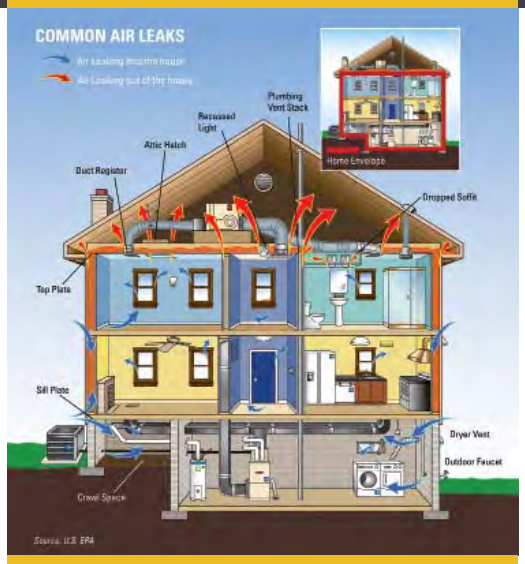
Guide and Resources to Reducing Building Energy Use

East Central Vermont: What We Want
Moving Toward Sustainability: Where We Live and How



Compiled by
Sustainable Energy Resource Group
www.serg-info.org
January 2014

East Central Vermont what we want

A Vibrant, Healthy and Equitable Region.

The information and resources in this Guide were compiled to help residents in the East Central Vermont region, located within the Upper Connecticut River Valley of Vermont and New Hampshire region and commonly referred to as the "Upper Valley," cost-effectively reduce residential energy use, save money and increase home comfort. The discussion of energy-saving programs, materials, resources, procedures, and tips for Upper Valley homeowners is broken into eight sectors relating to home energy use, outlined in the Table of Contents below: building envelope, home heating, home cooling, ventilation and air distribution, lighting, appliances and electronics, water heating and water-use conservation and food. Please note that terms defined in the glossary are denoted as bold and italicized terms within the text of the guide.

*For more information on this guide or other information on home energy-saving opportunities, contact SERG at 802-785-4126, SERG@serg-info.org or www.SERG-info.org .

Please note that although the target audience for this guide is residential ***much of the included information is relevant and beneficial to commercial, municipal and community entities*** with exception to the incentives and programs detailed. For more information regarding energy issues in Vermont within these sectors please visit Efficiency Vermont's Business section at http://www.efficiencyvermont.com/For-My-Business . Efficiency Vermont provides energy solutions and guidance for a wide variety of private, commercial and municipal sectors. In addition, the Vermont Energy & Climate Action Network http://www.vecan.net/ has several projects, initiatives and publications geared toward municipal and community organizations. In New Hampshire, NH Saves (http://nhsaves.com/business/efficiency.html) provides information, programs and support for businesses and New Hampshire Local Energy Solutions (http://www.nhenergy.org/) is a wonderful resource for NH's energy committees, municipalities and schools.

SERG would like to thank Dillon Gregory for his help with drafting some of this guide, Ray Brewster for his help in editing the guide and the American Council for an Energy Efficient Economy as the source for much of the information.

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The Guide and Resources to Reducing Building Energy Use was prepared by Sustainable Energy Resource Group (SERG) in partnership with Two Rivers-Ottauquechee Regional Commission and the Southern Windsor County Regional Planning Commission in support of the HUD funded East Central Vermont: What We Want Sustainability Plan. For more about East Central Vermont: What We Want project, please visit ecvermont.org or contact Loralee Morrow at lmorrow@trorc.org.

INTRODUCTION

Why the Focus on Building Efficiency?

Vermont has some of the oldest and least efficient housing stock in the country. This results in wasted energy use, high expenses for home heating and cooling and uncomfortable homes.

Figure 1: Comparison between US, VT and NH of Year Homes Built
Source: DPO4 Selected Housing Characteristics: 2010 American Community Survey 1-yr Estimates for US, VT and NH

Home heating accounts for about 64% of residential energy use in Vermont. The cost of number 2 heating oil and ***propane***, used by more than 60% of Vermont's residences, has risen more than 400% since 1999. These prices are expected to continue rising as supplies become more scarce and difficult to extract and demand continues to grow.

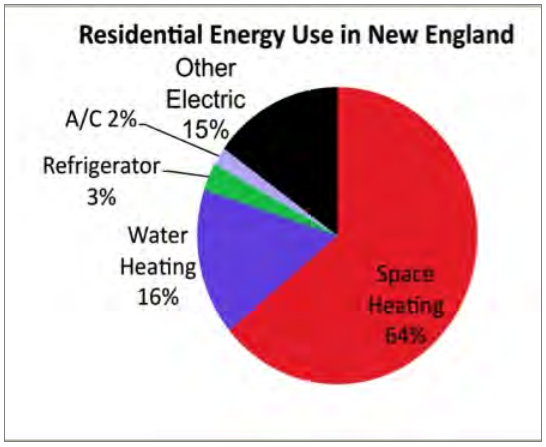

Figure 2: Residential Energy Use in New England
Source: Residential Energy Consumption Survey, 2005, U.S. Energy Information Administration

SECTION 1: BUILDING ENVELOPE

Home air-sealing and insulation are two of the most cost-effective energy-saving options available to homeowners. While there are many energy-saving measures homeowners can take themselves, (see "Tips" below) many of the biggest opportunities will require professional help.

I. **Energy Audits**: A good first step to home improvement is to hire a trained and certified professional Home Performance with Energy Star (HPwES) contractor who will study your home as a whole system, performing tests that address building air leakage, heating system efficiency, indoor air quality, and construction flaws that result in high energy bills, while identifying means of improvement. Home energy auditors will often perform air-sealing work as they go, and will connect you with qualified contractors as needed to complete major work. These auditors use the following sophisticated equipment:
   A. **Blower door**: A powerful fan that mounts into an exterior doorframe to determine a home's infiltration rate and identify specific leaking areas around the house.
   B. ***Duct blaster***: A fan attached to a ***forced-hot-air*** heating duct system to identify leaks that should be sealed.
   C. **Infrared camera**: A camera that takes images of surface temperatures anywhere in your home to detect thermal defects, such as a lack of insulation and air leakage.
   D. **Combustion analyzer**: A device that assists a contractor in measuring the combustion efficiency, presence of carbon monoxide (CO) and back-drafting of combustion gasses into the home.

II. **Home Performance Improvements**:
   A. **Finding and sealing air leaks**: In the average home, small openings in the "shell" (exterior walls, foundation, and ceiling-roof assembly) of the house account for nearly 30% of total heat loss.

Figure 3: Typical Sources of Air Leakage

These openings permit ***convective*** heat loss – the flow of warm air up and out openings high in the building, which pulls cold air in through openings low in the building. Some common sites of leakage include plumbing, chimney, and wiring penetrations, intersection of walls with attics and foundations, recessed lighting fixtures, attic stairs or access hatches, electrical switches and outlets, windows, doors, and baseboard molding. Seal gaps using a variety of methods. Caulk is the best solution for gaps less than ¼" wide, while expanding foam sealant can be used for larger cracks or holes. Foam insulation board with spray foam applied around the edges and any gaps can be used for sealing large openings such as plumbing chases and attic hatch covers. Various ***weather-stripping*** products can be used for features such as doors and windows. Finding and sealing air leaks, especially in unfinished attics and basements is usually one of the most cost-effective weatherization measures. This should be done BEFORE adding conventional insulation, i.e., fibrous types that come as loose-fill and as batts. Otherwise, air will continue to move through the added insulation, continuing the heat loss.

B. **Insulation** reduces ***conductive*** heat loss – heat moving through solid materials such as the wall, roof, and floor – which accounts for over 45% of all the heat a typical house loses.

i. **Types of Insulation**

a. **Loose-Fill** – Several insulation products, including cellulose and fiberglass, can be blown into place as loose-fill. This is a good method of insulation for open cavities, such as attic floors, because the loose-fill insulation easily fills the entire cavity, even difficult to reach areas, and it is inexpensive to apply. Air sealing (see above) should take place BEFORE applying loose-fill insulation or air will continue to leak through the added insulation. Cellulose – a renewable and recycled product made of shredded newspaper – that is treated with boric acid, which serves as a fire retardant and a repellant to rodents and insects, is preferred by many home efficiency contractors. Homeowners can often buy loose-filled insulation and rent a blower to apply the insulation themselves from a building supply store.

b. **Dense-Packed** –This is a means of applying blown-in insulation into encapsulated areas, like wall cavities, under pressure, which prohibits the insulation from settling – settling leaves gaps in the cavities – greatly reduces air movement through the dense-packed insulation. Dense-packing of insulation should be performed only by trained contractors.

c. **Board** – Some insulation products, like foam, come in sheets of varying lengths, widths and thicknesses that can be applied in open, flat situations. Care must be taken to air seal edges and joints to board insulation to prevent air leakage. Fire codes require that exposed foam be treated with an admixture that serves to guard against ignition, or covered with an adequate fire block. Check with your local fire marshal for guidelines.

d. **Spray-Applied** – Foam insulation is often applied in spray form, especially on irregular shaped surfaces, like stone foundation walls, as it

conforms to the applied area and serves as a water and air barrier, as well as insulation material. Fire codes require that exposed foam be treated with an admixture that serves to guard against ignition, or covered with an adequate fire block. Check with your local fire marshal for guidelines. Some other insulation materials can be spray applied as well.

e. **Batt** – Some materials like fiberglass, come in flat or rolled batts that are often applied in open stud, rafter or joist bays. Fiberglass batt insulation is not preferred by many home efficiency contractors because it is difficult to make sure that it completely fills the open cavities and it is so porous that air readily moves through it, reducing its insulation effectiveness.

