost must be greater than 1. Utility, Participant and Societal Cost Tests are also completed.
Detailed Program Information	
Target Audience	Single family residences up to a four-plex, including manufactured homes.
Identifying Customers	All residential electric and natural gas customers are targeted through a broad energy efficiency campaign, entitled "EveryLittleBit."
Ensuring Capacity and Capability of the Workforce	The program engages with the local HVAC/R association to build awareness and educate dealers about the program incentives.
Working with Trade Allies	The program publishes the local HVAC/R association's registered dealer list and encourage use of the yellow pages, but does not recommend specific contractors to its customers.
Reducing Financial Barriers	Incentives are offered to homeowners for qualifying measures and vary by measure and state in which the incentive is offered. See link for additional information https://www.avistautilities.com/savings/rebates/Pages/default.aspx.
Motivating Action through Marketing	"EveryLittleBit" is a multi-channel marketing effort that encourages customers to be more energy efficient, saving energy individually and resources regionally.
Verifying Savings	A combination of deemed savings based on regional and internal engineering analysis and impact evaluations is used. The impact evaluations are conducted to further refine deemed savings estimates.
Implementation Strategies	Programs are developed and implemented in-house. External contractors have been used for some hard to reach segments or measures (e.g. a multifamily direct install program).
Evaluation	The program has been evaluated as part of regulatory proceedings. In addition, internal auditing, internal process improvement analysis, and

	some impact analysis have been done.
Major Changes in the Past Year	The program is continually analyzed and programmatic changes are made as a result of process improvement analysis. Most recently tankless water heaters, ground source heat pumps, and replacement air conditioning programs were discontinued due to cost-effectiveness analysis.

Program Administrator Information	
Organization Name	BC Hydro
Program Manager Contact	Steve Connelly, 604-453-6344, stephen.connelly@bchydro.com
Organization Type	Utility
Geographic Scope of Program	British Columbia, Canada
Web site	http://www.bchydro.com/powersmart/residential.html
General Program Information	
Program Name	LiveSmart BC: Efficiency Incentive Program
Duration of Program	April 1, 2008 through March 31, 2011
Annual Budget	BC Hydro Only: (CAD) $5.3 million over 3 years
Funding Source	BC Hydro, Ministry of Energy, Mines and Petroleum Resources, Fortis BC, Terasen Gas, Natural Resources Canada
General Approach	The program is a collaboration between the BC Ministry of Energy, Mines and Petroleum Resources, Natural Resources Canada, BC Hydro, Fortis BC and Terasen Gas. It is designed to encourage homeowners to make energy-efficient retrofits to their homes and receive financial incentives for doing so.
Goals & Objectives	BC Hydro Goal: Realize an incremental annual DSM electricity savings of 13.0GWh/yr by end of March 2011. Objective is to realize maximum net benefits, contribute to meeting the province's electricity supply requirements for future generations in an environmentally responsible manner, and develop and foster a conservation culture in BC that leads customers to choose to make a dramatic and permanent reduction in electricity use.
Cost Effectiveness Test Used	TRC, UTC, RIM, Participant
Detailed Program Information	
Target Audience	Single family dwellings, row/town homes, mobile homes on permanent foundations, and permanently moored float homes
Identifying Customers	All BC homeowners are eligible if they own a dwelling that is meets the program criteria.
Ensuring Capacity and Capability of the Workforce	Training was offered on various topics to Service Organizations (Certified Energy Advisors) in BC.
Working with Trade Allies	Communications are done through trade organizations.
Reducing Financial Barriers	Financial Incentives from various program partners, with a maximum of $5,000 from Natural Resources Canada. There is no cap from the Ministry of Energy, Mines and Petroleum Resources, BC Hydro, Fortis BC, and Terasen Gas.
Motivating Action through Marketing	Designed to ensure that anyone who takes part will understand what they can do to make a real difference to their home's energy consumption and reduce energy costs.
Verifying Savings	Homes are assessed before and after retrofits are made, and savings are applied based on the retrofits made by participants.
Implementation Strategies	Service Organizations licensed by Natural Resources Canada are used to provide homeowners with both an initial home assessment and a follow-up home assessment.
Evaluation	Not completed yet.

Major Changes in the Past Year	Program intake was ended early due to higher-than-expected uptake. The program had been scheduled to be in market from April 1, 2008 to March 31, 2011 but ended early to new participants on August 15, 2009. Customers who had an initial home assessment between April 1, 2008 and August 15, 2009 have until March 31, 2011 (or 18 months after the date of their initial assessment, whichever is sooner) to complete their retrofits and have their second home assessment done.

