Unit 2 – Energy Efficiency

Objective

Each student will learn several techniques which are used to make a building more energy efficient. Students should understand how they can effectively contribute to the efficiency of the buildings they work and live in.

Skills

Each student will gain the following skills from this unit:

a. Identify green alternatives to conventional building practices.
b. Identify specific green practices that can be implemented in work and in personal lives.

Instructor Preparation

Study Unit 2 – Energy Efficiency and consider how best to present the principles taught in the unit. This unit may be best taught near the latter end of the training so that other work-related activities may be used as examples for implementing sustainable work practices. Consider ways to encourage discussion and personal experiences.

Materials & Equipment

It is suggested that each classroom be equipped with the following:

- Various Caulk Guns
- Window Insulation
- Programmable Thermostat
- Water Saving Shower Heads
- Various Light Bulb Choices

Suggested Unit Development

Have the students read, in turn, the following paragraphs. Allow time for discussion. Consider questions which help the students resolve potential scenarios which they may face in the workplace. This unit is very effective if taught in conjunction with the lab. Show the students how to actually perform the processes taught in this unit.

6.2.0 Weatherization

For our discussion, we will mostly focus on less controversial things and very inexpensive things that you can do right now that will have an instant impact: Weather stripping and caulking. In fact, some of the simplest things we learn will lead to the greatest dollar savings. A great example is insulating windows and doors which costs very little and can save up to half of the home's heating costs.

If you feel around the windows and wall sockets of your home, you will find places where a draft enters the home. Try this on a windy day and see how many you can find. Was there some space around a storm window, a crack in the window, or a loose frame? Even the tiniest crack is big enough for the wind to find its way in. As cold air comes inside, you pay more to heat the house. The U.S. Department of Energy gives advice on doing your own home energy audit.

6.2.1 Do-It-Yourself Home Energy Assessments (US DOE)

You can easily conduct a do-it-yourself home energy assessment (also known as a home energy audit). With a simple but diligent walk-through, you can spot many problems in any type of house. When assessing your home, keep a checklist of areas you have inspected and problems you found. This list will help you prioritize your energy efficiency upgrades.

6.2.1.1 Locating Air Leaks (US DOE)

First, make a list of obvious air leaks (drafts). The potential energy savings from reducing drafts in a home may range from 5% to 30% per year, and the home is generally much more comfortable afterward. Check for indoor air leaks, such as gaps along the baseboard or edge of the flooring and at junctures of the walls and ceiling. Check to see if air can flow through these places:

- Electrical outlets
- Switch plates
- Window frames
- Baseboards
- Weather stripping around doors
- Fireplace dampers
- Attic hatches
- Wall- or window-mounted air conditioners

Also, look for gaps around pipes and wires, electrical outlets, foundation seals, and mail slots. Check to see if the caulking and weather stripping are applied properly, leaving no gaps or cracks, and are in good condition.

Inspect windows and doors for air leaks. See if you can rattle them, since movement means possible air leaks. If you can see daylight around a door or window frame, then the door or window leaks. You can usually seal these leaks by caulking or weather stripping them. Check the storm windows to see if they fit and are not broken. You may also wish to consider replacing your old windows and doors with newer, high-performance ones. If new factory-made doors or windows are too costly, you can install low-cost plastic sheets over the windows.

If you are having difficulty locating leaks, you may want to conduct a basic building pressurization test:
1. Close all exterior doors, windows, and fireplace flues.
2. Turn off all combustion appliances such as gas burning furnaces and water heaters.
3. Then turn on all exhaust fans (generally located in the kitchen and bathrooms) or use a large window fan to suck the air out of the rooms.

This test increases infiltration through cracks, making them easier to detect. You can use incense sticks or your damp hand to locate these leaks. If you use incense sticks, moving air will cause the smoke to waver, and if you use your damp hand, any drafts will feel cool to your hand.

On the outside of your house, inspect all areas where two different building materials meet, including:

- All exterior corners
- Where siding and chimneys meet
- Areas where the foundation and the bottom of exterior brick or siding meet.