C. **Areas to Insulate**

i. **Attic floors** are a good place to start, as they are usually unfinished and easy to access, making them relatively easy and inexpensive to work on. As mentioned above, blown-in, loose-fill insulation is usually a good choice for open attic floors, but it is important to air-seal gaps and penetrations BEFORE insulating, or warm air will continue to move up and out through the insulation.

ii. **Basement walls** are a good place to focus, especially if they are unfinished and easy to access, as most foundation material is very prone to ***conductive*** heat loss. Fibrous insulation is not a good option for basements generally, because of potential moisture problems; basements are often insulated with rigid foam board or spray foam installed on the inside surfaces of basement walls.

iii. **Building walls** are another important place to consider adding insulation due to their large surface area, if there is easy access and if additional insulation can be added. Insulating building walls is often very cost-effective if the wall cavities are uninsulated and if they can be easily accessed for adding dense-packed insulation or if the wall cavities are open during renovations.

D. **Amounts of Insulation** – Insulation materials are measured in R-value per inch of the insulation product, or Resistance to heat loss. The higher the R-value, the better the material resists ***conductive*** heat loss. The U.S. Department of Energy (DOE) establishes total recommended R-values for various areas in a building in various parts of the country, depending on how cold the climate. DOE recommends in the following insulation levels for ***propane***, heat pump, ***fuel oil*** and electric in Upper Valley area, Zone 6 homes. More information on the Department of Energy's recommended insulation levels can be found at http://energy.gov/energysaver/articles/tips-insulation .

Attic	Cathedral Ceiling	Wall Cavity	Insulated Sheathing	Floor
R49 to R60	R30 to R60	R13 to R21	R5 to R6	R25 to R30

Table 1: Recommended insulation levels for Upper Valley area homes (Zone 6)

III. **Weatherization Programs:**

A. ***Home Performance with Energy Star*** **(HPwES)** is a national fee-for-service program administered by the DOE to help weatherize homes, making them warmer in the winter, cooler in the summer and more affordable to operate all year. Efficiency Vermont administers the program in Vermont, training contractors and providing participating homeowners with technical and financial assistance to get the work done. Contractors implementing the HPwES program are trained and certified according to Building Performance Institute (BPI) protocol and have BPI certifications. The HPwES contractors can perform home energy assessments and install improvements. There is also a do-it-yourself track of the HPwES program, which still requires that a HPwES contractor conduct tests before and after work is completed, but allows homeowners to receive incentives for improvements installed by them or other hired help. For more information on the HPwES program, including a list of participating contractors, available incentives and case summaries of homeowners who have gone through the HPwES program, contact Efficiency Vermont at 888-921-5990 or www.efficiencyvermont.com/homeperformance.

B. **Weatherization Assistance Program (WAP)** provides FREE energy assessments and improvements worth thousands of dollars to income-qualified Vermonters, helping participants save fuel, save money and increase home comfort by improving the energy efficiency of their homes. WAP is implemented through five non-profit agencies covering Vermont, most of which are the Community Action Programs (CAPs). More information on WAP in the Upper Valley, including income eligibility guidelines and applications, can be obtained from the two CAP agencies serving the East Central Vermont region: Southeastern Vermont Community Action (SEVCA), 800-464-9951 or 802-722-4575 or http://www.sevca.org/home-repair-weatherization-wx ; or Central Vermont Community Action Council (CVCAC), (877) 919-2299 or (802) 476-2093 or http://www.cvcac.org/index.php/weatherization/about-weatherization

IV. **Weatherization Tips:** Following are several cost-effective energy-saving measures that many homeowners and renters can do themselves in a building.

A. **Finding and Sealing Air Leaks** – Finding leaks will be easiest when it is very cold outside. Feel for cool drafts coming in areas low in the home – where the sill meets the foundation, through holes for pipes and wires and around doors and windows. Hold something that smokes, like incense, and look for smoke being sucked out along potential openings high in the building – attic hatches, upper floor windows, ceiling lights and electric outlets, etc. Seal all high and low openings with weather stripping, spray foam or caulk. For more information on finding and sealing air leaks or other energy-saving ideas, visit: http://www.serg-info.org/energysaving-tips/.

B. **Doors** – Weather-strip all exterior doors, and passages to the unheated areas of the home, including attic hatch, bulkhead door and doors to cold cellars and crawl spaces. Check and replace weather stripping when damaged or worn. If your exterior doors jiggle when closed or if you can see daylight around edges of a closed door, move the strike plate closer to the weather-strip so the door closes snugly against it; or add new weather stripping that is snug up against the door; or take any other measures as

needed to make the door work well and close snugly. Install storm doors and close them tightly.

C. **Windows** – Repairing and weatherizing windows is usually much more cost effective than replacing old windows. Install storm windows and close them tightly. You can download a handout on weatherizing windows at http://www.serg-info.org/wp-content/uploads/2011/09/Weatherizing-Windows.pdf
D. **Chimney and fireplace dampers** – Close them when not in use and make sure that they do not leak any significant air. See additional tips under Fireplaces on page 14.
E. **Fan Vents** – Check vents to all ventilation fans (clothes dryer, bathroom fan, range hood, etc.) to make sure they vent to outside the house (not into the basement or attic), and make sure they have a flap that closes tightly when the fan is off. Check the duct and vent periodically, and clear vent flaps of lint and other debris so they close tightly. When conditions warrant, replace any ventilation-fan caps with better-quality ones.
F. **Do-It-Yourself DVD Tips** - You can watch a half-hour video describing how to make these and other home energy-saving improvements at http://www.cctv.org/node/82725.
G. **Home Efficiency Calculator** – Calculate a free rough estimate of your home's energy efficiency at: http://www.serg-info.org/home-efficiency-calculator/.

V. **Technical and Financial Information, Resources and Incentives**

A. **Efficiency Vermont** runs the ***Home Performance with Energy Star*** (HPwES) program, contact Efficiency Vermont at 888-921-5990 or www.efficiencyvermont.com/homeperformance.
B. **NeighborWorks HEAT Squad** provides technical assistance and financing for the HPwES program in Windsor and Windham counties, contact 802-438-2303 or www.HeatSquad.org.
C. **Southeastern Vermont Community Action (SEVCA) and Central Vermont Community Action Council (CVCAC)** provide incentives and applications for the free Weatherization Assistance Program. Contact SEVCA at 800-464-9951 or 802-722-4575 or http://www.sevca.org/home-repair-weatherization-wx ; or CVCAC at (877) 919-2299 or (802) 476-2093 or http://www.cvcac.org/index.php/weatherization/about-weatherization.
D. **Sustainable Energy Resource Group** provides homeowners and towns with information on energy saving opportunities, programs and tips in the Upper Valley area. Contact, 802-785-4126 or www.SERG-info.org .
E. **"Green Energy Times"**, an energy publication published bi-monthly for this region, lists energy incentives in its center pages. Contact http://www.greenenergytimes.org.

SECTION 2: HOME HEATING

I. **Types of Home Heating Systems** – Home heating systems come in various designs, with different efficiency ratings, using various fuels and some are more appropriate for different applications. Check with your ***Home Performance with Energy Star*** contractor or a Heating, Ventilation, Air Conditioning (HVAC) contractor who specializes in high efficiency and/or renewable energy options for specific advice.

A. **Central Heating Systems** generally have a single large heating unit with heat distributed throughout the home by hot air ducts or hot water piping and radiators. Central heating system options include:

i. **Boiler**: A central system that heats water which is then circulated throughout the house, with heat distributed to rooms via baseboard hot water radiators, in-floor ***radiant*** heating, cast iron radiators or ***radiant*** heating panels on walls or ceilings. See http://www.energystar.gov/certified-products/detail/boilers for information on ***Energy Star*** rated, efficient boilers.

ii. ***Furnace***: A central heat provider that burns fuel to warm a heat exchanger, which typically uses a large blower to pass air over and around it, then forces the warmed air into the living area, usually through the ductwork to each room of your home. "Condensing" ***furnaces*** are designed to reclaim heat that escapes up the flue during operation, and these can be up to 90% efficient. ***Furnaces*** are typically referred to as ***forced-hot-air*** or FHA systems. See http://www.energystar.gov/certified-products/detail/furnaces for information on ***Energy Star*** rated, efficient ***furnaces***.

