Saving Money On Your Utility Bills

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Energy Consumption in the U.S.

“You’re not actually saving any money until you have recaptured the money you spent to do the energy measure.”
A house energy “audit” guides weatherization
There is No “Silver Bullet”

• No one thing will magically cut energy expenses a lot
• Many little things all add up to greatly-reduced costs
• Calculate the “life-cycle cost”
  – Cost of installation + cost of operation over lifetime
• Concentrate first on no-cost / low-cost options that offer biggest savings
Basic Rule of Heat Transfer

Heat always flows from a warmer area to a colder area

HOT → COLD
Home Heat Loss Example

- Infiltration: 37%
- Walls: 15% (R-19)
- Ceiling: 11% (R-30)
- Floor: 21% (R-13, R-1.6)
- Glass: 13% (R-3.2)
- Doors: 3%

1500 sq. ft. home with crawl space
Four Types of Heat Loss

• **Conduction** = heat transfer through solids
  – 6 inches of fiberglass = 8 feet of brick

• **Convection** = heat transfer through liquids & gases
  – 1/8” door gap = 6” round hole

• **Radiation** = heat transfer w/o solids, liquids or gases
  – Example: Warming by sunlight

• **Ventilation** = for health, moisture control
  – 30-50% R.H. indoors is ideal
home energy solutions

- No cost
- Low cost
- More costly

- Openable skylight with low-e glass and screening
- R-38 attic insulation
- Clothesline for drying
- ridge vent
- Photovoltaic-powered attic vent
- Photovoltaic panels with approved connection to power grid
- Deciduous trees on sun-facing side
- Light-colored roofing to reflect sunlight
- IC or sealed double-wall ceiling cans
- Whole-house fan
- Compact fluorescent lamps
- Ceiling fan
- Programmable thermostat
- Drapes and blinds drawn on all sun-facing windows
- Awning shading windows
- Trellis with deciduous vines
- Compact fluorescent lamps in exterior fixtures
- Wrap water heater
- Removable shade cloth
- Motion-detecting light switch
- Caulk around plugs
- Low-e or spectrally selective tint film on windows
- portable fan
- Nonreflective ground cover
- Inspect ducts, seal with mastic or approved metallic tape
- Weather-stripping around all doors
- Low-voltage landscape lights
- Set water heater at 120°
What You Can Do NOW to Save $$

The $100 solution for your home = PLUG THE HOLES

- Expandable foam
- Weatherstrip
- Outlet insulators
- Foil duct tape
- Water heater insulation blanket
- Caulking
Seal Out the “Stack Effect”
Weatherize Against Infiltration

- Wiring, pipe & duct penetrations in attic, under floor & through walls
- Caulking where dissimilar materials meet
- Weatherstripping doors, windows & sills
- Outlet insulators on exterior walls
- Vapor barriers
  - 20 GPD evaporates from crawl space into air of 1400 sq.ft. home
  - Install 4-6 mil plastic on “warm-in-winter” side
Installing Outlet Insulators

1. Before
2. Cover removed
3. Gasket to install
4. Gasket installed
5. Cover replaced & plugs added
HVAC System Air Ducts

- Caulk, tape or mastic joints = save up to 20% of ventilation heat loss
- Don’t use cloth duct tape!
- Insulate metal ducts to R-3 to R-6
HVAC System

Installation of Duct Mastic & Insulation
Control Air Leaks – weatherstrip doors

1) Weatherstripping the face of the door
2) Weatherstripping the edge of the door
Control Air Leaks – weatherstrip doors
Water Heaters

• Insulate if warm to the touch
• Set temperature to 120°F-135°F
• 3-5% savings for each 10°F reduction
• Use thermal trap on inlet/outlet
• Insulate water lines first 2 feet

Photo credit: http://www.california.com/~positivenergy/xina/graphics/blanket.gif
Insulate and turn down water heater

120-135°F for electric

Mid or Warm for gas
Stop hot water leaks and insulate pipes.