Program Administrator Information	
Organization Name	California Investor Owned Utilities
Program Manager Contact	PG&E: Jeff Gleeson, 415-973-3432, J5G3@pge.com SDG&E: Julia Mendoza, 858-654-1264, jmendoza@semprautilities.com SCE: Amri Christianto, 626-633-3044, Amri.Christianto@sce.com
Organization Type	Utility
Geographic Scope of Program	Statewide in California
Web site	Currently under development
General Program Information	
Program Name	TBD
Duration of Program	The program is being proposed now and will most likely be implemented in 2010-2012, with the intention of continuing into the next program cycle.
Annual Budget	Approximately $100 Million
Funding Source	Ratepayer
General Approach	Prescriptive program and performance pathways for program participation.
Goals & Objectives	Targets are still being developed, though the goal per home is to save an average of 20% in annual energy bills.
Cost Effectiveness Test Used	TBD
Detailed Program Information	
Target Audience	Initially the target is single family homes, with multi-family homes being included later in the program roll-out.
Identifying Customers	TBD
Ensuring Capacity and Capability of the Workforce	IOU training efforts will be utilized in a back-up role, as California's workforce development efforts are moving forward aggressively with funding from the California Energy Commission.
Working with Trade Allies	The IOUs held 4 public workshops and 1 public webinar to get input and prepare the trade allies for the program.
Reducing Financial Barriers	The program will offer customer incentives on the order of $1,000 for the basic prescriptive retrofit package and closer to $3,000 for the advanced, performance-based retrofit.
Motivating Action through Marketing	The IOUs are currently initiating market research to guide marketing decisions.
Verifying Savings	The basic program will follow a deemed savings approach and the performance programs will likely utilize modeled savings.
Implementation Strategies	The program will be contractor-driven and will utilize a third-party implementer.
Evaluation	TBD
Major Changes in the Past Year	Although the program has not launched, a considerable amount of activity has taken place in the California residential retrofit sector over the last year (including State Energy Program funds and AB 811 municipal financing districts).

Program Administrator Information	
Organization Name	Cape Light Compact
Program Manager Contact	Cape Light Compact: Briana Kane, 508-744-1277, bkane@capelightcompact.org
Organization Type	Efficiency Program Administrator
Geographic Scope of Program	Cape Light Compact, is made up of all 21 towns of Barnstable and Dukes counties
Web site	www.capelightcompact.org
General Program Information	
Program Name	Residential Conservation Services / Mass Save *(Note: This program is administered statewide in MA through several Program Administrators. The information in this summary is specific to Cape Light Compact.)*
Duration of Program	1980 through present
Annual Budget 2010	$4.3 million
Funding Source	System Benefit Charge funds, Forward Capacity Market proceeds, Regional Greenhouse Gas Initiative proceeds, and other funding sources including carryover and Energy Efficiency Reconciliation Factor funds.
General Approach	Comprehensive program with test-in/test-out.
Goals & Objectives 2010	Educate residential customers about saving energy in their homes and help them identify and install cost-effective upgrades. Cape Light Compact's specific goals for the year include: • 4,063 MWh estimated Net Annual savings • 43,462 MWh estimated Lifetime savings • 29 MW estimated Lifetime savings • 3,900 estimated participants
Cost Effectiveness Test Used	Total Resource Cost must be greater than 1 at the measure level.
Detailed Program Information	
Target Audience	All non-low-income residential customers living in single-family houses or one- to four-unit multi-family buildings.
Identifying Customers	All customers who call the toll-free number to learn about the program are asked several questions to determine their need for and general interest in making energy-efficient improvements. The program also uses vendors to guide customers to appropriate program services including targeted energy efficiency information, advanced diagnostics, efficiency rebates, and deep energy retrofit support.
Ensuring Capacity and Capability of the Workforce	The program strives to maximize energy savings by promoting and supporting contractor training and education in an effort to establish a broader workforce knowledgeable of proper installation techniques. The goal is to have a sustainable and experienced workforce that is focused on achievable maximum energy savings ready and able to meet customer demand.
Working with Trade Allies	N/A
Reducing Financial Barriers	The Residential Conservation Services / Mass Save program provides on site customer-specific information at no cost to the customer, free installation of instant savings measures, as well as an educational information regarding all statewide program incentives, financing options, and where to find information about Federal and State tax credits. The Program currently offers free direct installation measures

	and incentives of 75 percent of the installed cost of contractor-installed measures, up to $2,000. In addition, the Residential Conservation Services / Mass Save leverages funds available through the HEAT Loan program to provide qualified customers with 0 percent interest loans up to $15,000 with terms up to seven years. These can be applied towards the following energy efficiency upgrades: insulation, duct system improvements, high-efficiency heating systems, high-efficiency DHW systems, solar DHW systems, ENERGY STAR thermostats, ENERGY STAR windows, ENERGY STAR water heaters, and other renewable technologies on a pre-approved basis. A portion of the HEAT Loan may be used to finance the mitigation of barriers preventing the installation of energy efficient measures. In the past, safety barriers have been a significant obstacle in maximizing energy savings. Using HEAT Loan funds to manage safety issues will allow the program to access a broader spectrum of efficiency in the future.
Motivating Action through Marketing	Current forms of multi-media outreach include: a Web site (enhanced via the Statewide Integrated Energy Efficiency Website), bill inserts, radio, print and visual media advertising, new media advertising (advanced online options), and targeted marketing through community outreach initiatives such as Cambridge Energy Alliance, Marshfield Energy Challenge, and the Energy Smack-Down program.
Verifying Savings	The program uses deemed savings and third party QA/QC of work performed by contractors.
Implementation Strategies	The program is administered within each service territory by its Program Administrator and is coordinated statewide through the Residential Management Committee (RMC) that actively manages and steers the statewide program. The program is delivered by program vendors selected through a competitive bidding process.
Evaluation	The program is evaluated every 3 years.
Major Changes in the Past Year	The program is committed to a comprehensive whole-house approach and seeks to maximize both electric and gas energy savings (including fuel neutral incentives). The program plans to fully integrate the Residential Conservation Services / Mass Save and Gas weatherization programs, so that customers experience “one program” as opposed to multiple offerings. The Residential Conservation Services / Mass Save program design is undergoing an effort to significantly increase the number of properties serviced by the program, which will also lead to higher energy savings potential. The design will also allow Program Administrators to better capture and utilize property data for the purpose of identifying all available energy efficient measures, as well as targeting marketing efforts. Program Administrators will continue to explore new technologies in conjunction with significantly increasing the implementation of known cost effective measures. Program Administrators intend to increase the number of qualified major measure installers through establishing qualification/training guidelines using the BPI or its equivalent as a benchmark.