B. **Space Heat Sources** radiate heat directly from the heating unit to the surrounding space. These include ***propane*** and kerosene space heaters, wood-burning and pellet-burning stoves, and fireplaces.

C. **Passive Solar Heating** uses sunlight to provide space heating. Properly designed and oriented homes can gain much of the heat needed through solar gain. Most commonly, solar space heating systems require south-facing windows, which are not shaded in the winter. Other methods of solar heating utilize south facing wall panels that circulate solar heated air or solar hot water panels that use hot water for space heating. Solar heating works best when there is some means of capturing and storing heat in thermal mass during the day that can be radiated to the living areas in the evening.

D. **Geothermal or Ground Source Heat Pumps** rely on the stable 55 degree Fahrenheit temperature of the earth or groundwater in a well and use of an electric heat pump to provide both heating and cooling. Water is pumped through tubes buried in the ground, or from a well. In wintertime, the heat pump extracts heat from the water, and distributes it through the building. In summertime, the system is reversed with the heat pump using cool ground water to extract heat from the building. The initial capital investment for geothermal systems is relatively large. However, with Vermont's long, cold winters the technology is promising. See http://www.energystar.gov/certified-products/detail/heat_pumps_geothermal for information on ***Energy Star*** rated, efficient ground source heat pumps.

E. ***Air-source heat pump***, a relative newcomer to home heating, extract heat from outside air in winter, and discharges it inside the house; and reverses the operation to provide cooling during the summer. New heat pumps can operate efficiently down to -15° F.

They operate using electricity, but perform two to three times more efficiently than old-style electric-resistance heaters. See http://www.energystar.gov/certified-products/detail/heat_pumps_air_source for information on ***Energy Star*** rated, efficient air source heat pumps.

II. Heating Fuel Comparisons

More than 60% of Vermont homes are heated primarily with oil or ***propane***.

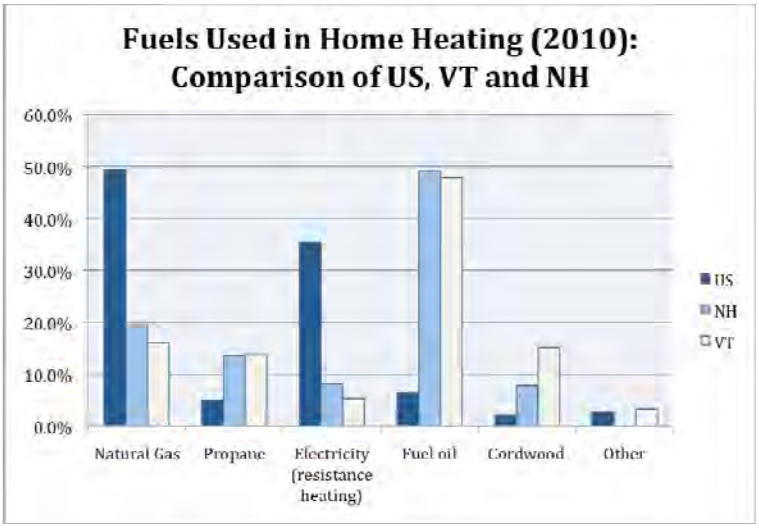

Figure 4: Fuels Used in Home Heating (2010) Comparison of US, VT, and NH
Source: DP04 Selected Housing Characteristics: 2010 American Community Survey 1-yr Estimates for US, VT, and NH

Oil and ***propane*** are two of the more costly ways of home heating. Note: the electric heating noted in this graph is for the old style electric "resistance" heating, not for air source heat pumps which are two to three times more efficient than electric resistance heaters.

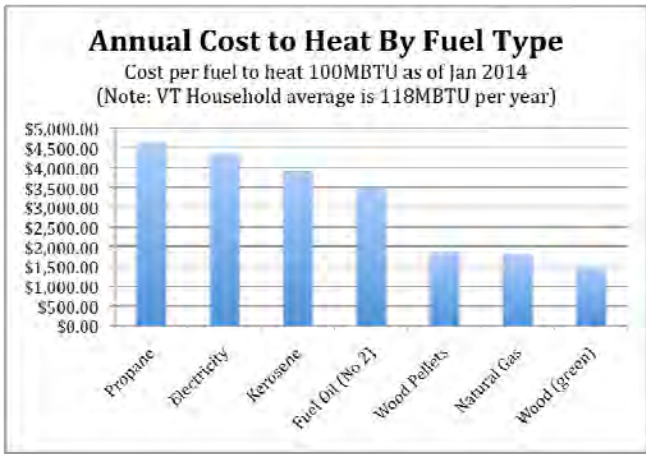

Figure 5: Annual Cost to Heat by Fuel Type per 100 MBTU
Source: Vermont Public Service Fuel Price Report January 2014, publicservice.vermont.gov/publications/fuel_report

A. **Oil and *propane***: Prices fluctuate, but are generally rising – prices have risen more than 400% since 1999 for oil. In the past year alone (Jan '13 to Jan '14) the average

retail price for propane increased over 10% and over 25% in the past five years in Vermont. They will continue rising as fuel sources become more scarce and expensive to extract, and as worldwide demand continues growing. Neither is expected to become cheaper to use over the long term. Also, it is worth noting that while ***propane*** is somewhat cleaner and more efficient burning, it has about 40 percent less energy potential in it per gallon than heating oil.

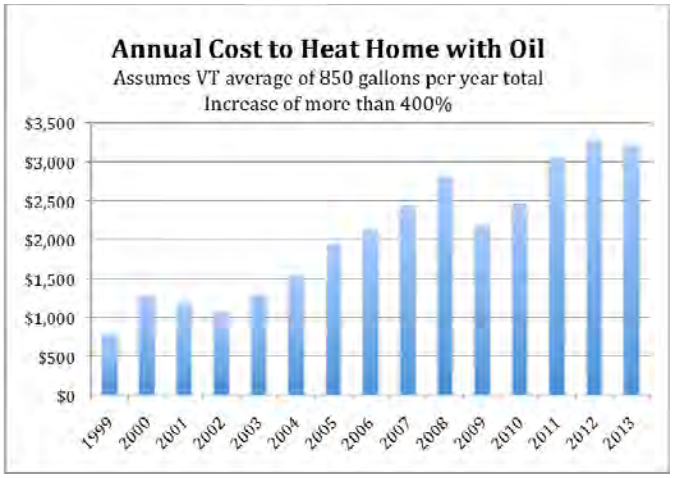

Figure 6: Annual Cost to Heat Home with Oil
Source: Energy Information Administration

B. ***Natural gas*: *Natural gas*** is normally delivered through pipelines and a distribution system that is not currently available in the East Central Vermont region. Where it is available, NG is currently a more economical fuel to use than heating oil or ***propane***.
C. **Electricity**: Electric resistance heating (conventional heating through electric radiators) is expensive to use. However, electrically-operated heat pumps are 2 to 3 times more energy-efficient than electric resistance heaters. New heat pumps can operate efficiently down to 15° F below zero. When combined with solar electricity as the fuel source, this can make using heat pumps a clean, renewable source for heating.
D. **Wood**: Cord wood is generally the cheapest heating fuel source in the region, especially when secured locally. It is even cheaper if it can be obtained from the building owner's land. It can be used in wood stoves, wood-burning inserts (which can be fitted in fireplaces), or in wood-burning ***furnaces*** and boilers.
E. **Wood pellets**: This fuel can be used in pellet stoves, and pellet-fired ***furnaces*** and boilers. Depending on how the fuel is purchased, pellets generally are only slightly more expensive than cordwood for heating fuel, and offer advantages in terms of handling and performance, including the duration of burning. They can be purchased in bulk (typically for larger heating installations) or in bags (typically for stoves). Pellet stoves do require electricity to operate, so either a back up heating system or back up generator are needed for power outages.
F. **For more information** on heating systems and the process of modifying, switching, or augmenting your present set-up, visit: http://www.aceee.org/consumer/heating

III. **Home Heating Tips –** There are numerous very cost-effective conservation and efficiency measures related to home heating and heating systems that will help you save energy and

money. Consider seriously doing conservation before making changes to heating systems (see more on this below under "New Heating Systems").