Water stain on a basement wall - locate and fix the source of the water promptly.
Insulate Against Heat Loss
R-Value

- Definition: A measure of a material’s ability to resist the flow of heat
- Higher values = less heat flow
- Buying R-Value
  - “Material” basis vs. “Installed” basis
- Compute R-Value cost per inch
R-Value of a Wall Section

- Interior Surface: 0.68
- 3/8” Gypsum Board: 0.32
- 3 1/2” Blanket Insulation: 11.00
  (vapor barrier on warm side)
- 3/8” Plywood: 0.47
- Bevel Siding: 0.81
- Exterior Surface: 0.17

Overall R: 13.45
How Much Insulation for MO?

- Attics = R-49
- Cathedral ceilings = R-38
- Walls = R-18
- Floor over crawl space = R-25
- Crawl space wall = R-19 (if conditioned)
- Slab edge = R-8
- Basement wall = R-11 (interior) = R-10 (exterior)

## Insulation R-Values (per inch)

<table>
<thead>
<tr>
<th>Type of Insulation</th>
<th>R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiberglass Batt</td>
<td>3.14</td>
</tr>
<tr>
<td>Fiberglass Blown (attic)</td>
<td>2.2</td>
</tr>
<tr>
<td>Fiberglass Blown (wall)</td>
<td>3.2</td>
</tr>
<tr>
<td>Rock Wool Batt</td>
<td>3.14</td>
</tr>
<tr>
<td>Rock Wool Blown (attic)</td>
<td>3.1</td>
</tr>
<tr>
<td>Rock Wool Blown (wall)</td>
<td>3.03</td>
</tr>
<tr>
<td>Cellulose Blown (attic)</td>
<td>3.13</td>
</tr>
<tr>
<td>Cellulose Blown (wall)</td>
<td>3.7</td>
</tr>
<tr>
<td>Vermiculite</td>
<td>2.13</td>
</tr>
<tr>
<td>Air-entrained Concrete</td>
<td>3.9</td>
</tr>
<tr>
<td>Urea terpolymer foam</td>
<td>4.48</td>
</tr>
<tr>
<td>Rigid fiberglass (&gt; 4lb/ft³)</td>
<td>4</td>
</tr>
<tr>
<td>Expanded Polystyrene (beadboard)</td>
<td>4</td>
</tr>
<tr>
<td>Extruded Polystyrene</td>
<td>5</td>
</tr>
<tr>
<td>Polyurethane (foamed-in-place)</td>
<td>6.25</td>
</tr>
<tr>
<td>Polyisocyanurate (foil-faced)</td>
<td>7.2</td>
</tr>
</tbody>
</table>
Attic Ventilation

- DON’T cover attic vents to save heat
- 1 sq.ft. free-vent area (FVA) per 150 sq.ft. of attic area
- Screens reduce FVA by 50%
- Split FVA equally between eaves & ridge
- Allow 1½” air space between insulation & roof
Crawl Space Moisture Control

• DON’T cover foundation vents to save heat
  – Leave open if house tests positive for radon
• 1 sq.ft. FVA per 450 sq.ft. of crawl space
Which Heating Fuel Source is the Best?

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Selling Unit</th>
<th>Avg. Efficiency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>KwH</td>
<td>100-280</td>
</tr>
<tr>
<td>Natural gas</td>
<td>CCF (therm)</td>
<td>65</td>
</tr>
<tr>
<td>LP (propane) gas</td>
<td>Gallon</td>
<td>65-80</td>
</tr>
<tr>
<td>Wood</td>
<td>Cord</td>
<td>15-60</td>
</tr>
<tr>
<td>Wood pellets</td>
<td>Ton</td>
<td>80</td>
</tr>
<tr>
<td>Corn (shelled)</td>
<td>Bushel</td>
<td>80</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>Gallon</td>
<td>60</td>
</tr>
<tr>
<td>Kerosene</td>
<td>Gallon</td>
<td>85</td>
</tr>
<tr>
<td>Coal</td>
<td>Ton</td>
<td>60</td>
</tr>
<tr>
<td>Biomass</td>
<td>Ton</td>
<td>40</td>
</tr>
</tbody>
</table>
Standard Heating Unit (SHU)

• One SHU = 100,000 BTUs

• Cost per SHU
  \[\text{Cost per SHU} = \text{Fuel cost} \times \frac{100,000}{\text{(Heat Content} \times \text{Avg. Sys. Eff.)}}\]