Program Administrator Information	
Organization Name	ComEd
Program Manager Contact	Sharon Madigan, 630-437-4638, sharon.madigan@comed.com
Organization Type	Electric Utility
Geographic Scope of Program	Northern 2/3 of Illinois, including Chicago metro area
Web site	www.comed.com/smartideas
General Program Information	
Program Name	All-Electric Home Performance Tune-Up
Duration of Program	Started June 1, 2009 and will end as an all-electric program on May 31, 2011
Annual Budget	$250,000 for Program Year 2 (June 2009 – May 2010), increasing to an estimated $380,000 in Program Year 3 (June-2010 – May 2011).
Funding Source	Ratepayer funded, per Illinois Public Act 95-0481.
General Approach	Direct install program that includes a home energy survey.
Goals & Objectives	537 MWh for Program Year 2 and 921 MWh for Program Year 3.
Cost Effectiveness Test Used	Total Resource Cost Test must be greater than or equal to 1.
Detailed Program Information	
Target Audience	Consumers in single family homes with electric space heat and electric DHW qualify. This amounts to a total of 155,000 all-electric single family homes in ComEd's service territory.
Identifying Customers	ComEd's billing system identifies homes with electric space heat. Customers qualifying for weatherization programs are then excluded from the program.
Ensuring Capacity and Capability of the Workforce	Per ComEd's TRC requirement, the program only includes all-electric homes. Due to the small size, the program is working with one implementation contractor.
Working with Trade Allies	ComEd has not yet begun working with Trade Allies on this program.
Reducing Financial Barriers	$25 customer co-pay. The balance of the costs of the direct installs and energy survey/technician visit are borne by the program.
Motivating Action through Marketing	ComEd is using direct marketing tactics with a geographic focus to reduce windshield time. Marketing messages include increased home comfort and reduced utility bills.
Verifying Savings	ComEd is required to contract an EM&V firm to analyze and report program savings for each of its efficiency programs on an annual basis. It is not yet able to apply deemed savings.
Implementation Strategies	ComEd has contracted with an implementation contractor who manages enrollments, fulfillment and reporting.
Evaluation	This program has not yet been evaluated but will be in the third quarter of 2010.
Major Changes in the Past Year	Because this is a brand new program, no changes were made in the first year.

Program Administrator Information	
Organization Name	Efficiency Vermont
Program Manager Contact	Emily Levin, 802-488-7694, elevin@veic.org
Organization Type	Efficiency Vermont is an energy efficiency utility. VEIC, a nonprofit organization, administers Efficiency Vermont under contract to the Vermont Public Service Board.
Geographic Scope of Program	Statewide in Vermont
Web site	www.efficiencyvermont.com www.efficiencyvermont.com/homeperformance
General Program Information	
Program Name	Vermont Home Performance with ENERGY STAR (HPwES) is the core offering for existing homes, though Efficiency Vermont also offers assorted rebates and incentives for Vermont homeowners: furnace fan motor rebate, fuel switch incentives, etc.
Duration of Program	Efficiency Vermont began offering HPwES in 2005.
Annual Budget	Approximately $2.5 million
Funding Source	Combination of an energy efficiency charge (EEC) on customers' electric bills, the Green Mountain Power Energy Efficiency Fund, and revenues from the Regional Greenhouse Gas Initiative and the New England Forward Capacity Market.
General Approach	Comprehensive market-based residential retrofit service.
Goals & Objectives	Continue sustained growth of the Vermont Home Performance with ENERGY STAR service • Complete between 600-750 home retrofits in 2010 and 800-1000 in 2011 • Increase quality and comprehensiveness of retrofit projects completed • Achieve the following unregulated fuels performance indicators: • Save 15,500 total MMBTUs in 2010 and 19,000 MMBTUs in 2011 • Increase average air leakage reduction per project • Increase percent of projects with at least 1500 sq. ft of insulation installed • Increase percent of projects with both shell and heating system measures
Cost Effectiveness Test Used	Societal Cost Test must exceed 1 at the level of each HPwES project.
Detailed Program Information	
Target Audience	Vermont homeowners (single-family)
Identifying Customers	Customers contact a certified HPwES contractor directly. Efficiency Vermont's marketing research indicates that the typical HPwES customer is an educated, older woman with disposable income, but our marketing efforts currently target a broad range of Vermonters.
Ensuring Capacity and Capability of the Workforce	Efficiency Vermont offers BPI certification courses and ongoing training and technical assistance to contractors that become active in the Vermont HPwES service. The program also partners with organizations that offer contractor training in other areas, such as installation techniques.
Working with Trade Allies	HPwES contractors are independent Vermont businesses, ranging in

