Investigating Home Energy Waste During Weatherization Week

LESSON PLAN

Age Level: 12 - adult. (The activity can be shortened and simplified for younger students.)

Activity time: 60-90 minutes

Objectives:

- Shadow a home energy advisor during an energy assessment to learn about basic thermodynamics and building-science concepts and recognize common areas for improvement identified during a home energy assessment
- Learn about the energy assessment process and then use hands-on tools to explore a home or classroom space and identify opportunities for reducing energy waste.
- Increase community engagement and educational outcomes from a Weatherization Week, can be modified to suit all ages.

Learning Outcomes:

- Participants will be able to apply thermodynamics and building science concepts to elements of everyday life and home energy use
- Participants will be able to identify examples of conduction, convection, and radiation in a home or classroom
- Participants will understand the basics of the stack effect (i.e. warm air rises, pulls cold air in through leaks)

Materials

- Infrared camera
- Thermal leak detector
- Clipboard
- Pen/Pencil
- Kill-a-watt meter (optional)
- Blower door (optional)
- Building Envelope and Heating and Cooling Systems worksheet (optional)
- Camera or smart phone (optional)

Resources

- Community Energy Action Teams (CEAT) curriculum binder, Island Institute
- Step One: Picking the Low-Hanging Energy Fruit, Charlie Wing
- Energy Saver: Tips on Saving Money & Energy at Home, US Department of Energy
- Air Sealing and Insulation, Efficiency Maine

Procedures

1. Activity prep (optional): Review "Introduction to the Thermal Leak Detector" and "Intro to Infrared Imaging" and complete "Identifying Air Leaks in Homes" worksheet with participants (see Community Energy Action Teams curriculum binder)
2. Activity leader reviews background information including energy consumption in homes, methods of heat transfer (conduction, convection, and radiation), common areas of heat loss, definition of weatherization, and common weatherization techniques. (10-15 minutes)
3. Activity leader and/or home energy advisor demonstrates how to use energy analysis tools including thermal leak detector, infrared camera, blower door (optional), and kill-a-watt meter (optional) and then demonstrates common air sealing tools and materials including caulk, spray foam, weather stripping, etc. (15-20 minutes)
4. Activity leader and/or home energy advisor leads a brief walkthrough of home to investigate air leaks and common areas of energy loss including doors (weather stripping), windows (trim and seals), attic access, pipe/plumbing chases, fireplaces and chimneys, basement walls and/or foundations, basement access (doors, bulkheads, etc.), ducts, walls, and more. Students will have an opportunity to take measurements using the tools. (20-30 minutes)
5. Participants break up into teams of 2 or 3 to record their observations about areas of energy waste and their recommendations for the top 3 improvements that the homeowner could make to save energy and reduce waste. OPTIONAL: Have participants take photos of areas of energy waste with a smart phone or the infrared camera (15 minutes)
6. Group reconvenes and completes assessment discussion

Modifications

If time permits, incorporate electrical energy use and waste by using the kill-a-watt meter and the lighting audit worksheet. For a more in-depth walkthrough of the house, use the Building Envelope and Heating and Cooling Systems worksheet which provides a list of questions to ask when collecting data about a building (home or business).

Assessment

Participants present their observations and recommendations in class (with photos if possible).

Discussion questions could be presented as a trivia / jeopardy game. Students can use notes from earlier:

- Where did you observe the most air leakage in the home? What was causing this leak?
- What could you use to fix this leak?
- Identify examples of *conductive*, *convective*, and *radiative* heat loss (or gain) in the house.
- Explain how one of the energy analysis tools helps to identify energy waste in the house.
- What was the most *surprising* thing that you learned during the activity?

Additional questions:

- How does weatherizing a home help fight climate change and other kinds of pollution?
- What is weatherization?
- Why is it important on islands?
- What are 3 benefits of weatherizing?
- Who can explain how the IR camera works?
- Who pays for your heat at home?
    - Is the school's heat free? Who pays for the school's heat?