• LP (propane) gas = $1.73/gal \times \frac{100,000}{(91,000 \text{ BTUs} \times 0.65)}
  = $2.93 per SHU

• Electricity = $0.10/KwH \times \frac{100,000}{(3413 \text{ BTUs} \times 1.00)}
  = $2.93 per SHU
### How They Rank (8/24/15)

<table>
<thead>
<tr>
<th>Heating System</th>
<th>Fuel Cost</th>
<th>Cost per SHU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-tight stove - dry red oak</td>
<td>$140 / cord</td>
<td>$0.92</td>
</tr>
<tr>
<td>Geothermal heat pump</td>
<td>$0.10 / KwH</td>
<td>$1.05</td>
</tr>
<tr>
<td>Pellet stove - shelled corn</td>
<td>$3.70 / bushel</td>
<td>$1.18</td>
</tr>
<tr>
<td>Pellet stove - wood pellets</td>
<td>$210 / ton</td>
<td>$1.60</td>
</tr>
<tr>
<td>LP gas H.E. forced-air furnace</td>
<td>$1.21 / gallon</td>
<td>$1.66</td>
</tr>
<tr>
<td>Biomass burner</td>
<td>$100 / ton</td>
<td>$1.74</td>
</tr>
<tr>
<td>Air-to-air electric heat pump</td>
<td>$0.09 / KwH</td>
<td>$1.78</td>
</tr>
<tr>
<td>LP gas older forced-air furnace</td>
<td>$1.21 / gallon</td>
<td>$2.05</td>
</tr>
<tr>
<td>Natural gas forced-air furnace</td>
<td>$1.70 / therm</td>
<td>$2.13</td>
</tr>
<tr>
<td>Forced-air furnace - #2 fuel oil</td>
<td>$2.21 / gallon</td>
<td>$2.66</td>
</tr>
<tr>
<td>Electric resistance heat</td>
<td>$0.10 / KwH</td>
<td>$2.93</td>
</tr>
</tbody>
</table>
Air Filters - MERV

Minimum Efficiency Reporting Value (MERV)

ASHRAE Standard 52.2
Efficiency in collecting very small particles

## MERV Ratings

<table>
<thead>
<tr>
<th>MERV</th>
<th>PARTICLE CONTAMINANT</th>
<th>TYPICAL CONTROLLED SIZE (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 4</td>
<td>&gt;10.0</td>
<td>Pollen, sanding dust, textile and carpet fibers</td>
</tr>
<tr>
<td>5 – 8</td>
<td>3.0 – 10.0</td>
<td>Mold, spores, hairspray, cement dust</td>
</tr>
<tr>
<td>9 – 12</td>
<td>1.0 – 3.0</td>
<td>Legionella, lead dust, welding fumes</td>
</tr>
<tr>
<td>13 – 16</td>
<td>0.3 – 1.0</td>
<td>Bacteria, most tobacco smoke, insecticide dust, copier toner</td>
</tr>
<tr>
<td>17 – 20</td>
<td>≤ 0.3</td>
<td>Virus, combustion particles, radon progeny</td>
</tr>
</tbody>
</table>
Poorly sealed filter access panel
Comparing Light Bulbs

- Watt = amount of energy used
- Lumen = amount of light produced

<table>
<thead>
<tr>
<th>Light Output (lumens)</th>
<th>Incandescent 1,200 hour life (watts)</th>
<th>Fluorescent 8,000 hour life (watts)</th>
<th>LED 50,000 hour life (watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>40</td>
<td>10</td>
<td>4-5</td>
</tr>
<tr>
<td>800</td>
<td>60</td>
<td>15</td>
<td>6-8</td>
</tr>
<tr>
<td>1100</td>
<td>75</td>
<td>20</td>
<td>9-13</td>
</tr>
<tr>
<td>1600</td>
<td>100</td>
<td>26</td>
<td>16-20</td>
</tr>
<tr>
<td>2600</td>
<td>150</td>
<td>28</td>
<td>25-28</td>
</tr>
</tbody>
</table>
More Ways to Save Energy