	size from sole proprietors to 20 person crews. Efficiency Vermont offers a list of certified HPwES contractors, and customers are free to choose whichever contractor they prefer. Participating contractors are required to meet Efficiency Vermont and BPI standards, and in return are able to offer their customers access to retrofit incentives. Participating contractors also have access to marketing support and ongoing technical assistance from Efficiency Vermont.
Reducing Financial Barriers	Efficiency Vermont offers a financial incentive up to $2,500 per comprehensive retrofit project, including a $250 audit fee rebate upon completion of a substantial portion of the work. The average incentive ranges from $1,000 to $2,000 per project. Incentives are based on the actual improvements completed (e.g., percentage of air leakage reduction, square footage of insulation installed, etc). Details are available on the Web site.
Motivating Action through Marketing	The key marketing message used in the program is: "When you have a drafty home, you aren't just losing heat, you're losing money. Improving the energy efficiency of your home through Home Performance with ENERGY STAR can make you more comfortable - and save you up to 30% on your energy bills. Take advantage of new incentives from Efficiency Vermont with up to $2,500 in incentives for energy efficiency improvements completed by a certified Home Performance with ENERGY STAR contractor." To deliver that message, Efficiency Vermont uses a variety of marketing strategies: • Word-of-mouth (neighbor to neighbor visits, open homes, etc) • Traditional PR channels (radio, newspaper, etc) • Website & keyword search • Customer testimonials • Contractor marketing support (yard signs, "tell a friend" cards, advertising templates, etc.)
Verifying Savings	Participating contractors report their savings to Efficiency Vermont using a standard reporting format. Efficiency Vermont staff review the reported data and perform quality assurance on a percentage of completed projects. Claimed savings are based on deemed savings (electrical) and estimated savings based on engineering calculations (thermal). Savings are reviewed by the Vermont Department of Public Service during an annual savings verification process.
Implementation Strategies	HPwES is a market-based service, so participating contractors directly perform the energy audits and improvements. Efficiency Vermont's role is focused on building the market in terms of both contractor supply (through training and quality assurance) and customer demand (through incentives and marketing).
Evaluation	While Efficiency Vermont's services have been comprehensively evaluated, no formal evaluation of the Vermont Home Performance with ENERGY STAR service has yet been completed.
Major Changes in the Past Year	Efficiency Vermont has made a number of changes to HPwES in the past year: • Revamped incentive structure, changing from % of project cost to an incentive based on the installed measures • Made incentives consistent across the state • Revamped project process to empower contractors to make the

	incentive offer to customers • Developed a new web-based reporting tool • Developed a mutual fund approach to allocate costs to multiple funders • Increased incentives and program budget based on new funding sources dedicated to unregulated fuels efficiency (RGGI and FCM) • Ramped up quality assurance activities • Implemented new word-of-mouth based marketing strategies

Program Administrator Information	
Organization Name	Energy Trust of Oregon
Program Manager Contact	Diane Ferington, 503-445-7621, diane@energytrust.org
Organization Type	Energy efficiency and renewable energy program administrator for four investor-owned utilities in Oregon
Geographic Scope of Program	Customers of Portland General Electric, Pacific Power, NW Natural Gas, and Cascade Natural Gas
Web site	www.energytrust.org
General Program Information	
Program Name	Home Energy Solutions
Duration of Program	The program has been in place since 2002 and funding is secured by the Oregon legislature until 2020.
Annual Budget	The Home Energy Solutions electric budget is $11.96 million and the gas budget is $12.5 million, for a total of $24.5 million.
Funding Source	Public Purpose Funds
General Approach	Home Energy Solutions is a comprehensive program using test-in/test-out protocols that offers prescriptive rebates.
Goals & Objectives	The 2010 electric savings goal is 37.3 million kWh (4.26 aMW). The 2010 gas savings goal is 1.5 million therms.
Cost Effectiveness Test Used	Utility Cost Test and Societal Test (TRC). Measures must have benefit cost ratios over 1.0 for both tests unless there is a strong market transformation argument.
Detailed Program Information	
Target Audience	Consumers in single family homes (up to four units).
Identifying Customers	The program performs a segmentation based on income, education, values, etc. and overlays that with a geographic screen to ensure that other goals are met, such as greater rural outreach, bundling of measures, and reengaging past participants.
Ensuring Capacity and Capability of the Workforce	Home Energy Solutions requires certain quality installation standards, and Trade Allies must participate in program orientation training and submit insurance certificates that meet our requirements before becoming eligible for participation. The program also offers its own tailored trainings and helps offset costs of other trainings such as BPI, HPwES, Oregon Department of Energy for HVAC, CheckMe, Performance Tested Comfort Systems, Building Analyst, Envelope Professional, and Heating Professional certifications.
Working with Trade Allies	Industry partners include home retrofit companies and any solar contractors who have applied to be a Trade Ally, are serving Oregon customers, and are installing measures that qualify for the program's incentives. The Trade Ally contractors are the ambassadors in the field. Some of the main benefits of this approach include generating customer leads by being listed on the program's website and our cooperative advertising program.
Reducing Financial Barriers	Cash incentives are paid to homeowners for energy efficiency and renewable energy projects; the specific amount varies by measure.
Motivating Action through Marketing	The main marketing messages used in the program are comfort, saving energy, reducing costs, improving safety/health at home, reducing dependence on fossil fuel use, improving the environment.