You should plug and caulk holes or penetrations for faucets, pipes, electrical outlets, and wiring. Look for cracks and holes in the mortar, foundation, and siding, and seal them with the appropriate material. Check the exterior caulking around doors and windows, and see whether exterior storm doors and primary doors seal tightly.

When sealing any home, you must always be aware of the danger of indoor air pollution and combustion appliance back drafts. Back drafting is when the various combustion appliances and exhaust fans in the home compete for air. An exhaust fan may pull the combustion gases back into the living space. This can obviously create a very dangerous and unhealthy situation in the home.

In homes where a fuel is burned (i.e., natural gas, fuel oil, propane, or wood) for heating, be certain the appliance has an adequate air supply. Generally, one square inch of vent opening is required for each 1,000 Btu of appliance input heat. When in doubt, contact your local utility company, energy professional, or ventilation contractor.

6.2.1.2 Insulation (US DOE)

Heat loss through the ceiling and walls in your home could be very large if the insulation levels are less than the recommended minimum. When your house was built, the builder likely installed the amount of insulation recommended at that time. Given today's energy prices (and future prices that will probably be higher), the level of insulation might be inadequate, especially if you have an older home.

If the attic hatch is located above a conditioned space, check to see if it is at least as heavily insulated as the attic, is weather stripped, and closes tightly. In the attic, determine whether openings for items such as pipes, ductwork, and chimneys are sealed. Seal any gaps with an expanding foam caulk or another permanent sealant.

While you are inspecting the attic, check to see if there is a vapor barrier under the attic insulation. The vapor barrier might be tarpaper, Kraft paper attached to fiberglass batts, or a plastic sheet. If there does not appear to be a vapor barrier, you might consider painting the interior ceilings with vapor barrier paint. This reduces the amount of water vapor that can pass through the ceiling. Large amounts of moisture can reduce the effectiveness of insulation and promote structural damage.

Make sure that the attic vents are not blocked by insulation. You also should seal any electrical boxes in the ceiling with flexible caulk (from the inside or attic side) and cover the entire attic floor with at least the current recommended amount of insulation.

Checking a wall's insulation level is more difficult. Select an exterior wall and turn off the circuit breaker or unscrew the fuse for any outlets in the wall. Be sure to test the outlets to make certain that they are not "hot." Check the outlet by plugging in a functioning lamp or portable radio.

Once you are sure your outlets are not getting any electricity, remove the cover plate from one of the outlets and gently probe into the wall with a thin, long stick or screwdriver. If you encounter a slight resistance, you have some insulation there. You could also make a small hole in a closet, behind a couch, or in some other unobtrusive place to see what, if anything, the wall cavity is filled with. Ideally, the wall cavity should be totally filled with some form of insulation material. Unfortunately, this method cannot tell you if the entire wall is insulated, or if the insulation has settled. Only a thermographic inspection can do this.

If your basement is unheated, determine whether there is insulation under the living area flooring. In most areas of the country, an R-value of 25 is the recommended minimum level of insulation. The insulation at the top of the foundation wall and first floor perimeter should have an R-value of 19 or greater. If the basement is heated, the foundation walls should be insulated to at least R-19. Your water heater, hot water pipes, and furnace ducts should all be insulated. For more information, see our insulation section.

6.2.1.3 Heating/Cooling Equipment (US DOE)

Inspect heating and cooling equipment annually, or as recommended by the manufacturer. If you have a forced-air furnace, check your filters and replace them as needed. Generally, you should change them about once every month or two, especially during periods of high usage. Have a professional check and clean your equipment once a year.

If the unit is more than 15 years old, you should consider replacing your system with one of the newer, energy-efficient units. A new unit would greatly reduce your energy consumption, especially if the existing equipment is in poor condition. Check your ductwork for dirt streaks, especially near seams. These indicate air leaks, and they should be sealed with duct mastic. Insulate any ducts or pipes that travel through unheated spaces. An insulation R-Value of 6 is the recommended minimum.