Answer sheet

Where did you observe the most air leakage in the home? What was causing this leak?

What could you use to fix this leak?
Examples: Caulk, spray foam, weather-stripping.

Identify examples of *conductive*, *convective*, and *radiative* heat loss (or gain) in the house.

- *Conductive – Cold walls or windows (heat transfer across a surface or through a material)*
- *Convective – Air leaks are all examples of convective heat loss – cold air moving around windows, doors, etc.*
- *Radiative – Feeling cold sitting under a window, feeling warm in front of a wood stove*

Explain how one of the energy analysis tools helps to identify energy waste in the house.

What was the most *surprising* thing that you learned during the activity?

How does weatherizing a home help fight climate change and other kinds of pollution?
Reduces energy use and waste, lowers a home's carbon emissions

What is weatherization?
Weatherization refers to a number of different processes that improve the thermal envelope of a building, increasing its ability to hold heat and prevent cold air to enter; Improving heating efficiency by reducing air leakage and improving insulation in a home or other building.

Why is it important on islands?
Island communities pay a higher price for heating fuels in general. This means that inefficient, leaky homes cost more to heat than they would if they were on the mainland. It also means that islanders stand to save much more money by weatherizing, as the expense they avoided is larger. Islands also have cold, stormy winters, making a weatherized home very important for comfort. Islands are starting to experience the impacts of climate change, so reducing our carbon emissions is very important.

What are 3 benefits of weatherizing?

1) *Increasing comfort*
2) *Saving money*
3) *Reducing carbon emissions / the effects of climate change*

Who can explain how the IR camera works?
Heat gives off infrared (IR) light, which humans cannot see with the naked eye. Different temperatures provide different IR frequencies. The IR camera is able to "see" different IR frequencies, and assigns them colors so humans can interpret them. We can use it to spot leaky sections of walls, floors, or ceilings. It is even used by firefighters to locate fire without entering a building!

Who pays for your heat at home?
Your family, or your landlord, likely pays for your heat at home.

Is the school's heat free?
No!

Who pays for the school's heat?
The tax payers support the school's budget, and the school contracts for their heat.

Standards that could be incorporated:

MS-PS3-3.

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

MS-ESS3-3.

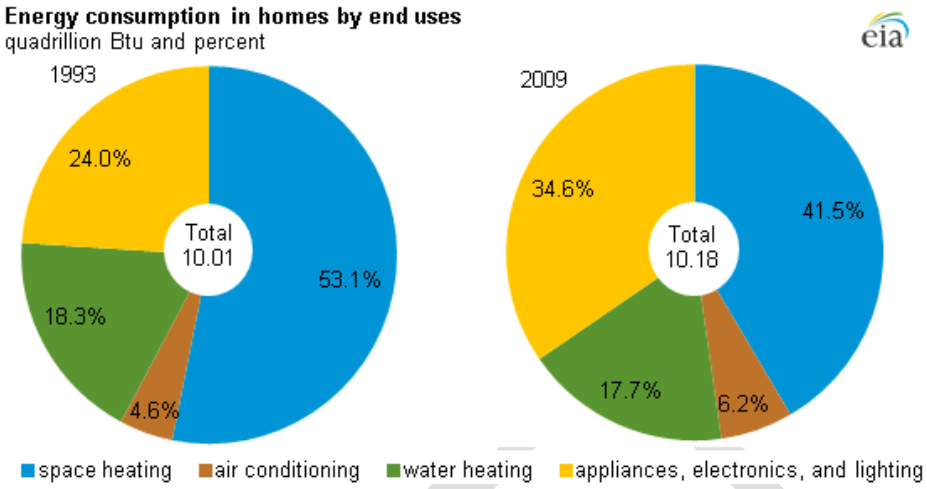
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. *[Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ESS3-4.

Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

Background Materials

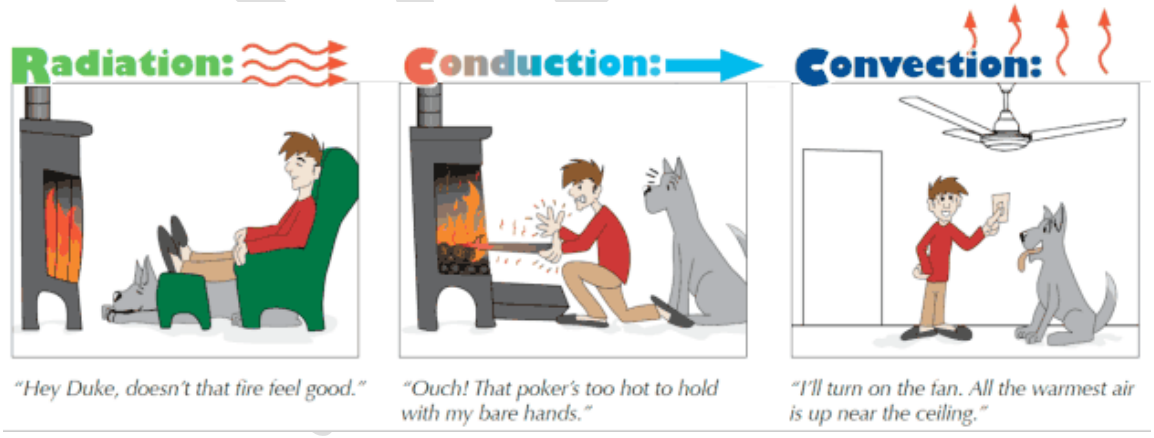
Home Energy Use: Space heating and appliances/electronics/lighting are the two primary sources of energy use in US homes. Collectively, homes consume 22% of the energy used throughout the country.



Source: US Energy Information Administration, Residential Energy Consumption Survey 2009

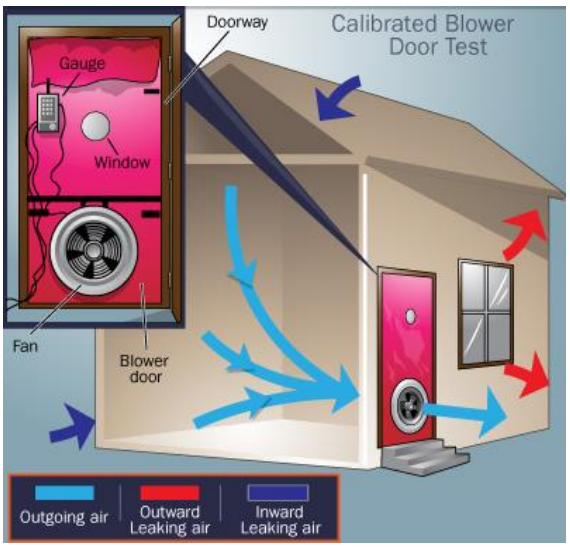
Heat Transfer

Heat energy is transferred through three different processes: **conduction, convection**, and **radiation**. Conduction is the transfer of heat energy from one substance to another through direct contact (e.g., touching a hot surface). Convection is the transfer of heat energy through a fluid (liquid or gas) caused by molecular motion (e.g., a fan blowing warm air). Radiation is the transfer of heat energy through waves, rays, or particles (e.g., warmth radiating from the sun or a wood stove). Source: ME Mechanical, Modes of Heat Transfer

