



The Energy Roadmap: Making Cost-Effective Efficiency Upgrades to Your Home

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Remodeling ...

People think ...

- Kitchen cabinets
- Countertops
- Sinks
- Carpeting



What about . . .

- Air leakage
- Leaky furnace ducts
- Insulation levels
- Appliance efficiency



Saving Energy with Home Performance Upgrades

- Saves you Money...
- Can Improve your Health...
- Can Improve your Comfort...
- Maximize Property Value...
- Can help the Environment...

Foster City Remodel Scenario



- Homeowners are planning a partial remodel or addition
- What should they address to improve energy-efficiency?

Energy Audit



- Performed by a Building Performance Institute (BPI) Certified “Building Analyst Professional”
- Not:
 - On-line
 - Over-the-phone
 - Electricity-only
 - Uncertified volunteers

BPI Building Analyst Home Performance Evaluation

- Air infiltration tested with Blower Door
- Furnace and major appliance efficiency evaluated
- Insulation levels evaluated
- Utility bill analysis



BPI Building Analyst Home Performance Evaluation

- Performed by a “Building Analyst Professional” certified by the Building Performance Institute
- Combustion safety testing
 - Carbon Monoxide production tested at furnace, water heater range, oven
 - Natural gas leaks tested for
 - Backdrafting tested at furnace & water heater



BPI Building Analyst Home Performance Evaluation

- May include
 - Duct Leakage Test
 - Air flow measurements
 - Lighting efficiency
 - Water fixture flow and toilet leakage test
 - Infrared thermal imaging
 - Electrical load measurements



Cost-Effectiveness: Prioritize Fundamentals

Fundamentals	Major Systems	Renewables
<ul style="list-style-type: none">•Behavior•Plug Loads•Weatherization•Timing Systems•Lighting•Air Sealing•Duct Work•Insulation•Appliances•Water & Vapor•Spot Ventilation	<ul style="list-style-type: none">•Air Conditioning•Heating•Ventilation Systems (HRV)•Water Heating•Windows	<ul style="list-style-type: none">•Solar Photovoltaic (PV)•Solar Thermal•Geo-Thermal•Water Catchment•Wind Turbines



Top 6 Areas for Cost-Effective Energy Efficiency Improvements



1. Lighting
2. Sealing
3. Insulation
4. Air Ducts
5. Pumps & Appliances
6. Furnace

1. Lighting Efficiency

Identify incandescent bulbs that can be replaced with fluorescents or LEDs.



Lighting Upgrade: Savings Potential

- \$ savings potential for replacement of incandescents with CFLs is huge.
- “Using new lighting technologies can reduce lighting energy use in your home by 50% to 75%.”

U.S. Dept. of Energy, *Energy Saver\$: Tips on Saving Energy and Money at Home* at 20 (Jan. 2006).

	100w Incandescent	23w CFL
Watts	100 w	23 w
Hours used	8000 hrs	8000 hrs
# of bulbs required	8	1
Cost per bulb	\$0.63	\$2.00
Total bulb cost	\$5.04	\$2.00
Energy used	800 kWh	184 kWh
Energy cost per kWh	\$0.12	\$0.12
Energy cost total	\$96.00	\$22.08
Total Cost	\$101.04	\$24.08
Savings with CFL		\$76.96

2. Seal Holes in Floor, Walls & Attic

Stack Effect

Imagine a hot air balloon. The balloon's hot air is more buoyant than the cool air around it, so the balloon rises. As we heat our homes, the warm air rises toward the ceiling. Roughly 20% - 30% of this costly warm air escapes into our attics, and the make-up air comes from our crawlspaces.