	The specific messages are chosen based on the target audience. The number one marketing vehicle is utility channels (bill inserts, newsletters and Web sites). The program also use advertising (print, online, radio, and very rarely, television), its Web site, events such as home shows, and contractors to promote the program by word of mouth and via their marketing (supported by coop funds).
Verifying Savings	Home Energy Solutions has an annual true-up process where Energy Trust updates savings estimates with the best available information. This is organized by the Energy Trust evaluation department, which uses either in-house or a 3rd party contractor to conduct process and impact evaluations on all programs.
Implementation Strategies	The program utilizes a wide range of strategies for its different offerings. Largely, the Trade Allies perform outreach and installation of measures for the program.
Evaluation	The most recent process and impact evaluation reports are publicly available on the Energy Trust of Oregon Web site: • Volume 1 • Volume 2
Major Changes in the Past Year	HES is undertaking a new effort in 2010 with OPOWER involving sending out reports to a 60,000 sample of consumers detailing their home's energy usage and telling them how it compares to their neighbors. This has been reflected in increased savings assumptions in 2010. Additionally in 2010 Energy Trust is phasing out incentives for gas furnaces as part of its standard existing homes program, due to evaluations which indicate that the market has already been transformed. Additionally, in 2010 multifamily properties are now served under a commercial programs rather than the existing homes program.

Program Administrator Information	
Organization Name	New Jersey Natural Gas
Program Manager Contact	Bob Kudrick, Manager, 732-938-1290, rkudrick@njng.com
Organization Type	Utility
Geographic Scope of Program	New Jersey Natural Gas (NJNG) serves nearly half a million customers in Monmouth, Ocean, Middlesex and Morris counties.
Web site	www.njng.com www.savegreenproject.com
General Program Information	
Program Name	The SAVEGREEN Project™
Duration of Program	The program runs for one year (September 8, 2009 – September 31, 2010) with the potential to extend to 12/31/10.
Annual Budget	$16.7 Million
Funding Source	Ratepayer funded surcharge (separate from exiting statewide Societal Benefits Charge).
General Approach	Encourage and promote voluntary participation in NJCEP Home Performance with Energy Star (HPwES) home energy audit program, encourage customers to implement the recommended improvements, and use HVAC equipment replacement opportunities to assess other whole house opportunities.
Goals & Objectives	Encourage and promote installation of high efficiency heating equipment and the installation of additional energy conservation measures (weatherization improvements) to buildings.
Cost Effectiveness Test Used	All five cost benefits tests are performed by the NJ Center for Energy Economic and Environmental Policy (CEEEP).
Detailed Program Information	
Target Audience	Residential homeowners
Identifying Customers	This is done through direct outreach to customers and relationships with contractors.
Ensuring Capacity and Capability of the Workforce	NJNG hired and trained 10 internal auditors who have received their BPI Building Analysts and Envelope certifications. In addition, NJNG works to educate existing HVAC contractors on the energy and financial savings their customers will realize by upgrading equipment and taking advantage of rebates and incentives offered by program.
Working with Trade Allies	Trade allies include accredited NJ HPwES HVAC and Air Sealing & Insulation Contractors, non-BPI HVAC contractors, equipment distributors, retailers, and realtors. Trade allies are able to inform, educate and help disseminate information about NJNG's programs to their customers about available incentives and rebates.
Reducing Financial Barriers	1) Whole Building – NJNG will provide 0% financing up to $10,000 on balance for up to 10 years for eligible customers (on approved jobs through participating NJ HPwES contractors). NJNG also anticipates receiving authorization to fund the cost of the HPwES Tier II and Tier III incentives available under the NJCEP program for customers in its service territory. 2) For equipment replaced due to immediate or imminent equipment failure NJNG offers enhanced rebates of $900 for qualified WARMAdvantage furnace or boiler installations. This requires a

	HPwES Tier I Audit to be performed, with the cost funded by NJNG. This audit entitles the customer to (up to) $1,000 of air and duct sealing measures funded by NJNG and performed by NJ HPwES contractor.
Motivating Action through Marketing	NJNG is promoting the financial and energy savings associated with installation of high-efficiency equipment to existing customers and the benefits converting to natural gas to others. Please reference "Working with Trade Allies" and "Implementation Strategies" to see how NJNG is getting marketing message(s) to its target audiences.
Verifying Savings	Savings verification is integrated with the NJCEP HPwES and WarmAdvantage programs. They perform quality assurance and report project savings.
Implementation Strategies	See "Working with Trade Allies" above. NJNG also has a community outreach specialist who presents about the SAVEGEREEN program and its incentives to numerous organizations throughout the NJNG service territory, including but not limited to: municipal green energy programs/teams, League of Municipalities, Sustainable Jersey, Chambers of Commerce, local energy fairs, school groups, and county environmental commissions.
Evaluation	NJNG expects evaluation to be coordinated with NJCEP programs.
Major Changes in the Past Year	The program is in its first year and thus, no changes have been made.

