SHOPWARE

Instructor's Guide

Residential Energy Efficiency Projects

Conducting a Home Energy Audit • Installing a Solar Electric System • Installing a Solar Hot Water System • Upgrading a Forced Air Furnace • Air Sealing and Insulating

Program Summary

After watching this series, the viewers will be able to explain the methods and materials used to:

- evaluate a home to identify energy savings opportunities
- properly insulate a home to reduce energy loss
- add a solar electric system to a house
- add a solar hot water system to a house
- upgrade a forced air furnace for energy savings

Preview activities

- Discuss the local weatherization program with the development agency that performs upgrades
- Visit a house where weatherization measures, such as insulation, are being installed
- Invite an architect in to talk about green building for new homes or renovations
- Invite a contractor in to talk about the work they do in solar or heating/cooling
- Review the Energy Star for New Homes program to become familiar with current trends and requirements in new homes
- Participate in a solar tour or green building tour or site visit organized by the local ASES or USGBC chapter

Vocabulary

AC, alternating current – is the flow of electrons in reversing directions. The electrical grid in the U.S. reverses direction 60 times per second.

AFUE, annual fuel utilization efficiency – is a measure of efficiency for combustion heating equipment. It represents the true, overall efficiency, including non-peak operation. A higher AFUE indicates greater efficiency.

Air barrier – is the border between the outside and the inside environment that stops the flow of air. The air barrier should be completely sealed and continuous to prevent air infiltration.

Blower door – is a tool that is used in weatherization and home performance testing. It consists of a large fan, a frame to mount it in and controls for the fan. The blower door exaggerates the air leak in a house by moving more air through the openings with the assistance of the fan.

Boiler – is a piece of equipment in which a fluid such as water is heated. When used for heating a home, the heated water circulates to radiators to deliver heat to the heated spaces.

BTU, British thermal unit – is a unit of energy needed to heat one pound of water by one degree Fahrenheit.

BTU/hr – is an expression of power in heating and air conditioning. An air conditioner or furnace will be sized by its power requirements as BTU per hour.

Bypass – in weatherization and energy efficiency, is a crack, gap, or hole around doors, windows, plumbing stacks, duct chases, and wiring that penetrate the ceiling and/or the floor. Sealing these locations will reduce unwanted air infiltration.

CFM – cubic feet per minute, is measurement of flow commonly used to describe air flow in delivery and ventilation.

Combiner box – is an electrical box that serves to parallel the output of several series strings of solar modules.

Crawl space – is an area in the basement or below the first floor that does not have enough space for a person to stand up, but where one can only crawl around.

DC, direct current – is the flow of electrons in one direction.

EER, energy efficiency ratio – is the ration of output cooling in BTU per hour to electrical power in watts. The higher the EER, the more efficient a unit is.

ERV, energy recovery ventilators – like HRV provide mechanical ventilation and energy exchange between incoming and outgoing flows. The major difference is that ERVs transfer humidity of the exhaust air to the incoming air.

Flashing – refers to a device used to prevent the passage of water into the structure.

Furnace – is a piece of equipment used for heating spaces. A forced air furnace uses a fuel such as propane, natural gas, or electricity to heat air and send warm air to the heated space through ducts.

Heat exchanger – is a piece of equipment that transfers heat from one medium to another.

HRV, heat recovery ventilation – is a method of mechanical ventilation that removes heat from exhausted air to apply it to incoming fresh air.

Infrared camera – produces an image that shows relative thermal values and surface temperatures. It is used to detect energy loss in home performance and weatherization diagnostics.

Insulation – slows heat flow into or out of a house. Its effectiveness at stopping heat flow is measured by its R-value.

Inverter – is the electronic device that converts direct current electricity into alternating current electricity.

Knee wall – is a short wall on the top floor that supports the rafters.

KW, kilowatt – or 1000 watts is a measure of electrical power.

Latitude – is a measure of that indicates how far north or south a location is.

Longitude – is a measure of that indicates how far east or west a location is.

Manual J – is a protocol used to determine heating and cooling loads established by ASHRAE, the American Society of Heating, Refrigeration, and Air-Conditioning Engineers.

Rafter, or roof rafter – is one of the sloped beams that supports a roof. It typically runs from the top of the wall to the ridge of the roof.

R-value – is the measure of a material's ability to resist the flow of heat. The higher the R-value, the greater the resistance it provides to heat loss.

SEER, seasonal energy efficiency ratio – is the ratio of cooling in BTU provided by a unit to the electrical energy consumed in watt-hours evaluated over an average of an entire season. The higher the SEER, the more efficient a unit is.

Sheathing – is a layer of material, such as OSB (oriented strand board), that is applied to the outside of the studs or rafters to strengthen the building. Exterior waterproofing materials such as siding or roof shingles are applied to the sheathing.