A. **Lower the thermostat** – With conventional central and space heat sources, you can save about 1% on your heating fuel use for each degree your thermostat is set back 8 hours a day throughout the winter. There are greater savings to be had if the temperature is set back several degrees, or for more hours per day. You can use a programmable thermostat to do this automatically and bring the heat back up to a comfortable temperature before you get up in the morning or return home. For more information, see: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=TH
B. **Turn heat off in unused rooms** – Close doors, close operable registers or cover heating registers and turn down thermostats in unused rooms. Make sure pipes do not freeze and moisture does not condense on walls in rooms where the heat is reduced.
C. **Duct-sealing and duct insulation** – Large heat loss occurs as the result of leaky ductwork in ***forced-hot-air*** heating systems. Inspect, seal, and insulate all heating ducts to ensure minimal energy loss between the ***furnace*** and the heating vents or registers. HPwES contractors can use a duct blaster to measure heat loss from these locations. Homeowners can seal ducts' joints and seams using high-temperature metal-foil tape, or a brush-on ***mastic*** (duct tape does NOT work for this).
D. **Hot-water distribution piping** – insulate this with good quality pipe insulation.
E. **Heat Circulation** – In the rooms that are being heated, keep heat registers and return air vents uncovered and unobstructed for easy air circulation.
F. **Tune Up Heating System** – Have your heating system tuned up and cleaned annually to ensure it is operating at peak efficiency. If you have a forced hot air system, change the ***furnace*** air filter regularly. For more information on how to inspect your heating system, visit: https://www.energystar.gov/index.cfm?c=heat_cool.pr_hvac
G. **Fireplaces –** Fireplaces are a very inefficient means of home heating, since they pull in an enormous amount of outside air for combustion, and most of the heat goes up and out the chimney. Consider sealing off the fireplace chimney permanently with an inflatable chimney pillow or a caulked-in-place foam plug to better seal it off. See "Draft Stopper" available from www.batticdoor.com or the "Chimney Balloon" available from www.chimneyballoon.us. If you really want to keep your fireplace, install tight-fitting glass fireplace doors, sealed with fire rated caulk to the fireplace surround and close air vents in the door when you are done viewing the fire, and close chimney and fireplace dampers when the fire is out. Alternatively, you can install a woodstove (or other unit-type heating appliance) in your fireplace with its exhaust pipe venting into a tight-fitting chimney adapter. This is a good way to turn a fireplace to advantage.
H. **New Heating Systems –** Consider replacing your old heating system with a new high efficiency heater **AFTER** you have weatherized your home. Weatherizing first will reduce your home's heat load (amount of heat required to keep your home comfortable), allowing you to purchase a smaller heating system, which is likely to be cheaper to purchase and less expensive to run. If you purchase a larger heater first and then weatherize later, you will end up with an oversized heating system, which can cause overheating, and may run less efficiently than a properly sized system. Make sure that your new heating system is efficient and properly sized to your home heating needs.

SECTION 3: HOME COOLING

I. **Conservation Strategies**: Preventing heat build-up in your home rather than cooling it using air conditioning is much cheaper and more energy-efficient. Here are some tips.
   A. **To keep your house cool** in summer, close doors and windows when the temperature outside is warmer than your home's interior. When the outside temperature cools off, open up the house and let the cool air in. Openings high and low in the house will allow warm air to flow up and out the top, pulling cooler air in below.
   B. **Prevent the sun from heating** your house by closing curtains or shades, preferably light-colored ones, and ideally ones that are insulated and sealed on edges. Outside awnings or roof over-hangs that block high summer sun are also very effective.
   C. **Reduce sources of interior heat** by using the microwave or toaster oven instead of the regular oven.
   D. **Change all lights** from inefficient, heat-producing incandescent bulbs to ***CFLs*** or ***LEDs***. Turn off appliances and equipment when not in use, as practical.
   E. **Use bathroom fans** to vent warm moist air from showers and baths. When showering, allow it to run 20 minutes afterwards to remove heat and moisture. Automatic controls such as timers and speed controls may come in handy and can be added to many bathroom fans.
   F. **Lowering indoor humidity** will also make you feel cooler. Use the range-hood fan to pull hot and moist air out and cover pots when cooking.
   G. **Moving air**: Comfort can be dramatically improved with the use of fans to create an interior "wind chill" effect. In addition, when used properly, window fans can effectively ventilate rooms if the doors and windows are left open when outside air is cool. Fans use much less energy than air conditioners, so try them first before going to air conditioners.

II. **Weatherize to Keep Cool**
   A. **Weatherization methods**, such as those listed in Section I above to help with home heating, will make it easier to cool the home during the summer. A well-insulated and sealed home will keep cooler air in longer and keep heat out.
   B. **Good quality windows** with low-E glass reduce solar gain in the summer by blocking out a large percentage of unwanted heat. Some manufacturers' glass coatings and aftermarket-supplied films are useful too.
   C. **Lighter colors** on the exteriors tend to reflect more solar radiation from your house, cutting down on the amount of heat penetrating the walls especially, and the roof. Consider lighter-colored exterior paints for the walls especially.

III. **Cooling System Options**
   A. **Central air conditioning**: This consists of a compressor unit, usually located outside the house, which removes heat from inside the house and discharges it outside. Inside, a system of coils cools the air that is distributed throughout the house via ducts. Central air conditioning systems tend to be more effective and efficient than individual room conditioners for cooling and removing moisture from every room in the house. However, all air conditioners use significant amounts of electricity. So it's

recommended to try the methods suggested above, before implementing air conditioners.

B. **Room air conditioning**: Mounted through windows or walls, these units use the same compressor-driven process as central air conditioners, but limit conditioning to areas or rooms. The benefit of room air conditioners is that they may cost less than a large central system and may suffice in smaller well-insulated homes or to cool off single rooms where you retreat on especially hot days. Cooling off a smaller area generally requires less energy than cooling off a whole house. New air conditioners are generally more energy-efficient than old ones, so if you must use these, newer ones are better. Look for ***Energy Star*** rated air conditioners that are more efficient than standard units. See http://www.energystar.gov/certified-products/detail/air_conditioning_central or http://www.energystar.gov/certified-products/detail/air_conditioning_room for more information.

C. ***Air-source heat pumps***: As mentioned above, ***air-source heat pumps*** are high efficiency electric heaters that can also provide area cooling similar to room air conditioners. Heat pumps used in cooling mode are more efficient than individual room air conditioners.

IV. **For more information** on air conditioning and cooling systems in general, visit: http://www.aceee.org/consumer/cooling

SECTION 4: VENTILATION AND AIR DISTRIBUTION

To ensure residents' healthy respiration, homes must achieve about one third of an air change per hour of fresh air. (This can be expressed as .3 ACH, or about a third of the home's indoor volume.) Specific Vermont ventilation and combustion safety requirements are outlined in the Vermont Residential Building Energy Code Handbook. A lack of fresh air can lead to health problems due to indoor air pollutants, including, but not limited to excess moisture, radon, combustion byproducts, volatile organic compounds, tobacco smoke, etc. Therefore, it is important that air-tight homes are properly ventilated to ensure safety as well as efficiency. Typically, it is preferable to provide this fresh air through mechanical ventilation, as opposed to natural ventilation, because with mechanical ventilation you can:

- Remove interior moisture, odors and volatile organic compounds (VOCs), found in some paints, glues, carpeting, furniture and mattress foam, etc.) from particular areas;
- Ventilate exactly the right amount of air and deliver fresh air to rooms of high habitation;
- Incorporate a heat recovery ventilator (HRV) or energy recovery ventilator (ERV) allowing for transfer of up to 90% of the heat in the outgoing air to the incoming air.

I. **Natural ventilation**: Air will naturally flow between the inside and outside of a house due to temperature and pressure differences. This process, called the "stack effect", is a natural current that flows upward: as warm buoyant air moves up and out of small leaks in a home, cool air is pulled in through leaks in the lower portion of the house. Some homeowners may choose to increase natural ventilation in restricted areas, like bedrooms while sleeping at night by opening windows.

II. **Mechanical ventilation**: Mechanical ventilation can be induced through the use of:
    - Exhaust-only systems that create negative pressure, pulling make up air in through leaks in the home's air barrier, or through intentional vents. (These are sometimes called "one-ended" ventilation systems; see note below on "balanced" systems.)
    - Heat recovery ventilators (HRV) that capture heat from the outgoing air and return it to the house through the incoming air.
    - Energy recovery ventilators (ERV) that capture heat and moisture from outgoing air and return them to the house through the incoming air.

    Of particular concern are leaks in the duct system of homes with forced air heating or cooling systems. Duct leaks, especially those located outside the thermal envelope (heated and cooled space of the building), can result in tempered air being pushed outside and outside air being pulled into the house. This unwanted infiltration causes heating and cooling systems to use more energy because they are forced to heat or cool more air. Sealing ductwork (using the same methods used for heating ducts, above) will reduce this leakage and lower energy use.