Program Administrator Information	
Organization Name	Northeast Utilities
Program Manager Contact	Craig Clark, 860-832-4917, clarkca@nu.com
Organization Type	Electric and Natural Gas Utility
Geographic Scope of Program	Connecticut Light & Power service territory
Web site	www.cl-p.com/hes
General Program Information	
Program Name	Home Energy Solutions
Duration of Program	The program was launched in 2006 and will extend through 2012, though it will likely be offered past that date.
Annual Budget	$15 Million
Funding Source	Connecticut Energy Efficiency Fund (electric rate payer funds), augmented with funds from the CT gas companies, ARRA funding, and RGGI proceeds.
General Approach	Comprehensive program using test-in/test-out protocols that includes CFLs, domestic hot water, power monitors, appliances, HVAC, and insulation.
Goals & Objectives	Goals for 2010 include a savings target of 285,541 lifetime MWh and 9M lifetime hundred cubic feet of gas.
Cost Effectiveness Test Used	Only electric benefits are included.
Detailed Program Information	
Target Audience	All homes in the CL&P service territory. The program is fuel blind.
Identifying Customers	Leads are either generated by the utility or the approved Home Energy Solutions vendors.
Ensuring Capacity and Capability of the Workforce	The program has been ramping up to a total of 18 Home Energy Solutions vendors and 120 technicians. To do this CL&P sponsors quarterly utility trainings. A program requirement is that one technician on each job must be BPI certified.
Working with Trade Allies	The key trade allies for the program are regulators, contractors, residential building trades, and fulfillment vendors.
Reducing Financial Barriers	CL&P requires participants to make a $75 co-pay in order to receive an average of $700 in value from the direct install. The program is about to employ financing to encourage deeper energy retrofits.
Motivating Action through Marketing	Direct mail has worked the best for the Home Energy Solutions program. It now is piloting a discount coupon. The program also works with municipal green committees and is even working with the Girl Scouts in a grass roots approach. Over 85% of jobs still get done through word of mouth marketing.
Verifying Savings	The program relies on deemed savings, inspections, and test-in/test-out performance pricing ($1/CFM 50). A third-party evaluation is in progress.
Implementation Strategies	CL&P issues RFPs to the residential efficiency industry to obtain approved contractors and set pricing per measure.
Evaluation	In progress
Major Changes in the Past	Several tweaks have been made along the way, including launching a

Year	Home Energy Solutions Tier II in 2010 to address the deeper retrofit market.

Program Administrator Information	
Organization Name	New York State Energy Research and Development Authority (NYSERDA)
Program Manager Contact	James Reis, 518-862-1090, jfr@nyserda.org
Organization Type	Public Benefit Corporation
Geographic Scope of Program	Systems Benefit Charge territory in upstate New York and New York City
Web site	www.getenergysmart.org
General Program Information	
Program Name	New York Home Performance with ENERGY STAR® (HPwES)
Duration of Program	The program has been in place since 2001.
Annual Budget	$11.65 million for the Market Rate HPwES Program $10.8 million for the low-income HPwES Program These figures are based on a projected five-year budget.
Funding Source	Systems Benefit Charge
General Approach	Comprehensive energy efficiency program with test-in/test-out, including a priority on health & safety measures.
Goals & Objectives	The HPwES Program was designed as a market transformation program intended to make permanent changes in the role energy efficiency plays in the residential marketplace. Completed projects through HPwES are expected to save 26.1 million kWh over a five year period ending June 30th, 2011.
Cost Effectiveness Test Used	A Savings to Investment ratio of 1.0 or greater is required to qualify for the Assisted HPwES subsidy at the project level. Market rate HPwES jobs are not held to a cost effectiveness test at the project level. At the Program level, HPwES uses the Total Resource Cost (TRC) test.
Detailed Program Information	
Target Audience	Owners of single (1-4) family homes (demand-side), contractors (supply-side)
Identifying Customers	Participating HPwES contractors market themselves through a cooperative advertising incentive. The program uses regional marketing (print, TV, Radio, Web) and maintains a Web site.
Ensuring Capacity and Capability of the Workforce	NYSERDA works with a statewide network of training centers that provide Building Analyst, Envelope, Heating Specialist and Cooling Specialist training, as developed by NYSERDA. BPI certifications & accreditation are a program requirement.
Working with Trade Allies	New York's HPwES Program relies on a network of trained and accredited contractors throughout the State. These contractors perform the comprehensive home assessment, install the measures, and conduct the final test out. An implementation contractor provides technical assistance to home performance contractors. A quality assurance contractor provides third-party quality assurance testing on a percentage of homes.
Reducing Financial Barriers	Low interest loans or homeowner financing incentive (up to $3,000) are made available to homeowners for 10% of the cost of eligible measures or a 50% subsidy (up to $5,000) for 60-80% AMI or SMI, which may be combined with low interest loans.