6.2.1.4 Lighting (US DOE)

Energy for lighting accounts for about 10% of your electric bill. Examine the wattage size of the light bulbs in your house. You may have 100-watt (or larger) bulbs where 60 or 75 watts would do. You should also consider compact fluorescent lamps for areas where lights are on for hours at a time. Your electric utility may offer rebates or other incentives for purchasing energy-efficient lamps

There are many simple things you can do to reduce your personal carbon footprint and save money too! Let us look at your car. One of the easiest ways to increase your gas mileage is to check your tire pressure. Remember riding a bike with a tire that needed air? It took so much more effort. The same is true with your car. Even a couple of pounds underinflated can cost you a couple of miles per gallon. That could be $10 more per week in your pocket! It is easy to do many things that have a big impact. Other car ideas are a clean air filter and slowly pulling away from a stop.

About 87% of all energy in the US comes from burning fossil fuels. Huge coal plants can burn an entire train load of coal every day to make electricity for your city.

Lifecycle has become an important concept in decision making. Not just what it will cost today but how much over its lifetime. Consider these three light bulbs. The first is the common 60-watt incandescent bulb which costs about $0.50 and lasts for about 1000 hours and use about $54 per year if you kept it burning all the time (you'd replace it 9 times during the year). The second bulb is the florescent costing $3.50 and lasting 10,000 hours (more than a year) and it would use $13 in electricity. the newest type bulb is the LED costing about $25 but it would last 30,000 hours (3.5 years) and use only $6 of electricity over its lifetime. Which will you choose next time you replace a bulb?



6.2.1.5 Thermostats (US DOE)

Another smart buy is a programmable thermostat that sets the heat down automatically when you are not home. These can be bought for as little as $20 and can save up to 20% of your month's natural gas bill. That's a "pay back period" of only a couple months time! There are literally hundreds of little ideas that can add up to big savings. ..

Ideas:

- Turn hot water heater down to 120°.
- Caulk around windows and make sure doors are hung straight and close completely
- Insulate hot water heater and hot water pipes
- Faucets with low-flow heads can reduce water usage by 10% .
- Look into ways to make your toilet low flush. Several easy methods exist including putting a brick in the tank.
- Washing laundry in cold water will make your clothes last longer.
- Front loading, Energy Star washers can save up to 25% of the cost to wash clothes.
- Better yet, use a clothesline.
- Set the sleep mode on your computer.
- Always buy Energy Star appliances and shop by lifecycle costs.
- Be aware that "wall warts" leak electricity even when the device is not being used.
- Carpool, try public transportation or, even better, try riding a bike to work several days a month.
- Be a smart consumer!

Another smart idea is to recycle aluminum, plastic and newsprint. It takes 20 times the energy to make an aluminum can from ore as from a recycled can. But only 2 in 5 cans are made from recycled materials. We throw millions of cans away every day. The same is true with newsprint and plastic bottles. A garbage bag full of used aluminum cans can be sold for $2 to $3, an added benefit of recycling!

What does all this have to do with industry jobs? Today's builders are being asked to take lifecycle choices into account as they build. Just deciding how the new home will face the sun, plantings for shade, energy efficient appliances, solar panels, passive heating and water recycling are becoming common, and you need to understand what your customer is wanting.

6.2.1.6 Weather Stripping (US DOE)

You can use weather stripping in your home to seal air leaks around movable joints, such as windows or doors. To determine how much weather stripping you will need, add the perimeters of all windows and doors to be weather stripped, then add 5% to 10% to accommodate any waste. Also consider that weather stripping comes in varying depths and widths.

Choose a type of weather stripping that will withstand the friction, weather, temperature changes, and wear and tear associated with its location. For example, when applied to a door bottom or threshold, weather stripping could drag on carpet or erode as a result of foot traffic. Weather stripping in a window sash must accommodate the sliding of panes: Up and down, sideways, or out. The weather stripping you choose should seal well when the door or window is closed while still allowing it to open freely.

Choose a product for each specific location. Felt and open-cell foams tend to be inexpensive, susceptible to weather, visible, and inefficient at blocking airflow. However, the ease of applying these materials may make them valuable in low-traffic areas. Vinyl, which is slightly more expensive, holds up well and resists moisture. Metals (bronze, copper, stainless steel, and aluminum) last for years and are affordable. Metal weather stripping can also provide a nice touch to older homes where vinyl might seem out of place. You can use more than one type of weather stripping to seal an irregularly shaped space. Also take durability into account when comparing costs.