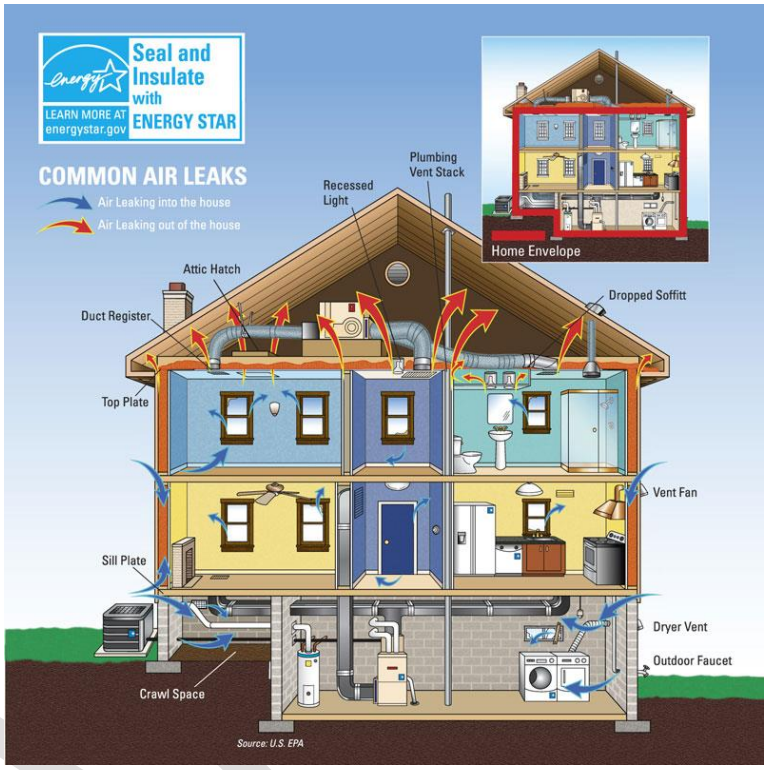


Source: Dr. Energy Saver Home Services, How Insulation Works, or Doesn't

Assessing Air Leaks

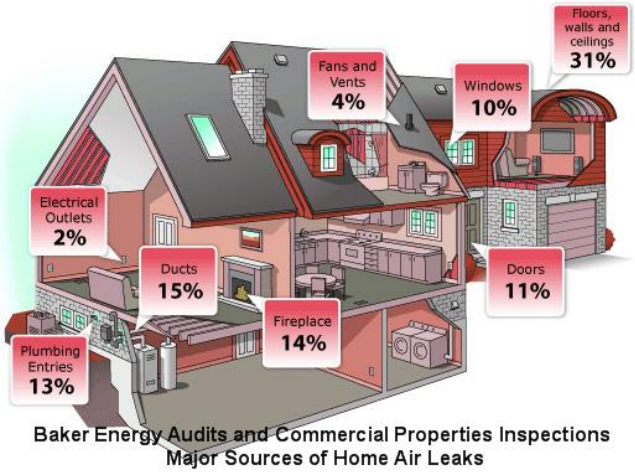


A blower door pulls air through a house, exposing air leaks. Source: How Stuff Works.



Air leaks are common around windows, doors, and anywhere where piping or wiring enters the house from outside. Attics and basements are the most common places to find air leaks and insulation issues, so home energy advisors (also known as energy auditors) will often focus on those areas of the home. Air leaks, along with missing insulation, can be identified through an **energy audit** (sometimes called an energy assessment). During this process, a certified professional will spend an hour or more investigating your home, using a blower door, infrared camera and other tools to understand how air (and therefore heat) moves throughout your home. The **blower door** helps to determine a home's air tightness. It uses a powerful fan that mounts into the frame of an exterior door and then pulls air out of the house, lowering the air pressure inside. The higher outside air pressure then flows in through all unsealed cracks and openings. A blower door measures air leakage in cubic feet per minute at 50 pascals of pressure, or CFM_{50}. Each 1,000 CFM_{50} of air leakage is *roughly* equivalent to a one square foot hole in the side of a house or a one square foot window left open.

Weatherizing a home by sealing air leaks and improving insulation is one of the best ways to reduce energy waste. In a leaky home, small air leaks can let as much air escape as an open window! Basic air sealing can help reduce heating fuel use, in a typical Maine home by about 15%. Lower your heating fuel use helps save money and reduce pollution that causes climate change and health problems like asthma. It's a win-win-win!



Baker Energy Audits and Commercial Properties Inspections
Major Sources of Home Air Leaks