    An effective measure is to install a "balanced" ventilation system that provides equal amount of airflow in and out of the home, keeping the pressure of the interior space relatively constant and thus preventing unwanted infiltration. With this type of system, the home can be designed to be very airtight, helping to conserve energy as well. These systems generally use a powered heat-recovery or energy-recovery ventilator that exchanges air and energy between the outgoing and incoming air streams.

See http://www.energystar.gov/certified-products/detail/fans_ventilating for information on ***Energy Star*** rated, efficient ventilation fans.

III. **Tips**:
   A. **Improving air quality** within a home first requires determining and controlling the sources of pollution. Use ***sealed-combustion*** appliances (such as heaters and clothes dryers) that ventilate exhaust air outdoors; air-seal all passages to the garage to ensure no chemicals are entering your home; control moisture by keeping water away from the building and covering dirt floors with a sturdy vapor barrier sealed at the seams and edges to the foundation wall; use shower fans and dehumidifiers to reduce indoor humidity; and finally use non-toxic household products.
   B. **"Exhaust locally" at the source**. For example, using a range hood fan to evacuate cooking gas fumes, moisture and odors, and bath fans to remove bath and shower moisture, is more cost-effective than using large ventilation or heating and cooling systems to do the same work. It will also keep pollutant contamination to a minimum. (Note: all these fans should vent to the exterior. Range fans that are of the recirculating type do no particular good; also, bath fans and clothes-dryer vents should never terminate inside the building.)
   C. **Air-filter or air-purifier appliances** can be beneficial. Use an appliance with a mechanical filter (which traps particles on a porous surface) or electrostatic filter (which attracts particles to a negative charge), or both, to remove particulate matter in the air. These are available at many home-appliance vendors. See http://www.energystar.gov/certified-products/detail/air_purifiers_cleaners for information on ***Energy Star*** rated, efficient air purifiers.
   D. **Dilution:** You may have heard the expression, "dilution is the solution to pollution." This may not save the world, but in the case of homes, general dilution through a planned whole-house ventilation strategy is an important means of reducing pollutants.

IV. **For more information** on ventilation, air distribution, and its impact on energy use, visit: http://www.aceee.org/consumer/ventilation

SECTION 5: LIGHTING

I. **Lamp Types**
In the average American home, lighting accounts for 5 to 10% of total energy use, and costs $50 to $150 per year in electricity. The lighting type used traditionally in American homes, the incandescent bulb, converts only 10% of the electricity it uses into useable light – the rest is converted to heat. As a result lighting provides a great opportunity to save energy and money.

A. ***CFLs – Compact fluorescent lamps*** are a popular and highly efficient alternative to the incandescent bulb. Many types are easily compatible with screw-in lamp fixtures and come in a wide variety of options. ***CFLs*** use about a quarter of the energy of an incandescent bulb to provide the same amount of light and last up to seven times longer, making them a wise investment. Look for ***ENERGY STAR*** -qualified CFL's to ensure the highest performance and reliability. (Note: since CFL's depend on trace amounts of mercury to operate they should be disposed of properly. Rest assured though, the amount of mercury used is not significant enough to pose a health risk in your home and use of ***CFLs*** keeps more mercury from being released to the atmosphere than they contain, by reducing energy use and the associated mercury pollution generated by many fossil fuel-fired power plants.)

B. ***LEDs – Light-emitting diodes*** are semiconductor devices that produce visible light when an electric current is passed through them. ***LED*** lighting is more efficient, durable, versatile and longer lasting than traditional bulbs and ***CFLs***. ***LEDs*** don't burn out or fail like incandescent or CFL bulbs, instead they experience lumen depreciation, which causes the amount of light produced to decrease over time. As a result the products' "lifetime" is set based on when the light output decreases 30 percent. However, they do have a very long effective life – typically quoted from 25,000 to 100,000 hours. ***LEDs*** are "directional" light sources, which means they emit light in a specific direction, unlike incandescent and CFL bulbs, which emit light – and heat – in all directions. For this reason, ***LED*** lighting is able to use energy more efficiently in many applications. ***LED*** bulbs and fixtures are designed to provide the distribution of light needed, varying with the application or location. As is the case with ***CFLs***, there are more ***LED*** choices available than ever before on store shelves and the prices are coming down as ***LEDs*** become more available on the market. Look for ***ENERGY STAR*** -labeled bulbs to ensure high quality and performance. Samples of ***LEDs***:

C. ***Energy Star*** **Rated Lighting** – See http://www.energystar.gov/certified-products/detail/light_bulbs or http://www.energystar.gov/certified-products/detail/light_fixtures for information on ***Energy Star*** rated, efficient lighting.

II. **Controls** - The best practice for saving energy is to turn lights off when they are not needed. Controls help ensure this practice by automatically turning lights on when needed and off when not. There are three common categories of lighting controls: dimmers; motion, occupancy or photosensors; and timers.

A. **Dimmer controls** provide variable indoor lighting and when dimmed, save energy by reducing watts consumed. They are inexpensive, but it is important to use dimmable bulbs, which is indicated on bulb packaging as some bulbs, especially ***CFLs*** require special dimming ballasts and bulb holders. The majority of ***LED*** bulbs on the market

today are dimmable. But you may need to replace an existing dimmer switch with one compatible with ***LEDs***. Fully compatible ***LED*** dimmers are expected to increase on the market as the ***LED*** industry expands.

B. **Motion, occupancy, and photosensor (photocell) controls**
   i. **Motion sensors** – are typically used in outdoor lighting for security and utility lighting. They automatically turn lights on when they detect motion and turn them off a short while after motion stops. They pair well with a photosensor since lights are typically only needed when it's dark and people are present.
   ii. **Occupancy sensors** – detect indoor activity within a certain area. They provide convenience by turning lights on automatically when someone enters a room, and save energy by turning lights off soon after the last occupant has left the room. There are two types of occupancy sensors including ultrasonic (detect sound) and infrared (detect heat and motion). These are often used for halls, stairs, foyers, restrooms, etc, where people pass through and light is not needed for a long time.
   iii. **Photosensor controls** – are used to prevent lights from operating during daylight hours. They sense ambient light conditions making them especially useful for outdoor lighting. Photosensor controls are not commonly used indoors.

C. **Timer controls** are used to turn lights on or off at specific times. There are several types but two common ones are manual (which plug into an outlet), and hard-wired programmable timers (similar to programmable thermostats). Timers can be especially effective for outdoor lighting when used in combination with photosensor controls, which adapt to seasonal day-length variation. Timers can be used indoors as well, for instance to give an unoccupied home a lived-in look, but they are not useful for lighting control when the home is occupied.

III. **Natural lighting** – The benefits of natural lighting versus artificial lighting are enormous – not to mention 'natural' is free and uses no energy! Studies have shown that natural light helps maintain good health, decreases stress, and improves productivity. The best opportunity to incorporate daylighting is during the design phase of a building or renovating project, as there are many architectural techniques and technologies that can maximize your home's daylighting potential. Maximizing natural daylighting in an existing home can be more difficult but you can rearrange furniture to optimize use of daylight for reading, cooking and other activities. You can also paint walls a lighter color to reflect light into space instead of absorbing it.

IV. **Incentives** – Efficiency Vermont provides incentives that help lower the purchase price for energy-efficient lighting products. To see if any lighting incentives are available, contact Efficiency Vermont at 888-921-5990 or www.efficiencyvermont.com .

SECTION 6: APPLIANCES AND ELECTRONICS

Appliances and electronics account for about 13% and 4% of a home's energy costs respectively. Individual appliances and electronics account for varying shares of this usage and cost. Below is a graph of electricity usage for many common household appliances, developed by energy.gov. Note that the figure indicates typical annual cost of electricity for use of the appliance (and not the short-term amount of electricity consumed when the appliance is in operation).