Weather stripping supplies and techniques range from the simple to the technical. Consult the instructions on the weather stripping package. Here are a few basic guidelines:

- Weather stripping should be applied to clean, dry surfaces in temperatures above 20°F (-7° C).
- Measure the area to be weather stripped twice before you cut anything.
- Apply weather stripping snugly against both surfaces. The material should compress when the window or door is shut.

When weather stripping doors:

- Choose the appropriate door sweeps and thresholds for the bottom of the doors.
- Weather strip the entire door jamb.

- Apply one continuous strip along each side.
- Make sure the weather stripping meets tightly at the corners.
- Use a thickness that causes the weather stripping to tightly press between the door and the door jamb when the door closes, without making it difficult to shut.

For air sealing windows, apply weather stripping between the sash and the frame. The weather stripping should not interfere with the operation of the window.

Weather stripping	Best Uses	Cost	Advantages	Disadvantages
Tension seal: Self-stick plastic (vinyl) folded along length in a V-shape or a springy bronze strip (also copper, aluminum, and stainless steel) shaped to bridge a gap. The shape of the material creates a seal by pressing against the sides of a crack to block drafts.	Inside the track of a double-hung or sliding window, top and sides of door.	Moderate; varies with material used.	Durable. Invisible when in place. Very effective. Vinyl is fairly easy to install. Look of bronze works well for older homes.	Surfaces must be flat and smooth for vinyl. Can be difficult to install, as corners must be snug. Bronze must be nailed in place (every three inches or so) so as not to bend or wrinkle. Can increase resistance in opening/closing doors or windows. Self-adhesive vinyl available. Some manufacturers include extra strip for door striker plate.
Felt: Plain or reinforced with a flexible metal strip; sold in rolls. Must be stapled, glued, or tacked into place. Seals best if staples are parallel to length of the strip.	Around a door or window (reinforced felt); fitted into a door jamb so the door presses against it.	Low	Easy to install, inexpensive.	Low durability; least effective preventing airflow. Do not use where exposed to moisture or where there is friction or abrasion. All-wool felt is more durable and more expensive. Very visible.
Reinforced foam: Closed-cell foam attached to wood or metal strips.	Door or window stops; bottom or top of window sash; bottom	Moderately low	Closed-cell foam an effective sealer; scored well in wind tests. Rigid.	Can be difficult to install; must be sawed, nailed, and painted. Very visible. Manufacturing

	of door.			process produces greenhouse gas emissions.
Tape: Nonporous, closed-cell foam, open-cell foam, or EDPM (Ethylene Propylene Diene Monomer) rubber.	Top and bottom of window sash; door frames; attic hatches and inoperable windows. Good for blocking corners and irregular cracks.	Low.	Extremely easy to install. Works well when compressed. Inexpensive. Can be reinforced with staples.	Durability varies with material used, but not especially high for all; use where little wear is expected; visible.
Rolled or reinforced vinyl: Pliable or rigid strip gasket (attached to wood or metal strips.)	Door or window stops; top or bottom of window sash; bottom of a door (rigid strip only).	Low to moderate.	Easy installation. Low to moderate cost. Self-adhesive on pliable vinyl may not adhere to metal; some types of rigid strip gaskets provide slot holes to adjust height, increasing durability. Comes in varying colors to help with visibility.	Visible.
Door sweep: Aluminum or stainless steel with brush of plastic, vinyl, sponge, or felt.	Bottom of interior side of in-swinging door; bottom of exterior side of exterior-swinging door.	Moderate to high.	Relatively easy to install; many types are adjustable for uneven threshold. Automatically retracting seeps also available, which reduce drag on carpet and increase durability.	Visible. Can drag on carpet. Automatic sweeps are more expensive and can require a small pause once door is unlatched before retracting.
Magnetic: Works similarly to refrigerator gaskets.	Top and sides of doors, double-hung and sliding	High	Very effective air sealer.	

