

Technology Focus

An update on technologies for energy and resource management prepared by the New Technology Demonstration Program



Comprehensive weatherization utilizes blower doors and other advanced diagnostic and implementation techniques.



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Single-Family Residential Building Weatherization

New technologies applied through a comprehensive, single-family weatherization program reduce energy use, improve comfort and health, and help meet energy reduction goals

Overview

Weatherization programs have successfully reduced the average overall energy consumption of existing single-family residential dwellings by 12% to 23% or more. Even if residential buildings have received prior energy-efficiency improvements, these levels of energy savings may still be achieved through a comprehensive weatherization approach while obtaining the added benefits of a more healthy indoor environment and improved indoor comfort.

What Is Comprehensive Weatherization?

Comprehensive weatherization is a whole-house approach to improving the energy-efficiency of an existing home. Under the whole-house approach, all the energy-impacting systems in the house are examined and improved simultaneously as needed. A whole-house approach ensures that no cost-effective opportunity to save energy in a building is lost. It also ensures that the package of conservation measures installed will work together in the most effective manner to reduce energy use and provide a healthy indoor environment. The energy-impacting systems examined under

a whole-house approach include the building shell (ceilings, walls, floors, windows, and doors), heating and cooling equipment (including its control system and the energy distribution system), ventilation systems, domestic hot water system, and lighting.

Why Is Weatherization Needed?

Weatherization reduces the energy use of existing single-family homes that are not slated for major revitalization or renovation. Because existing housing will likely represent the largest portion of the housing stock for many years to come, the energy deficiencies of existing housing must be addressed if energy improvement goals and mandates applicable to housing are to be met.

Weatherization not only reduces energy use and cost, but it also improves the health of occupants and the environment. Weatherization can reduce health risks from mold, radon, combustion by-products, and other contaminants. Additionally, weatherization can reduce noise, eliminate entry points for insects and other pests, and improve building durability by reducing moisture related problems.

Does Weatherization Really Work?

The U.S. Department of Energy (DOE) operates the Weatherization Assistance Program, the nation's largest residential energy conservation program. This program, designed for low-income families, conducts weatherization operations using almost \$400 million from multiple funding sources to weatherize approximately 200,000 low-income homes each year. Cost-effective savings of this program have been documented. State evaluations indicated that, in gas-heated homes, the program saves about 23% nationally and has a benefit-to-cost ratio of about 1.8. Some state evaluations report savings as large as 34%.

What if My Housing Has Already Been Weatherized?

Previous energy-efficiency improvements made to single-family housing may have only addressed some of the home's energy systems and likely did so one at a time. Energy-efficiency measures installed under this type of approach may not be performing as well as intended because of the complex interactions between building systems. It is likely that additional opportunities remain.

Diagnostic procedures, efficiency measures, installation techniques, and the overall understanding of building science have improved considerably in the 1990's. Homes weatherized as recently as five years ago can benefit from new knowledge in many areas such as air leakage control, duct leakage and its impact on backdrafting combustion appliances, and air conditioner operation.

What Are the Elements of a Comprehensive Weatherization Program?

A comprehensive weatherization approach begins with the careful identification of homes to be weatherized. Homes that have severe energy inefficiencies should be selected first to help provide the most energy savings and ease the process of initiating the program.

A thorough home energy assessment is performed next on each individual house to identify house specific deficiencies and opportunities. This assessment can take 2-4 hours per home. In instances where many units of the same type exist (e.g., in military family housing), home assessments may only need to be done on a sample of each type.

A thorough visual inspection is performed to document current efficiency levels of the building shell as well as installed equipment and lighting. Diagnostic testing on the building envelope and air distribution system is performed. This determines current leakage rates and sources of air leakage. Current operating efficiencies of installed heating and cooling equipment are gauged, and potential health related problems are

Elements of a Comprehensive Weatherization Program

- House selection
- House assessment
- Measure selection
- Measure installation
- Quality verification
- Occupant education (optional)

examined (e.g., from backdrafting or carbon monoxide production from combustion appliances).

After the assessment, the costs and energy savings for each possible energy conservation opportunity is identified and the cost-effective opportunities are selected. House repairs necessary for the proper performance of selected measures are also identified. For example, roof and wall repairs may be needed to protect insulation.

By considering a full range of conservation opportunities at the same time, the conservation measures selected for each house will work together as an optimum system to reduce energy use cost effectively and improve house performance. The National Energy Audit (NEAT) approved by DOE for use in its Weatherization Assistance Program is one example of a comprehensive audit tool available to help select appropriate conservation measures from among a wide range of possible options. DOE has compiled a directory of other building energy tools that may also be useful. The Resources section at the end of this Technology Focus provides information on how to obtain a copy of NEAT and access DOE's directory on building energy tools.

Once energy conservation opportunities are identified, experienced installers trained on the latest energy tools and techniques are needed to install the improvements. For example, crews equipped with blower doors and duct blowers are needed to effectively seal air leakage sites in the building envelope and ducts. Installers of gas-fired heating systems must install and tune them while making



A duct blower is used by house inspectors and installation crews to identify and seal leaks in air distribution systems.

flue-gas analyses and carbon monoxide measurements. Air conditioners and heat pumps must be installed and adjusted based on refrigerant superheat and subcooling measurements.