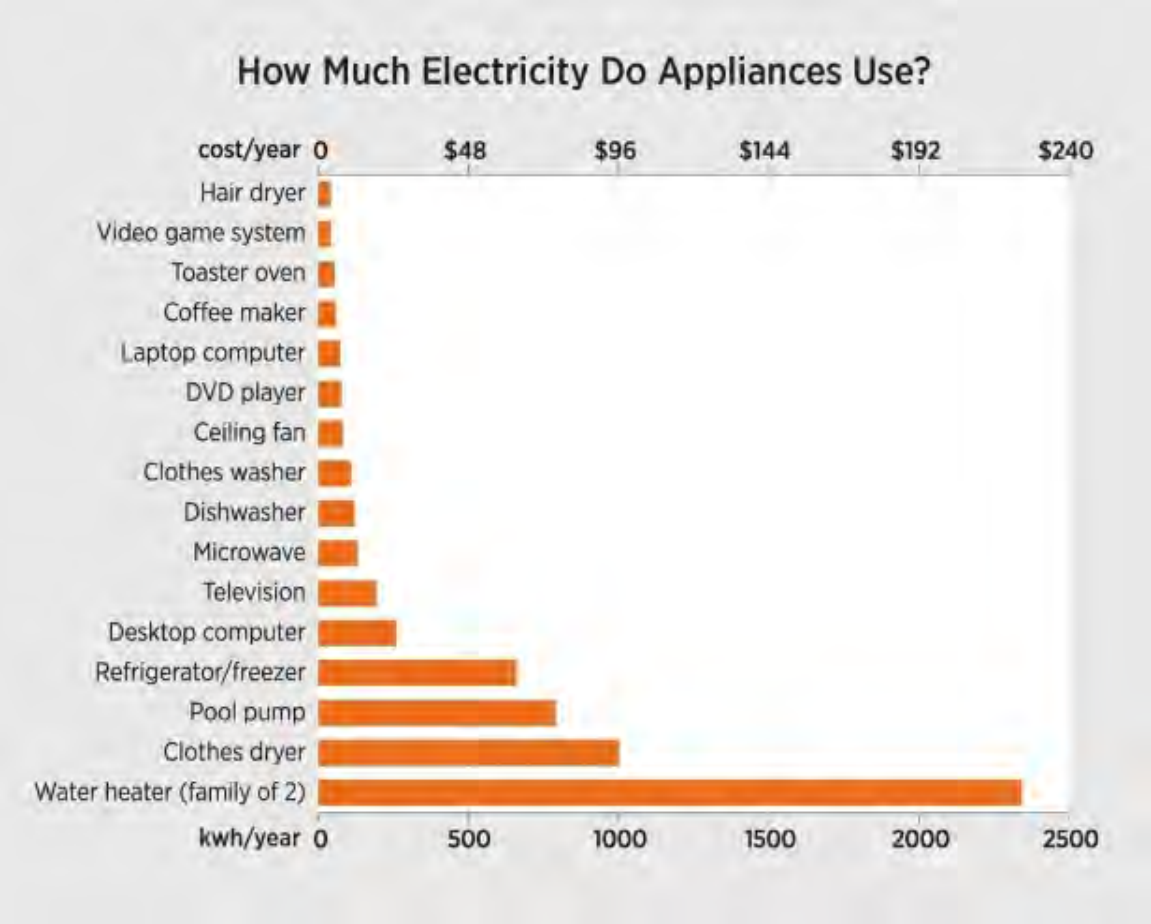

Figure 7: Comparison chart of how much electricity various appliances use

I. ***ENERGY STAR*** – ***Energy Star*** http://www.energystar.gov is one program that will assist you in identifying and purchasing new energy-efficient appliances and electronics. ***Energy Star*** - labeled products usually exceed federal energy efficiency and quality standards by a substantial amount. Although these products may sometimes have a slightly higher price tag, they usually save you money over the lifetime of the product. The monthly cost of operation that is included in your electric bill for the period over which you use the product is where the efficiency of a product more than makes up for a slightly higher upfront cost of an ***Energy Star*** over a non- ***Energy Star*** product. Look for the bright yellow and black EnergyGuide label on most appliances to help understand the estimated yearly operating cost. Links to various parts of the EnergyStar website for specific appliances are referenced elsewhere in this Guide.

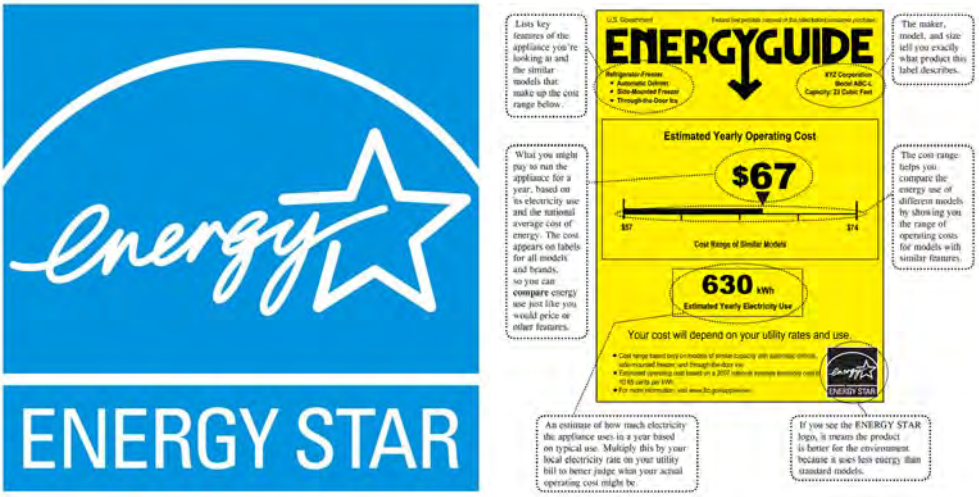

Figure 8: Energy Star and EnergyGuide Labels
Source EnergyStar and Federal Trade Commission

II. **Metering** –Watt meters measure the amount of electricity used by your home's appliances and electronics and identify the biggest consumers. This information can help you prioritize which appliances and electronics should be replaced. Two such meters to look for are the Kill-A-Watt or the Watts Up? Pro Power Meter. Watt meters can be borrowed from Efficiency Vermont, some local libraries and Sustainable Energy Resource Group (SERG). SERG has a handout, available on request, for interpreting Kill-A-Watt meter info against listings on http://www.energystar.gov site to figure paybacks for getting a new appliance. Kill-A-Watt meters can also be purchased from Energy Federation Incorporated – www.efi.org or 800-876-0660.

III. **Smart Meters** - Many homes now have a "smart meter" – a replacement provided by the electric utility for the old electric meter. A smart meter is capable of relaying information on your home's power use to the electric utility. Once utilities have systems in place, this will allow you to view your consumption on a yearly, daily and hourly basis, giving you the information needed to fully understand your usage, and allowing you to identify potential areas to decrease it. For homes without a smart meter, a power-use monitor can help identify real-time changes in energy usage viewable through an easy-to-read screen. Some such monitors include The Energy Detective, the Power Cost Monitor, or the Cent-A-Meter. The benefit of Smart meters will be realized when the electric utilities have the systems in place to gather information reported by them and make it available to consumers – which is a work-in-progress at this writing.

IV. **"Phantom" or "vampire" loads** – Many electronics continue to draw energy even when they are turned off. Devices like TVs, stereo systems, computers, microwaves, phone chargers, or anything with a small ***LED*** light that runs continuously, continue drawing power in their off mode. This energy usage is often referred to as the phantom or vampire load, and costs the average home about $200 per year. In order to reduce these loads by home electronics, it is important to understand the two, three or even four modes an electronic device might operate in; for detailed information on this, go to aceee.org/consumer/home-electronics . To reduce phantom or vampire loads two good general practices are unplugging the product or using a power strip, either a basic one or a sophisticated one.

A. **Unplug** - By unplugging the product or its charger you eliminate all potential for phantom loads. Do this when it is practical and easy.
B. **Power strip** - Alternatively, use a power strip with an on-off switch. This will allow you to quickly and completely cut all power to the devices. If you'd like to keep unsightly power strips hidden and accessible, look for a power strip that includes a remote switch. Some electrical outlets also now come with a switch that can be turned off right on the outlet. Some power strips also include surge protectors.
C. **Advanced power strip** – There are often electronics in a home entertainment center that must generally be in a standby mode so their internal calendars, clocks and channeling work properly, such as cable boxes, satellite boxes, DVR's etc. Some of these receive information from media providers at any and all hours, and so are 'on' even when they appear to be off. If these devices are completely turned off with a standard power strip they may require reprogramming or time to reboot and download information before use. In this case, look for advanced power strips to manage these set-ups and reduce phantom loads. Advanced power strips include three types of sockets: always on, control, and switched outlets. There are several types of advanced power strips on the market. The US-DOE's National Renewable Energy Laboratory has developed an infographic to help identify these types with a flow chart to help identify which type is best for you.

V. **Incentives** – Efficiency Vermont provides incentives that help lower the purchase price for energy-efficient appliances. To see if any incentives on lighting, appliances or electronics are available, contact Efficiency Vermont at 888-921-5990 or www.efficiencyvermont.com . You can also check out the energy ratings of the year's new ***Energy Star*** rated appliances at www.energystar.gov .

SECTION 7: WATER HEATING AND WATER-USE CONSERVATION

Typically water heating is the third-largest energy user in the home at roughly 14% of a home's energy costs after heating and cooling the home. Consider that there are several different types of water heaters on the market, and follow a few suggestions to find an effective way to achieve energy savings.