	window channels.			
Tubular rubber and vinyl: Vinyl or sponge rubber tubes with a flange along length to staple or tack into place. Door or window presses against them to form a seal.	Around a door.	Moderate to high.	Effective air barrier.	Self-stick versions challenging to install.
Reinforced silicone: Tubular gasket attached to a metal strip that resembles reinforced tubular vinyl	On a door jamb or a window stop.	Moderate to high.	Seals well.	Installation can be tricky. Hacksaw required to cut metal; butting corners pose a challenge.
Door shoe: Aluminum face attachment with vinyl C-shaped insert to protect under the door.	To seal space beneath door.	Moderate to high.	On the exterior, product sheds rain. Durable. Can be used with uneven opening. Some door shoes have replaceable vinyl inserts.	Fairly expensive; installation moderately difficult. Door bottom planning possibly required.
Bulb threshold: Vinyl and aluminum	Door thresholds	Moderate to high.	Combination threshold and weather strip; available in different heights.	Wears from foot traffic; relatively expensive.
"Frost-brake" threshold: Aluminum or other metal on exterior, wood on interior, with door-bottom seam and vinyl	To seal beneath a door.	Moderate to high.	The use of different materials means less cold transfer. Effective.	Moderately difficult to install, involves threshold replacement.

threshold replacement.				
Fin seal: Pile weather strip with plastic Mylar fin centered in pile.	For aluminum sliding windows and sliding glass doors.	Moderate to high.	Very durable.	Can be difficult to install.
Interlocking metal channels: Enables sash to engage one another when closed	Around door perimeters.	High.	Exceptional weather seal.	Very difficult to install as alignment is critical. To be installed by a professional only.

6.2.1.7 Caulking (US DOE)

Caulk forms a flexible seal for cracks, gaps, or joints less than 1/4" wide. You can use a caulking compound to seal air leaks in a variety of places throughout your home, including around windows and door frames.

In addition to sealing air leaks, caulking can also prevent water damage inside and outside of the home when applied around faucets, ceiling fixtures, water pipes, drains, bathtubs and other plumbing fixtures.

Caulk is used when the crack is between dissimilar materials, such as the aluminum storm window frame and the wood window sill. Choose a good quality silicone caulk and a caulk gun, both which are very inexpensive.

Although not a high-tech operation, caulking can be tricky. Read and follow the instructions on the compound cartridge. Save yourself some trouble by remembering a few important tips:

•For good adhesion, clean all areas to be caulked. Remove any old caulk and paint, using a putty knife or a large screwdriver. Make sure the area is dry so you will not seal in moisture.

•Apply caulk to all joints in a window frame and the joint between the frame and the wall.

•Hold the gun at a consistent angle. Forty-five degrees is best for getting deep into the crack. You know you have the right angle when the caulk is immediately forced into the crack as it comes out of the tube.

•Caulk in one straight continuous stream, if possible. Avoid stops and starts.

•Send caulk to the bottom of an opening to avoid bubbles.

•Make sure the caulk sticks to both sides of a crack or seam.

•Release the trigger before pulling the gun away to avoid applying too much caulking compound. A caulking gun with an automatic release makes this much easier.

•If caulk oozes out of a crack, use a putty knife to push it back in.

•Do not skimp. If the caulk shrinks, reapply it to form a smooth bead that will seal the crack completely.

Before applying new caulk, remove old caulk or paint residue remaining around a window using a putty knife, stiff brush, or special solvent. After old caulk is removed, new caulk can then be applied to all joints in the window frame and the joint between the frame and the wall. The best time to apply caulk is during dry weather when the outdoor temperature is above 45°F (7.2°C). Low humidity is also important during application to prevent cracks from swelling with moisture. Warm temperatures are also necessary so the caulk will set properly and adhere to the surface.

6.2.2 Conclusion

Each of us has a role to play in ensuring the planet is healthy. By knowing how much you impact the problem personally, you can be more aware of choices you make. You have seen through weatherization exercises that very little money needs to be spent to have a big impact. It is really about choice for both you and your future customer. There are always trade-offs, such as the cost now versus the savings later. After reading this module, you should be better equipped to address the issues you encounter.

Weatherization Exercise 1: Your home audit.