- Replace/clean furnace filter every 1-3 months
- Energy-saving (programmable) thermostats ($50-$100)
  - Winter: Set heating unit to 68°F max. (63°F night-time)
    - 3% more energy use per degree increase
  - Summer: Set air conditioning to 78°F min.
    - 8% more energy use per degree decrease
- Clean lime from water heater
- Re-level blown-in attic insulation
- Set ceiling fans for season
- Insulate attic access door
- Unplug appliances when not used
- Put tight-fitting doors on open fireplaces
More Ways to Save Energy

• Clean refrigerator coils; remove frost from freezers
• Keep lights clean; shut off when not in use
• Use south-facing windows to collect solar heat
• Personal attitude & behavior
• Wear layered warm clothes indoors during winter
• Take short showers instead of baths
• Regulate windows & doors (train kids)
• Upgrade to EnergyStar-efficient appliances
• Plant trees (deciduous on south; evergreens on north)
## Investing in Energy Efficiency

<table>
<thead>
<tr>
<th>Energy Measure</th>
<th>Return on Investment, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change to fluorescent lamps</td>
<td>41</td>
</tr>
<tr>
<td>Seal heating and cooling ducts</td>
<td>41</td>
</tr>
<tr>
<td>Upgrade to EnergyStar clothes washer</td>
<td>37</td>
</tr>
<tr>
<td>Replace refrigerator with EnergyStar unit</td>
<td>37</td>
</tr>
<tr>
<td>Install EnergyStar programmable thermostat</td>
<td>30</td>
</tr>
<tr>
<td>Install R-12 water heater insulation jacket</td>
<td>28</td>
</tr>
<tr>
<td>EnergyStar heat pump to replace old HVAC system</td>
<td>19</td>
</tr>
<tr>
<td>Upgrade to EnergyStar dishwasher</td>
<td>18</td>
</tr>
<tr>
<td>Weatherizing and sealing the home</td>
<td>9</td>
</tr>
<tr>
<td>Increase wall and attic insulation to DOE levels</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Lawrence Berkley National Laboratory, 1997 costs
My Top 10 Cheap List for Homes

- Caulk outside joints where dissimilar materials meet
- Weatherstrip exterior door and window gaps
- Install interior storm window kits on single-pane glass
- Insulate older water heaters; set temp. to 120-135°F
- Seal air duct leaks; put tight-fitting doors on open fireplaces
- Use south-facing windows to collect solar heat
- Use CFLs/LEDs; keep lights clean; shut off when not in use
- Add attic insulation if now less than 6 inches thick
- Wear clothing in layers & set back thermostat
- Involve whole family in energy management program
Farms
Cutting Tractor Fuel Consumption

• Do a general tune-up to manufacturer specs.
• Replace tractor oil & fuel filters to improve efficiency
  – 3.5% increase if somewhat dirty
  – 10-20% increase if extremely dirty
• Match the tractor to the load
• “Gear up and throttle down”
  – Reduce engine RPM up to 20% in higher gear
  – 15-30% fuel saved
Cutting Tractor Fuel Consumption

• Use radial tires. Adjust tire pressure based on load
  – 6-7 psi normal
  – 10-12 psi for rough terrain or heavy loads
• Ballast tractor to give 8-15% wheel slippage
• Combine or cut trips over the field (no-till)
Livestock Buildings

• Most heat loss occurs through ventilation
  – Resist temptation to under-ventilate to save energy; fine-tune ventilation instead
  – Ventilate to provide about 60% relative humidity

• Do regular maintenance on environmental controls
  – Clean shutters, fan blades & motor fins
  – Check heater controller settings (so heat & fans don’t compete)

• Check curtains for tight fits; patch holes

• Insulate heated buildings
  – Keep insulation dry with vapor barriers
  – Protect insulation from rodents (sanitation, screen out, baits, traps)
More Farm Energy-Saving Tips

• Soil test before applying lime or fertilizer
• Know the fertilizer value of your manure & use it
• Use cattle instead of machinery to harvest forage
• Spray weeds instead of brush-hogging them
• Calibrate your sprayer before applying chemicals
• Use radios or cell-phones to communicate rather than driving
• Install impact barriers around fuel tanks
• Install locks on fuel tanks; remove keys from tractors
That’s a lot to chew on!
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  Room 326-W, Whitten Building  
  14th and Independence Ave., SW  
  Washington, DC 20250-9410

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