Solar collector – Devices that generally include glass and a frame that are designed to absorb heat from the sun into some sort of fluid such as water or antifreeze solutions. They are available in many styles such as flat-plate collectors, batch systems, and evacuated tube collectors.

Solar heat gain coefficient (SHGC) – describes the fraction of solar radiation that passes through a window, door, or skylight. The lower the number, the less solar heat it transmits.

Solar module, or solar panel – is the assembly of glass and solar cells, encapsulated and held in an aluminum frame. Solar modules are described with electrical parameters such as watts, volts, and amps.

Solar photovoltaic (PV) modules – or panels, contain cells that when exposed to sunlight, generate an electric current.

Solar thermal energy – refers to heat from the sun. The sun's heat can be used to heat water or air. Solar thermal energy can also be used to create electricity.

Storage tank – in a hot water system provides a location to store heated water.

Stud – is a vertical member in a wall that is meant to support the wall and offer a place to attach drywall. Studs are typically installed between a bottom and a top plate which run horizontally.

Thermal barrier – is the assembly of materials that are designed to slow down the transfer of energy. This typically includes insulation.

Truss – is an engineered roof support system that arrives and is installed as one assembly. Trusses are available in a variety of shapes.

U factor – is the rate at which a window, door, or skylight conducts non-solar heat flow. Expressed as Btu/hr-ft2-F. It is the reciprocal of R-value.

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Weatherization – is the group of practices that help protect a building from the elements, particularly the heat and the cold as well as from moisture and wind. In protecting the building, the energy requirements are reduced.

Assessment questions

1. Name two typical places where air infiltration takes place.

2. What are some ways to increase R-value?

3. How is a blower door used in an energy audit?

4. What are the typical places where insulation is installed in existing homes?

5. What materials are used to seal holes in the building envelope?

6. Name some obstructions that can reduce solar output.

7. What is the role of the inverter?

8. Describe how the support hardware for solar collectors and solar modules are attached the building.

9. Name a few ways that you can find the rafters.

10. Describe the path of the collection fluid in a solar hot water system.

11. What factors are important in selecting a pump for the solar hot water system?

12. How do you determine the size of the furnace required?

13. Why should joints in ductwork be sealed?

14. Which test will guarantee that a new furnace exhausts properly?

15. A programmable thermostat helps save energy by:

Assessment questions answers

1. Name two typical places where air infiltration takes place.
   - Plumbing chases in basement and attic
   - Wiring chases in basement and attic
   - Duct work chases in basement and attic
   - Recessed lights
   - Near chimneys
   - Doors
   - Windows
   - Holes in walls at outlets
   - Holes in exterior wall for mechanical penetrations
   - Attic hatch

2. What are some ways to increase R-value?
   - Blow additional insulation in walls or attic
   - Add rigid insulation material to outside walls
   - Install batt insulation

3. How is a blower door used in an energy audit?
   - Find how leaky a house is
   - Determine the location of air leaks that require sealing
   - Test before and after any improvements are made

4. What are the typical places where insulation is installed in existing homes?
   - Blown into attics on top of ceiling
   - Blown into attic between rafters
   - Blown into walls between the studs
   - Batts in walls
   - Batts in attic
   - Rigid board insulation on outside of walls
   - Rigid board insulation on top of roof
   - Rim joist area above foundation wall
   - At the foundation wall, sometimes, inside or outside

5. What materials are used to seal holes in the building envelope?
   - Caulk
   - Spray foam
   - Weatherstripping

6. Name some obstructions that can reduce solar output.
   - Chimneys
   - Trees
   - Other buildings
   - Utility poles and wires
   - Plumbing stack and other vents
   - Dormers

7. What is the role of the inverter?
   - The inverter converts direct current electricity to alternating current electricity. A grid-tie inverter also synchronizes with the grid.

8. Describe how the support hardware for solar collectors and solar modules are attached the building.
   - The rack is usually anchored into the rafter, not the sheathing, of the roof. This might be an anchor bolt that is 4-5 inches long. This anchor has some kind of flashing installed that prevents leaks in the roof at that attachment point.

9. Name a few ways that you can find the rafters.
   - Hammer test
   - Infrared camera
   - Measurements inside the attic

10. Describe the path of the collection fluid in a solar hot water system.
    - Solar heated fluid circulates from the collectors to the heat exchanger. The heat exchanger transfers the heat content to the storage tank. The circulating fluid returns to the collectors again now at a lower temperature and ready to absorb more heat.

11. What factors are important in selecting a pump for the solar hot water system?
    - Type of fluid
    - Amount of flow
    - Size of pipes
    - Volume of fluid
    - Location of storage tank and collectors

12. How do you determine the size of the furnace required?
    - Manual J calculation provides guidance on proper sizing of a furnace.

13. Why should joints in ductwork be sealed?
    - Sealed ducts reduce air leakage and send conditioned air to the desired location. If ducts leak severely, energy is used to heat the air but it never reaches the destination. As a result of sealing the ducts, the furnace should not run as long or as often also.