Use this checklist from "The Daily Green"

thedailygreen.com homeenergyauditchecklist

Grab a pencil and a clipboard and, using our online guide, The DIY Home Energy Audit, find out how energy-efficient your home is. To read more, go to: *http://www.thedailygreen.com/green-homes/latest/DIY-home-energy-audit*

audit item	location	description	audit result	date fixed	notes
air leaks	corner 1				
	corner 2				
	corner 3				
	corner 4				
	chimney 1				
	chimney 2				
	chimney 3				
	exterior door 1				
	exterior door 2				
	exterior door 3				
	exterior door 4				
	windows, LR				
	windows, DR				
	windows, FR				
	windows upper				
	foundation				
insulation	attic floor				
	attic hatch				
	snow melt				
	basement ceil.				
	basement walls				
	hot water pipes				
	furnace ducts				
	exterior wall 1				
	exterior wall 2				
	exterior wall 3				
	exterior wall 4				
	storms floor 1				
	storms floor 2				
	storms floor 3				
filter check	furnace filters				
a/c coil	inside coils				
	outside coils				
vent check	floor 1				
	floor 2				
	floor 3				
duct check	basement				
	attic				
	other				
pro inspect	entire system				

Weatherization Assessment

When you read critically, you analyze and question what you read. To decide whether you agree or disagree, you need to be able to decide if the author is stating facts, stating their opinion, or making a generalization and if these are truthful. Too often we jump to conclusions, accept an author's writing as our own views but do not critically analyze what they are saying. Part of becoming a critical thinker is developing the ability to accept or reject facts, opinions and generalizations.

A **fact** is a statement that can be proven by research. It may be proven true or false.

An **opinion** is a statement that expresses feelings, beliefs or personal judgments but cannot be proven so some people will agree and others will not. Watch for words such as think, believe, best, worst, wonderful and should.

A **generalization** is like an opinion, someone's judgment but is always wrong because it allows for no exceptions. Watch for words like all, always, and never.

Read the following and decide which are facts, which are opinions and which are generalizations.

1) Gasohol is good for the environment and should be used in all cars.
2) Gasohol is, on average, 10¢ cheaper than regular at Lincoln gas stations.
3) Solar panels on houses are ugly but save lots of money.
4) Every home should switch to a tankless water heater to save money.
5) Lincoln drivers use gasohol at a higher rate than Omaha drivers

2) and 5) are facts which could be researched and determined to either be true or false
1) and 3) are opinions and 4) is a generalization. Why?

Rank the following as either F, O or G.

_____ The new LED light bulbs cost $35 and use only 2 watts of electricity.
_____ An 60-watt incandescent bulb costs only $0.60 so is always cheaper to use.
_____ Fluorescent bulbs contain mercury which is bad for the environment.
_____ You should always replace incandescent bulbs with fluorescent bulbs when they burn out.
_____ I believe a kilowatt costs about $0.10 in Lincoln.
_____ All light bulbs generate about the same amount of light.
_____ An LED light bulb can last for 30,000 hours of use or more.
_____ An incandescent bulb will always burn out after 1,000 hours of use.
_____ A fluorescent bulb will never burn out.
_____ Fluorescent bulbs should not be used outdoors.

Rewrite the following statements so they only express facts.

Another really smart buy for any home is a programmable thermostat that sets the heat down automatically. These can be bought anywhere for as little as $20 and can save up to 20% of your month's natural gas bill. That's a payback period of only a couple months!

_____
_____
_____

Turning the water heater down to 120° will save money. It's always a good idea to insulate the water heater and hot water pipes. I believe you can save over $500 per year with a tankless water heater.

_____

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_____

Reduced flow show heads and faucets can save 10% of the homes water usage. A simple way for everyone to save water is simply to put a brick in the toilet tank so a flush uses less water. A low flush toilet is believed to be the best to buy.

_____

_____

_____

Everyone knows that washing your laundry in cold water will make your clothes last longer. The new washing machines save energy by rapidly spinning the cloths almost completely dry, saving time in the dryer. Front load washers can save you 25% or more over top load washers. A clothesline is always a better way to dry clothes, and they smell wonderful.

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_____

_____

"Wall warts" leak electricity even when their device is not being used. Always unplug "wall warts" before leaving home for the day as they will overheat and start a fire.

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