I. **Fuel** – In the US the majority of households use ***natural gas*** or electricity to heat water, while a small percentage use ***propane*** or heating oil. In the Upper Valley of New Hampshire and Vermont, the most common fuels for hot water heating are electricity and ***propane***, with a smaller number of households using ***fuel oil***, solar or wood, and a very few using other fuels or means. There are currently no ***natural gas*** lines to the region. Historically, electric resistance water heaters were inefficient and expensive to run. However, modern electric water heaters are highly insulated and more efficient than their predecessors, and can be reasonably considered for use. Some solar-system companies are now installing electric water heaters and additional ***PV*** panels to provide the electricity they use, eliminating the need and cost for a separate hot water panel system.

   No matter which fuel and type of water heater is used it is important to understand and evaluate the life-cycle costs of various water heater types, including up-front costs of the system, and life-time operating costs. Although some types may be more expensive up front, the yearly energy costs can quickly make up that difference and more for more efficient water heaters.

II. **Types of water heating appliances**
   A. **Storage** – Storage water heaters, with tanks, are the most common in the U.S., and likely in Vermont as well, as they are the least expensive to buy and install. They are fueled by most of the common energy sources (in our region electricity and ***propane***). There are two main types, direct-fired and indirect-fired tanks. Note that for ALL heaters with storage tanks, heat is lost through the walls of the tank (constantly), so energy is consumed even when hot water is not being used, though newer tanks are better insulated, greatly reducing this standby heat loss.
      i. **Direct-fired heaters.** These have their own burner or coil to heat water in a tank. They are often electric, ***propane***-fired, or a bit less common, oil-fired.
      ii. **Indirect-fired heaters.** For homes using an energy-efficient gas, oil or ***propane***-fired boiler for space heating, indirect water heaters are one of the best options available. They use the home's space heating boiler as the heat source and circulate hot water on a separate zone or circuit from the boiler through a heat exchanger in an insulated water tank.
   B. **Tankless** (also referred to as on-demand or instantaneous water heaters) do not store hot water. Instead a gas burner or electric element heats water only when needed. Tankless water heaters are more efficient due to the reduction in standby heat loss. However, at this time they are relatively expensive and not appropriate for all situations.

   C. **Heat Pump** – Heat-pump water heaters are much more efficient than the traditional conventional electric water heaters. Heat-pump water heaters use electricity to extract

heat from outside or surrounding air and transfer it to the hot water, instead of creating electric resistance heat. This results in a one-third to one-half reduction in electricity use compared to conventional electric models. They are not very common, but the market share is predicted to grow.

D. **Solar** – Solar water heaters harness the sun to heat water, usually include solar hot-water panels, plumbing connections from the panels to storage tanks, controllers, and are often tied into the building's more conventional hot water system. There are different designs of panels, and many other specifics. These systems can save 50-70% of your water heating energy, compared with many conventional systems, over the long term. However, the initial cost can be significantly higher and homes' sites can affect your ability to take advantage of this technology. Modern solar hot-water systems are more forgiving in terms of orientation than earlier systems were. A qualified installer can help assess your situation and advise on how best to set up your system for your situation. A newer, related approach, mentioned above, is that of using solar electric/***Photovoltaic (PV)*** panels to power electric water heaters. Many solar installers are adding ***PV*** panels instead of separate solar hot-water systems. The advisability of this approach might depend on whether the home has or intends to have a ***PV*** system. There may be federal or state incentives on solar systems.

III. **Water Heating Conservation** - The American Council for an Energy Efficient Economy recommends the following tips to save energy with your new or existing water heater.

A. Many tank-type water heaters installed before 2004 were poorly insulated, resulting in much standby heat loss (heat lost through the walls of the tank). If you can feel heat from touching your electric water heater's tank, install an insulating jacket that costs about $10 and can reduce heat loss by 25-40% and saving about 4-9% on your water heating bill. Check with the manufacturer or a plumber about how to do this. Do NOT add an insulating jacket to a direct ***propane*** or oil-fired water heater.

B. Keep water heater temperature as low as sufficient. Each 10°F decrease generally saves you 3-5% on water-heating costs. Most households find around 120°F is comfortable. If you can't hold your hand under your hot water after it is coming out of the faucet at its hottest, the thermostat should be turned down. This will reduce the standby heat losses. Check with your manufacturer, owner's guide, or a plumber if you have any question as to how to do this.

C. Insulate all hot water pipes, especially those closest to the hot water tank. This helps reduce standby losses as the water travels from the water heater and to the fixtures using water. It will also help keep water in the pipes from cooling quickly when the flow is turned off, saving energy when it is turned back on within an hour.

D. See http://www.energystar.gov/index.cfm?c=water_heat.pr_water_heaters_landing for information on energy-efficient ***Energy Star*** rated water heaters.

IV. **Water-use conservation** – WaterSense, an Environmental Protection Agency Partner Program, encourages people to save energy by saving water because it takes energy to pump, heat, treat and deliver the water we use every day in our homes. For example by installing a WaterSense-labeled low-flow showerhead you could save 2,900 gallons of water, 13 days of energy to power your home and $70 per year. The WaterSense label, like the EnergyStar label, ensures that labeled products save water, help reduce energy use and perform well. Currently the program includes products and services within the following categories: showerheads,

toilets, bathroom sink faucets and accessories, urinals, and irrigation controllers. Work has begun to expand the program to four additional categories including water softeners, professional certificate programs, soil moisture-based control technologies and flushometer-valve toilets. For more information on products and the program visit http://www.epa.gov/WaterSense/

V. **Tips:** WaterSense recommends the following practices that can help you reduce your water and energy usage at home.
   A. **Indoors**
      i. Fix those leaks! Thousands of gallons of water are lost to leaks in fixtures and irrigation systems. Check yours in March during WaterSenses Fix a Leak Week.
      ii. Make sure that your plumbing fixtures, toilets, faucets and shower heads, are low-flow types.
      iii. Turn off the tap while brushing your teeth.
      iv. Take shorter showers.
      v. Use your dishwasher only when fully loaded. If you hand-wash dishes, plug the sink or use a wash basin rather than letting the faucet run.
      vi. Keep a pitcher of cold water in the refrigerator instead of running tap water till cold.
      vii. Wash full loads of laundry or use appropriate water level and load size selections.
   B. **Outdoors**
      i. Capture rain water in a barrel for outside use. Place the barrel on a raised platform under the eaves' down spout and run a hose from the barrel to gravity-feed your gardens.
      ii. Create a water-smart landscape by planting regionally appropriate, low water-using and native plants.
      iii. Create specific "hydrozones" in your gardens by grouping plants according to water needs.
      iv. Use plants appropriate to site conditions by considering soil type, exposure, evaporation rates and moisture levels.
      v. Minimize turfgrass by planting where it serves a practical function such as play areas. Turfgrass typically requires the highest percentage of irrigation water and by minimizing and choosing native grasses or types that don't need a lot of water, energy and water consumption can be reduced.
      vi. Mow lawn at the tallest height within the recommended mowing range for the turf species grown. This prevents thirsty new growth, by allowing longer drought resistant lawns with deeper root growth.
      vii. Use mulch around shrubs and garden plants to reduce evaporation, inhibit weed growth, prevent erosion and moderate soil temperature. Maintain mulch around shrubs and plants, remove weeds and thatch as necessary.
      viii. Minimize or eliminate fertilizer. If fertilizer is needed look for products containing "natural organic" or "slow-release" ingredients.

SECTION 8: FOOD

Although food cooking and storage don't typically contribute a large amount to a household's energy bills, there are opportunities to save. Typically this can be done using a combination of more efficient appliances and equipment as well as adjusting preparation and cooking practices. In addition, a huge amount of energy is imbedded in growing, harvesting, processing and transporting our food that can be saved.

I. **Refrigerator-Freezer** – Over the past 15 years energy use in typical new refrigerators with top-mounted freezer has decreased by about half! And in 2014, federal law will require another 30% electricity usage reduction. If your refrigerator is old consider replacing it. (The expected life span of a refrigerator is about 15 years.) Besides replacing the fridge when it is time, there are some steps that can be taken to help an existing fridge's energy efficiency. Follow the tips below to get a new efficient refrigerator, or make your existing one run more efficiently.
   A. **New** - The best way to compare energy performance among refrigerators of varying types and features is to compare the "kWh/year" measurement found on the yellow EnergyGuide labels. You can find energy use information of all new energy-star-rated refrigerators at http://www.energystar.gov/certified-products/detail/refrigerators and freezers at http://www.energystar.gov/certified-products/detail/freezers. See TopTenUSA (www.toptenusa.org) for the top ten energy-efficient refrigerators and freezers based on size. Features that have an impact on energy efficiency include:
      i. Freezer compartments: top-mounted vs. side-by-sides: refrigerators in these two categories are held to different energy standards with side-by-sides using 10-30% more energy.
      ii. Convenience features, especially through-the-door ice-makers and water, increase energy consumption
      iii. Size: a 25-cubic foot refrigerator will meet the needs of most households. If your needs are less than that consider a more compact fridge. For households with greater storage needs, resist the urge to operate multiple refrigerators, especially with the second one in the basement or garage; typically one larger refrigerator uses less electricity than two smaller ones.
   B. **Existing** –
      i. Keep any refrigerator between 36 and 38 F° and the freezer compartment between 0 and 5 F°.
      ii. Check door seals for cracks and deterioration and replace as needed.
      iii. Keep refrigerator in a cool place. Avoid sunny spots, and proximity to stoves or dishwashers – situations that cause the fridge to work harder.
      iv. Minimize frost build-up.
      v. Keep your freezer full and organized.
      vi. Let hot foods cool before storing.
      vii. Defrost frozen foods in the refrigerator.
      viii. On models with a power-saver or energy-saver switch, keep it on as long as you do not see condensation on the outer surface. This prevents extra heaters within the unit's walls from operating to reduce moisture and condensation on the outer surface.