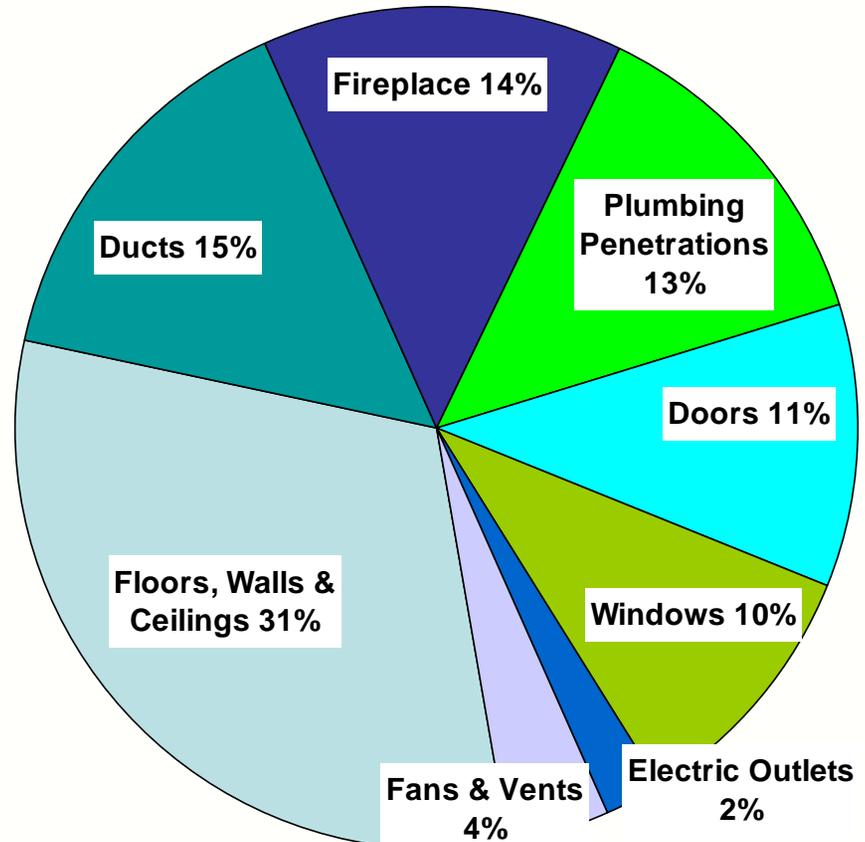
graphics by Energy Star

Air Sealing Cont.

“You can increase the comfort of your home while reducing your heating and cooling needs by up to 10% by investing in proper insulation and sealing air leaks.”

Energy Saver\$ at 4.

Primary Air Infiltration Locations

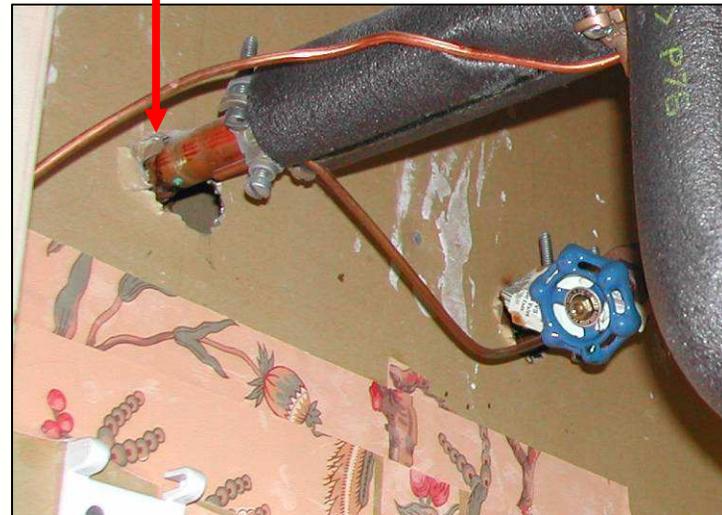


Data: David Johnson, What's Working, for Build It Green (2007);
graphics © Emerson Environmental, LLC