Experienced and conscientious installers are also needed to perform more traditional measures such as attic and wall insulation. Poor installation of measures is a common occurrence that can be avoided through careful selection of contractors. Poorly installed measures do not save energy as intended and can adversely affect other systems in the house.

Verification of measure installation and performance is the final necessary step to ensure that systems are operating as intended. Such commissioning provides an opportunity for the weatherization program and contractors to improve their practice. Commissioning includes

inspecting contractor work and using available energy use data to confirm expected savings.

Occupant education can be a complementary element of a comprehensive weatherization program. Occupants ultimately operate the energy systems installed in the house and thus have significant impact on energy use. Occupant education instructs people in the proper operation and maintenance of new or existing energy systems so that the full potential of these systems is realized. Topics frequently covered in occupant education include filter changing, thermostat operation, strategies to reduce cooling load such as closing window shades, and use of whole-house fans and ventilation systems.

How Can a Weatherization Program be Implemented?

The DOE Weatherization Assistance Program exemplifies a process for implementing a comprehensive weatherization program. Sources of additional information on this program are provided in the Resources section.

Guidance on how to implement such a program, as well as opportunities available in energy education and improved maintenance, are detailed in two documents developed for the U.S. Air Force and U.S. Army (see the Resources section for information on how to obtain these guides). A Retrofit Guide provides a workable framework within which to structure the various parts of a comprehensive weatherization program, as well as helpful suggestions and sample contract language to develop and carry out the program. The guide addresses

how to hire building energy consultants to perform audits and select measures and installers to perform the recommended energy conservation opportunities. An Inspection Field Manual identifies the important energy-efficiency features that an inspector should examine during field inspection and defines a correct or “standard-of-practice” installation for the inspector.

Can Weatherization be Performed as Part of an Energy Savings Performance Contract?

FEMP is currently developing Super Energy Savings Performance Contracts (ESPCs) to facilitate the installation of energy-efficiency measures. These Super ESPCs reduce the time required to implement an ESPC project from years to months. Projects are implemented by issuing delivery orders against existing Super ESPCs. Contact information to learn more about FEMP's ESPC Program is provided in the Resources section

A comprehensive weatherization program could be implemented under a “general purpose” Super ESPC program being developed for the various regions of the U.S. However, the customized diagnosis and installation activity required to weatherize housing is not typical of the commercial-style performance contracting addressed by these “general purpose” Super ESPCs. Consequently, FEMP plans to develop a “technology-specific” Super ESPC specifically for housing weatherization.

A weatherization program could also be implemented in conjunction with a utility program and could use the expertise of the local providers of the DOE Weatherization Assistance Program for many of the implementation steps.

Resources

National Energy Audit (NEAT). NEAT was developed by the Oak Ridge National Laboratory for the U.S. Department of Energy. The software can be ordered through the Energy Science and Technology Software Center (ESTSC), P.O. Box 1020, Oak Ridge, TN 37831-1020, (423) 576-2606, Fax: (423) 576-2865, E-mail: estsc@adonis.osti.gov. A description of the software is provided at an Oak Ridge National Laboratory web site: www.ornl.gov/divisions/energy/oscp/Neatmhea.htm. For further information contact Oak Ridge National Laboratory, Buildings Technology Center, P.O. Box 2008, Oak Ridge, TN 37831-6070, (423) 574-4506.

Building Energy Tools. U.S. Department of Energy, Office of Building Systems, EE-41, 1000 Independence Ave. SW, Washington, DC 20585, (202) 586-9445, web site: www.eren.doe.gov/buildings/tools_directory.

Weatherization Assistance Program. U.S. Department of Energy, Office of State and Community Programs, EE-44, 1000 Independence Ave. SW, Washington, DC 20585, (202) 586-4074, web sites: www.eren.doe.gov/buildings/state_and_community/weather.html and www.energy.wsu.edu/org/waptac.

Retrofit Guide for Military Family Housing: Energy-Efficient Weatherization and Improvements and Housing Energy-Efficiency Inspection: Field Manual. These guides were developed by the Oak Ridge National Laboratory for the U.S. Air Force and U.S. Army. These guides are included on the military's Construction Criteria Base (CCB) and are also located at the following Oak Ridge National Laboratory web site: eber.ed.ornl.gov. Copies may also be obtained from Headquarters United States Air Force, Office of The Civil Engineer, Housing Division and Air Force Civil Engineer Support Agency, Civil Engineer Technical Support. For further information, contact Oak Ridge National Laboratory, Buildings Technology Center, P.O. Box 2008, Building 3147, Oak Ridge, TN 37831-6070, (423) 574-0749.

Super Energy Savings Performance Contracts. U.S. Department of Energy, Federal Energy Management Program, EE-90, 1000 Independence Ave. SW, Washington, DC 20585, (202) 586-5772, web site: www.eren.doe.gov/femp/financing.html.



For More Information

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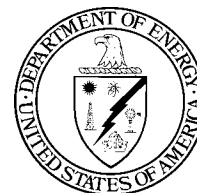
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