II. **Cooking Appliances** In relation to cooking appliances, there are several options on the market. However, some options make no difference in terms of energy use and can be decided on purely by preference. These include whether the appliance is a range or cooktop-and-oven combination, gas or electric, and conventional burner with electric ignition, or sealed burners. A self-cleaning feature is one to value, as these ovens have more insulation in the casing, which results in better energy-efficiency. However, try not to use the feature more than once a month as you'll end up using more energy than is saved. If choosing an electric cooktop, there are a number of burner options that affect efficiency as well as purchase cost. In order of increasing efficiency, and purchase cost, these include: solid disk, exposed coil, ***radiant***, halogen or induction. However, in most cases it is more cost-effective to invest in better cookware (see more below) versus a more efficient cooktop, as the overall energy used in cooking rarely justifies additional investment in a cooktop based on energy savings alone. Some efficient cooking appliances to consider include:
    A. **Convection ovens** continuously circulate heated air around the food being cooked, reducing required temperature and cooking time, thereby cutting energy use by about 20% when compared to conventional ovens.
    B. **Microwave ovens** drastically reduce cooking times, resulting in about a two-thirds reduction in energy use per meal compared to a conventional oven, despite their high energy use when operating. They are hard to beat for efficient rewarming tasks. Using a microwave in the summer instead of an oven can save on air conditioning costs too, as less heat is generated in the kitchen. Some microwave features to look for that further increase energy efficiency and cooking performance include: temperature probes, variable power settings, and controls to turn off microwave when food is cooked.
    C. **"Rapid-cook" ovens** combine microwaves with typically halogen lights or convection cooking technologies improving quality of food while cutting cook times.
    D. **Pressure cookers** can reduce cooking times of many foods.
    E. **Other specialized small appliances** MAY help save on cooking-fuel use. And finally, cooking on hearth appliances such as woodstoves may work well for some households.

III. **Cookware**
    A. Use sturdy, flat-bottomed cookware. The benefits of using good cookware can make a drastic difference in energy use. Cookware in good condition is important too. For example, using a warped pan to boil water for pasta versus a flat-bottom pan can result in a 50% energy increase!
    B. Use highly heat-***conductive*** materials on cooktops, including copper-bottom pans, which heat up faster than regular pans. Generally, for conventional cooking, pots and pans that include copper or aluminum in their construction can be among the most efficient. Many name-brand, top-performing cookware sets have these metals laminated on or within them. In the oven, use glass or ceramic which allows you to decrease oven temperatures about 25 degrees Fahrenheit with the same cook time.

IV. **Efficient Cooking Tips**
    A. Match the pan and burner or heating element sizes – a 6-inch pan on an 8-inch burner wastes over 40% of the heat produced.

B. Keep the stovetop clean – blackened burners can absorb a lot of heat and reduce efficiency while keeping the stovetop clean and shiny increases reflectivity to heat cookware. With electric-coil ranges, the burners of which have heat-reflector dishes, there is some gain in using dishes with chrome-colored finish.
C. Reduce cooking times by defrosting frozen foods in refrigerator before cooking, keeping preheat times to minimum, keeping oven racks clear and staggering pans to improve air flow, avoiding 'oven-peeking,' and turning off heat in oven or electric burner just before cooking is finished to avoid overcooking.
D. Prepare double portions, so that a second portion or meal only requires reheating.
E. Use the self-cleaning option after normal oven use, so residual heat is used.

GLOSSARY

Glossary terms are highlighted within the text of the guide as bold and italicized terms.

Air distribution - The supply of treated air from central heating or air-conditioning systems by blowing it through ductwork into space.

Air-source heat pumps - a relative newcomer to home heating, extract heat from outside air in winter, and discharges it inside the house; and reverses the operation to provide cooling during the summer. New heat pumps can operate efficiently down to -15° F. They operate using electricity, but perform two to three times more efficiently than old-style electric-resistance heaters. See http://www.energystar.gov/certified-products/detail/heat_pumps_air_source for information on Energy Star rated, efficient air source heat pumps.

Compact Fluorescent Lamp (CFLs) - are a popular and highly efficient alternative to the incandescent bulb. Many types are easily compatible with screw-in lamp fixtures and come in a wide variety of options. CFLs use about a quarter of the energy of an incandescent bulb to provide the same amount of light and last up to seven times longer, making them a wise investment.

Duct blaster - A fan attached to a forced-hot-air heating duct system to identify leaks that should be sealed.

Energy Star - Energy Star is a government-initiated labeling program created by the U.S. Environmental Protection Agency (EPA) in the early 1990s to recognize and promote energy-efficient products.

The program has also been adopted by Australia, New Zealand, Canada, Japan and Europe. Electronic devices that carry the Energy Star logo generally consume 20 to 30 percent less energy than required by federal standards.

The Energy Star logo is an international standard symbol for energy efficiency.

Forced-hot-air (FHA) - a **forced air** heating system is simply a heating system that blows hot air through duct work throughout your house.

Fuel oil, No. 2 - is a low viscosity, liquid petroleum product used as a fuel for furnaces or boilers in buildings. Heating oil consists of a mixture of petroleum-derived hydrocarbons in the 14- to 20-carbon atom range that condense between 482 and 662 °F during oil refining. Heating oil condenses at a lower temperature than petroleum jelly, bitumen, candle wax, and lubricating oil, but at a higher temperature than kerosene. Heating oil produces 138,500 British thermal units (146,100 kJ) per US gallon and weighs 8.2 pounds per US gallon (0.95 kg/l). Number 2 fuel oil has a flash point of 126 °F.

Furnace - an enclosed structure in which heat is produced (as for heating a house or for reducing ore)

Types of Heat Transfer:

- ***Conductive –*** The transfer of energy between objects that are in physical contact or heat moving through solid materials such as the wall, roof, and floor

- ***Convective –*** The transfer of energy between an object and its environment due to fluid motion or the transfer of heat by means of air currents, such as the flow of warm air up and out openings high in the building, which pulls cold air in through openings low in the building
- ***Radiant heat –*** The transfer of energy to or from a body by means of the emission or absorption of electromagnetic radiation, or the type of heat that radiates out from an element, warming objects rather than the air.

Home Performance with Energy Star (HPwES) – A national program which uses a comprehensive, whole-house approach to improving energy efficiency and comfort at home, while helping to protect the environment started by the United States Environmental Protection Agency and Department of Energy. The Home Performance with ENERGY STAR program has 40 programs, to date, across the country, which are administered by various utilities and state energy offices. Efficiency Vermont runs HPwES in Vermont – 888-921-5990, www/efficiencyvermont.com/homeperformance.

Light Emitting Diode (LED) - are semiconductor devices that produce visible light when an electric current is passed through them. LED lighting is more efficient, durable, versatile and longer lasting than traditional bulbs and CFLs.

Mastic - any of several sticky putty-like substances used as a filler, adhesive, or seal in metal duct work, wood, plaster, or masonry.

Natural gas - flammable gas, consisting largely of methane and other hydrocarbons, occurring naturally underground (often in association with petroleum) and used as fuel.

Photovoltaic (PV) – a field of semiconductor technology involving the direct conversion of electromagnetic radiation as sunlight, into electricity. A photovoltaic cell (PV cell) is a specialized semiconductor diode that converts visible light into direct current (DC).

Propane – a colorless, gaseous hydrocarbon found in petroleum and natural gas. It is widely used as a fuel.

Sealed combustion (appliances) - Sealing of combustion chamber to prevent spillage of combustion products. Draw combustion air from outside and ventilate to outdoors, often through concentric ducting.

Weather-stripping - A narrow piece of material, such as plastic, rubber, felt, or metal, installed around doors and windows to protect an interior from external extremes in temperature.