Seal Holes in Walls/Ceilings



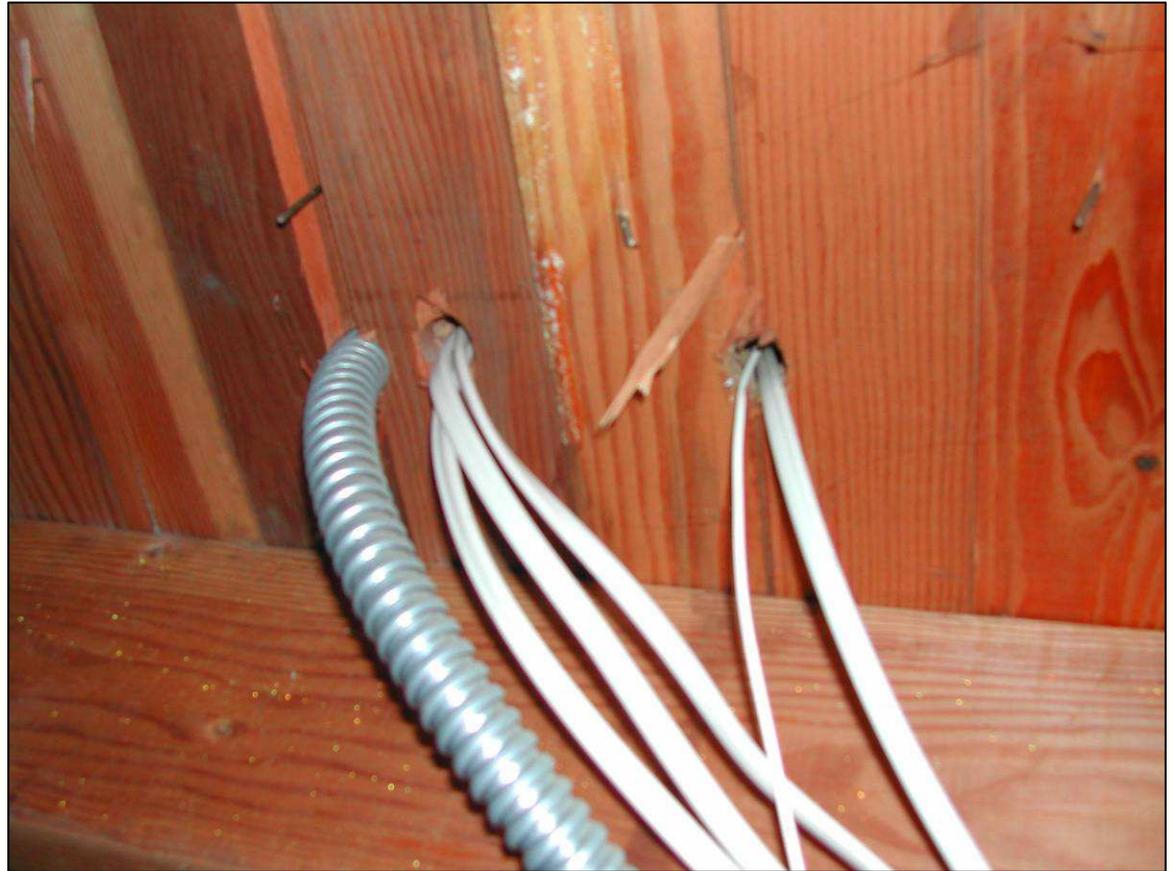
Seal openings around pipes and electrical lines, vents and ducts.



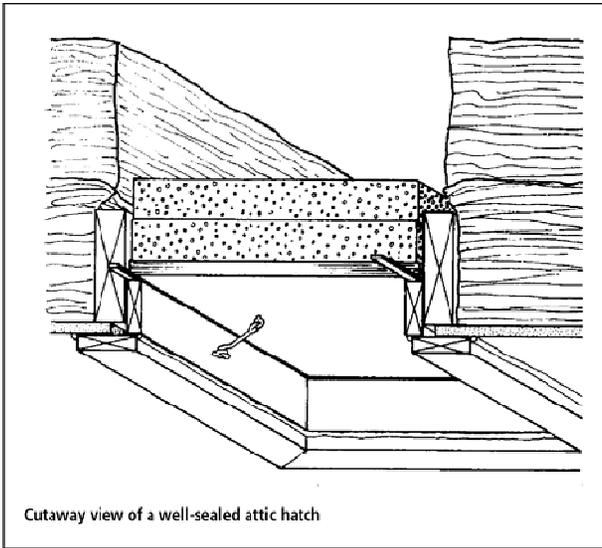
Seal Between Attic and Conditioned Space



Seal Sub-Floor in Crawl Space



Seal and Insulate Attic Entrance



3. Insulate

R-38 attic

New homes are required to have an insulation level of R-30 in their attic, but R-38 is recommended*, and R-50 is great.