14. Which test will guarantee that a new furnace exhausts properly?
    - Combustion safety/back draft test

15. A programmable thermostat helps save energy by:
    - Setting the temperature lower/higher when the occupants are sleeping or away from home. This uses less energy to heat/cool when there are no occupants.

Other Resources

Affordable Comfort, Inc. (www.affordablecomfort.org) is an educational resource for the home performance industry. ACI organizes regional and national conferences.

Building Performance Institute (www.bpi.org) administers certifications for people working in the home performance industry.

Energy Star (www.energystar.gov) sets standards for new homes as well as appliances. Offers webinars and educational materials.

Green Building Advisor (www.greenbuildingadvisor.com) addresses building and remodeling green homes.

Home Power Magazine (www.homepower.com) covers nearly all things energy for the home with technical coverage of solar, wind, hydro, efficiency, vehicles, and more.

Residential Energy Services Network (www.resnet.us) administers certifications for people working in the home energy assessment field.

Other Titles from Films Medis Group

Green-ovating: Home Renovations for a Sustainable World
Spotlighting the best practices, technologies, and materials available to residential remodelers and builders, this four-part series shows how existing homes can be transformed to improve energy efficiency, eco-friendliness, livability, and sustainability while enhancing the health and well-being of their occupants. Remodeler and builder Robert Post accompanies leading designers, builders, landscape architects, and other practicing green professionals to working jobsites where they discuss and illustrate the practical application of green principles to every aspect of remodeling and renovation. **Correlates to all National CTE Organizational Standards (including the provisions of the Perkins Act)**. Viewable/printable discussion questions are available online. A Shopware Production. 4-part series, 38-42 minutes each.

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DVD (Chaptered) ISBN 978-1-61616-042-5

More Than a Box with Windows:
Schluter Headquarters—A Case Study in Green Design and Construction
Building green: that was the goal of Schluter, a company specializing in tile installation systems. It wanted its new Canadian headquarters to be low impact, energy efficient, comfortable to work in, and a showcase for tiles. This documentary narrated by energy conservation specialist Jon Eakes explores the science that went into the design and construction of the award-winning, LEED Gold-certified building while explaining why the integration of green systems is essential to making an office that is ecologically responsible. "A common misconception about sustainable design," says Sustainable Architecture & Building Magazine, "is that it may be complicated, or that it is not worth the investment. However this project clearly proves that intelligent, environmentally aware decisions can produce systems that are simpler to operate, and a building that is much more economical in the long run." A film by Richard Burman. **Portions in French with English subtitles**. (59 minutes)

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DVD (Chaptered) ISBN 978-1-61753-886-5

Residential Construction Framing
Residential framing combines the construction of floors, walls, ceilings, and a roof to create the skeleton of a home. Shot on location at an active building site, this four-part series gives detailed, step-by-step instructions for framing a house, built one story at a time. Along the way students learn OSHA-approved jobsite safety guidelines and special "Tool Tips," along with "Green Tips" for extra efficiency, savings, and sustainability. A viewable/printable instructor's guide is available online. A Shopware Production, in conjunction with the National Association of Home Builders Production Unit. 4-part series, 8–13 minutes each.

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DVD (Chaptered) ISBN 978-1-61753-493-5

Passive Passion: Buildings Doing More with Less
In 1990 European physicists set out to test the limits of cost-effective energy efficiency. The result was the first passive house, a four-unit townhouse that combined heavy insulation, airtightness, and heat-recovery ventilation to achieve reductions of up to 90 percent in the energy required for heating and cooling. This program introduces the passive house concept—popular in Europe, but slower to catch on in the States—and showcases some beautiful examples in Austria and Germany. Viewers meet co-originator Wolfgang Feist, who explains the mechanics behind the design; Henry Gifford, who hopes to popularize it in the U.S.; and Dieter Roskoni, who still lives in the first-ever passive house. (22 minutes)

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OSHA Construction Safety Video Clip Collection

Every year, more than 800 construction workers in the U.S. lose their lives while on the job, and approximately 31,000 suffer serious injuries. As tragic or debilitating as these cases are, the reality is that they are also preventable. This video compilation uses powerful animated sequences to show how such hazards occur, and how close attention to OSHA safety standards can protect lives and livelihoods going forward. With an average length of three minutes, each clip focuses on a particular work setting and can be presented in stand-alone fashion or in conjunction with other clips. Scenarios focus on fall prevention, carbon monoxide poisoning, struck-by accidents, and excavation safety. The animation does not graphically depict bodily injuries, but each clip presents a true record of an actual accident. Viewer discretion is advised. (37 minutes)

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Fax: 1-800-678-3633
E-mail: Custserve@Films.com

Shopware, an Infobase Learning company
132 West 31st Street
17th Floor
New York, NY 10001