Motivating Action through Marketing	"Save Energy! Save Money! Home Performance with ENERGY STAR can help you lower your energy bills & make your home safer and more comfortable." Marketing efforts include participation in home shows and consumer events throughout the state and conducting regionally targeted marketing (TV, Print, Radio, and internet) based on market activity in that region. Contractors receive cooperative advertising incentives for approved marketing materials.
Verifying Savings	NYSERDA competitively selected a third party evaluation contractor to establish a rigorous and defensible estimate of the energy savings that can be attributed to the program.
Implementation Strategies	Participating contractors complete a performance-based comprehensive home assessment (CHA) that uses advanced diagnostic testing equipment and energy modeling computer software. These tools help home performance contractors understand how well the home is functioning as a unit, which measures are most needed, and which measures, singly and in combination, will achieve a targeted level of cost-effective investment. Results of the CHA are used by contractors and households to prioritize and select measures for installation and to qualify householders for financing.
Evaluation	Market Characterization & Assessment, Impact Evaluation, and Process Evaluation.
Major Changes in the Past Year	None

Program Administrator Information	
Organization Name	Public Service Electric & Gas (PSE&G)
Program Manager Contact	Rachael Fredericks, 732-939-2401, Rachael.Fredericks@pseg.com
Organization Type	Electric and Natural Gas Utility
Geographic Scope of Program	PSE&G Service Territory / Urban Enterprise Zones
Web site	www.pseg.com/wholehouse
General Program Information	
Program Name	Whole House Efficiency Program
Duration of Program	Approved for 2009-2012
Annual Budget	$10 Million
Funding Source	Ratepayer funds and Regional Greenhouse Gas Initiative (RGGI) proceeds.
General Approach	Direct installation of cost effective measures as recommended by an energy audit and blower door test. The program includes a free energy audit and 8 hours of free air sealing for all participants. Incentive levels for other energy saving measures are based on household income. The program provides all benefits up front and customers repay their contribution on the utility bill over 5 years.
Goals & Objectives	Improve more than 15,000 homes in Urban Enterprise Zone municipalities. Leverage community partners to identify and recruit participants. Develop in-house energy efficiency expertise and deliver program services with the utility workforce. Create new job opportunities in energy efficiency.
Cost Effectiveness Test Used	Total Resource Cost test.
Detailed Program Information	
Target Audience	Residential electric and/or gas utility customers. Single family and multifamily residences with 4 or fewer units, both owner and renter occupied. Households above the income threshold for the low income programs. Mid to upper income households within Urban Enterprise Zone towns.
Identifying Customers	The program leverages relationships with community agencies to identify targeted customers within Urban Enterprise Zone areas. Community agencies and non profits market door to door and host events to recruit, income qualify, and schedule the first customer appointments. The program also utilizes direct mail in areas to augment community agencies or in areas not serviced by community agencies.
Ensuring Capacity and Capability of the Workforce	Audits and air sealing performed by utility workforce trained to perform this work by BPI certified trainers. Ongoing QA/QC.
Working with Trade Allies	BPI certified sub-contractors deliver any services not provided by utility labor.
Reducing Financial Barriers	The program provides a free audit and 8 hours of free air sealing. For all other services, the program covers 100% of all project costs up front with 0% on-bill repayment of customer investment over 5 years.

	Depending on the household income the customer will be responsible for either 50% or 20% of the total cost of energy savings measures beyond the free energy audit and air sealing.
Motivating Action through Marketing	The marketing messages are: "Free Services! Save money and save energy. Address health and Safety concerns."
Verifying Savings	To ensure energy savings calculations that are consistent from customer to customer and also consistent with the NJ Clean Energy Program Home Performance with Energy Star Program (HPwES), the program utilizes the same audit software approved by the NJ Board of Public Utilities for use by the NJCEP HPwES. In addition, ongoing QA/QC is done by internal supervisors and independent inspectors.
Implementation Strategies	The program began initial operation in the first quarter of 2009 in two cities, Newark and Trenton, the largest city in New Jersey and the state capital. In the summer operations were expanded to the remaining Urban Enterprise Zone municipalities in a phased approach as new employees were hired and trained and new community agencies were brought on board. The program is currently available in all 25 Urban Enterprise Zone municipalities.
Evaluation	An evaluation is scheduled for 2011.
Major Changes in the Past Year	In the third quarter 2009, two program changes were implemented: the income requirements for the 80% incentive were expanded from 300% to 400% of the federal poverty guidelines and the on-bill repayment period was changed from 2 years to a 5 years.