R-15 wall

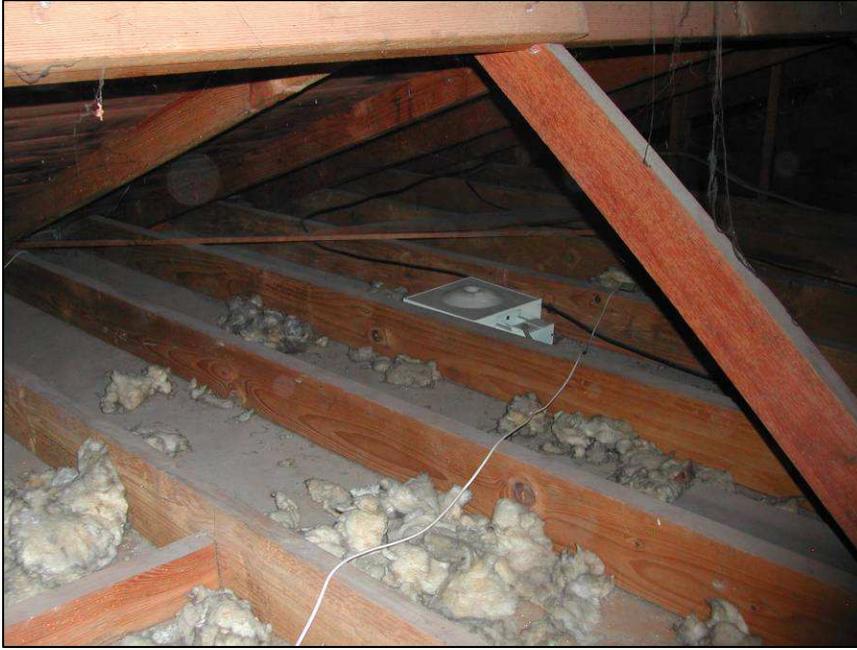
R-13 is standard, but High-Density R-15 batts or loose-fill can be used.

R-13 to 19 floors

*U.S. Department of Energy Recommended R-Values, for homes heated with natural gas in this climate zone.



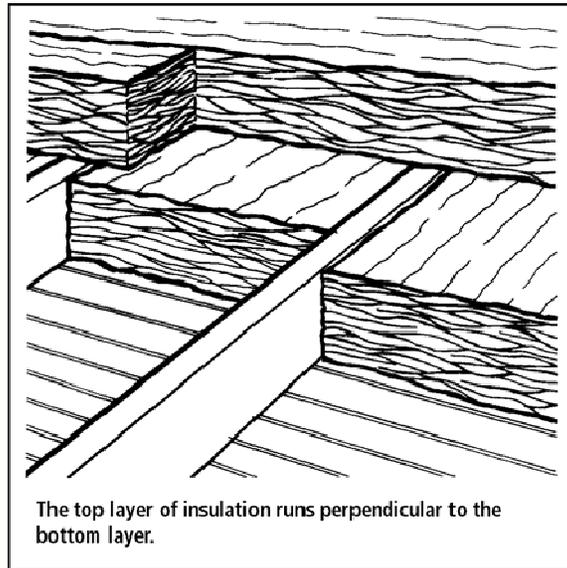
Insulate Attic



“One of the most cost-effective ways to make your home more comfortable year-round is to add insulation to your attic.”

Energy Saver\$ at 6.

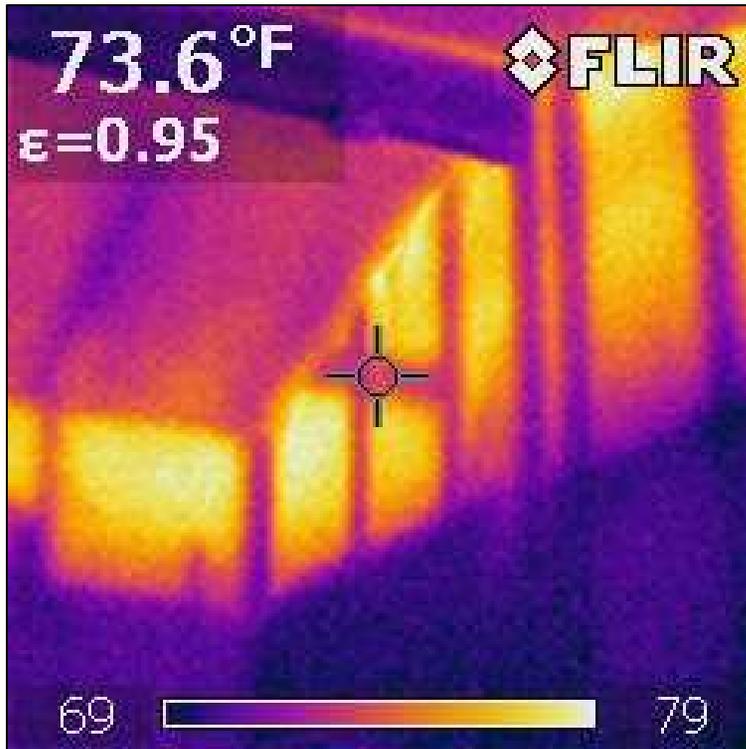
Insulate Attic



- Preferably blown-in cellulose.
- Bury air ducts
- Needs to come into contact with all 5 sides of the joist bay to work effectively -- make sure no gapping or compression.
- Pay close attention to kneewalls and wrap with FSK to improve R-Value