Program Administrator Information	
Organization Name	Vectren Energy Delivery
Program Manager Contact	Ohio: Bob Baird, 937-312-2541, rlbaird@vectren.com Indiana: Joan Evans, 812-491-4329, jevans@vectren.com
Organization Type	Utility
Geographic Scope of Program	Ohio: Dayton Ohio and surrounding counties within Vectren's service territory Indiana: Roughly the lower half of Indiana, excluding Indianapolis
Web site	www.vectren.com
General Program Information	
Program Name	Home Energy Savings Program
Duration of Program	The program launched in July/Aug 2009 and is a 5 year pilot program.
Annual Budget	Not provided
Funding Source	Ratepayer
General Approach	The program uses a test-in/test-out model and offers incentives for upgrades to weatherization and appliances.
Goals & Objectives	The objective is to reduce energy usage and to gather data to allow Vectren to fine tune the approach to the whole house concept so that the program has a better benefit cost ratio.
Cost Effectiveness Test Used	Total Resource Cost must be greater than 1 at the program level unless there is a social benefit aspect involved.
Detailed Program Information	
Target Audience	Residential customers in single family homes or condos.
Identifying Customers	The program targets customers with higher than average usage and in homes older than 1980.
Ensuring Capacity and Capability of the Workforce	The program is administered through a contractor, who manages the subcontracting, requires certifications, and provides training if needed.
Working with Trade Allies	This is done through the implementation contractor.
Reducing Financial Barriers	The incentive is from 50 to 70% percent of the project cost, depending upon the work performed.
Motivating Action through Marketing	Vectren uses a direct mail approach to marketing this program due to the limited participation the budget can sustain.
Verifying Savings	Deemed savings are used to estimate impacts, but the program will be evaluated to verify that expected savings are accurate.
Implementation Strategies	A program contractor is implementing the program and managing all subcontractors.
Evaluation	It has not been evaluated yet but will be in the future.
Major Changes in the Past Year	None

Program Administrator Information	
Organization Name	Wisconsin Focus on Energy
Program Manager Contact	Carter Dedolph, 608-249-9322 x315, carterd@weccusa.org
Organization Type	Efficiency Program Administrator
Geographic Scope of Program	Statewide in Wisconsin. Per legislation, all Wisconsin Investor Owned Utilities must participate in Focus on Energy and municipal and cooperative utilities may elect to participate or run their own similar programs.
Web site	http://www.focusonenergy.com http://www.focusonenergy.com/Residential/Home-Improvement
General Program Information	
Program Name	Home Performance with ENERGY STAR
Duration of Program	Full program implementation since 2001. No scheduled end date.
Annual Budget	Varies from year to year. As program information is updated, it is posted on the program Web site.
Funding Source	Public Benefit Funds
General Approach	Electric and natural gas program that provides a comprehensive whole house program with test-in/test-out requirements and prescriptive incentives.
Goals & Objectives	Energy savings (both electric and gas) is the primary goal. Focus on Energy has 12-month, calendar year goals. So every year, a new budget and energy savings goals are set. Additionally, Home Performance with ENERGY STAR helps homeowners care for their investment by making energy efficiency improvements that save money and increase the comfort, safety, durability and value of their home.
Cost Effectiveness Test Used	Focus on Energy has a portfolio-level goal, which utilizes the Total Resource Cost test. All residential, business, and renewables programs must meet a TRC of >1 when aggregated together. Individual programs are reviewed with the TRC as well, but all programs ultimately feed into the portfolio goal.
Detailed Program Information	
Target Audience	Dwellings with 1-3 units, though single-family homes are the major focus. Contractors and consultants are targeted to deliver this "free market" program.
Identifying Customers	Focus on Energy and Home Performance with ENERGY STAR put significant efforts into marketing via a numerous sources. To date, few targeted marketing efforts have been utilized, though that will likely change moving forward.
Ensuring Capacity and Capability of the Workforce	All consultants, contractors, and other trade allies have varying levels of requirements they must adhere to in order to promote their partnership with Focus on Energy. Continuing education requirements are set for some partners. Ongoing training is approved by Focus on Energy and offered through a variety of sources (e.g. the Energy Center of Wisconsin, Wisconsin Builders Association, etc.). For some partners certain certifications are required.

Working with Trade Allies	Contractors—largely HVAC and insulation installers—are the program's key industry trade allies. This is the group that completes the work recommended by the program's partnering consultants. As well, the trade ally group includes real estate agents, mortgage and bank representatives, and other "non-installing" organizations (e.g. the local Sierra Club chapter, etc.). The thought behind this is that it takes a village to make home energy retrofits happen.
Reducing Financial Barriers	Measure-level incentives are offered for a variety of shell measures at varying incentive levels. In addition, multiple measure incentives are offered and paid directly to homeowners. Financing is offered through Energy Finance Solutions (EFS). Homeowners must choose between the incentives and the financing; they cannot receive both. Post-test incentives are offered to consultants. An air sealing incentive is offered to trade allies.
Motivating Action through Marketing	The main marketing message is that Home Performance with ENERGY STAR helps with a home's comfort, safety, durability, and energy efficiency. This message is delivered via a number of mediums (e.g. radio, print, Internet, postcards, trade shows, etc.). Various staff also assist with the large number of speaker requests from around the state.
Verifying Savings	The program uses deemed savings set by Focus on Energy's third party evaluator. It also reviews paperwork associated with jobs and uses a robust quality assurance/quality control program.
Implementation Strategies	The program is implemented via free market providers. Partnering consultants conduct initial energy assessments (e.g. test-in process). Contractors and trade allies perform the work recommended by consultants. Then, consultants come back to test-out/verify work has correctly been installed. Once that verification is completed, consultants fill out appropriate paperwork for the homeowner, send in to Focus on Energy for processing, and a check is cut and sent directly to the homeowner.
Evaluation	The program has been evaluated by a third party. Most recent evaluations can be found online.
Major Changes in the Past Year	No major changes in 2009.

9 Appendix F: References and Resources

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