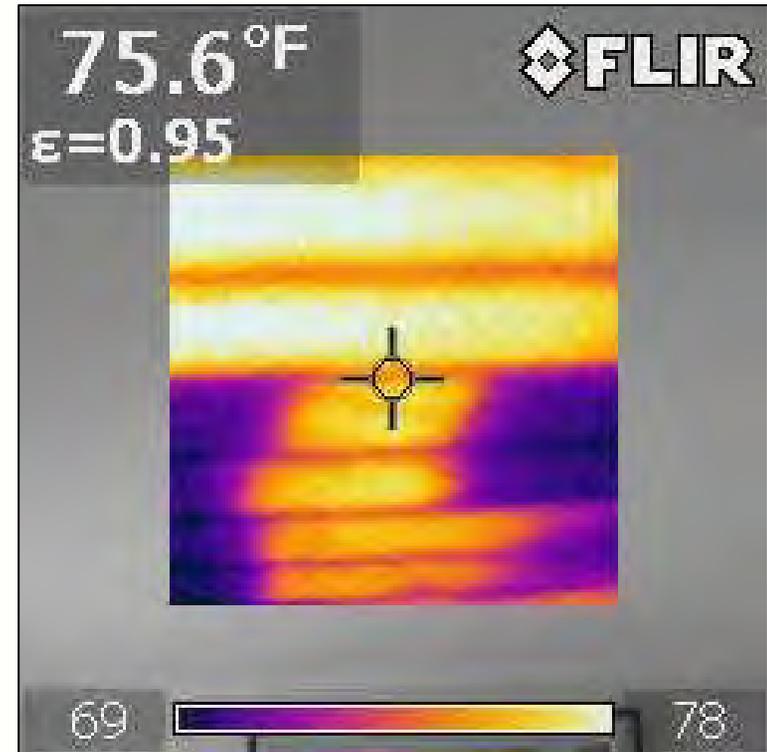


Infrared Photos of Poor Insulation



This wall **WAS INSULATED!!!**

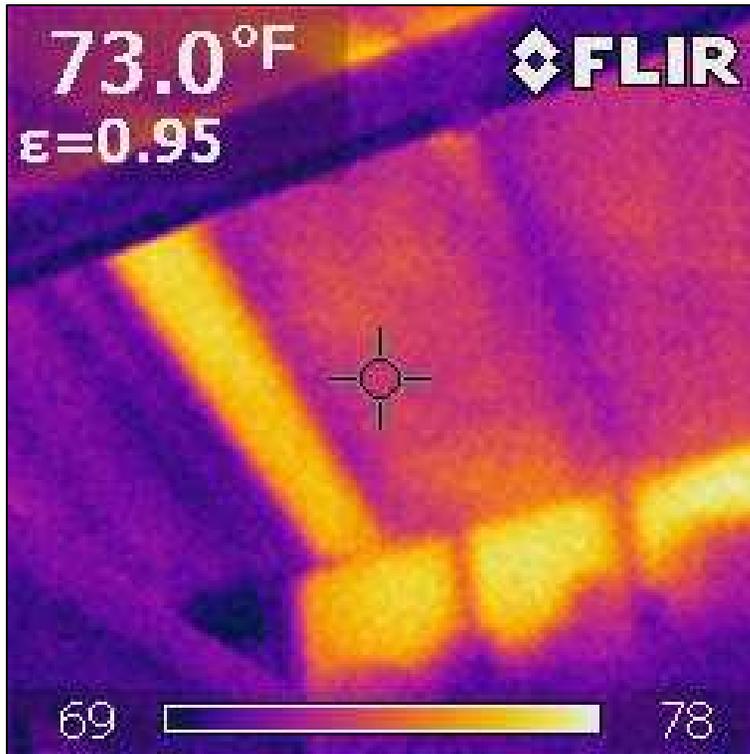
Attic knee-walls are often the worst performing thermal area in the home!



Areas of **MISSING INSULATION...**

Photo shows insulation missing in vaulted ceiling and excessive heat gain from hot attic space.

Infrared Photos of Poor Insulation

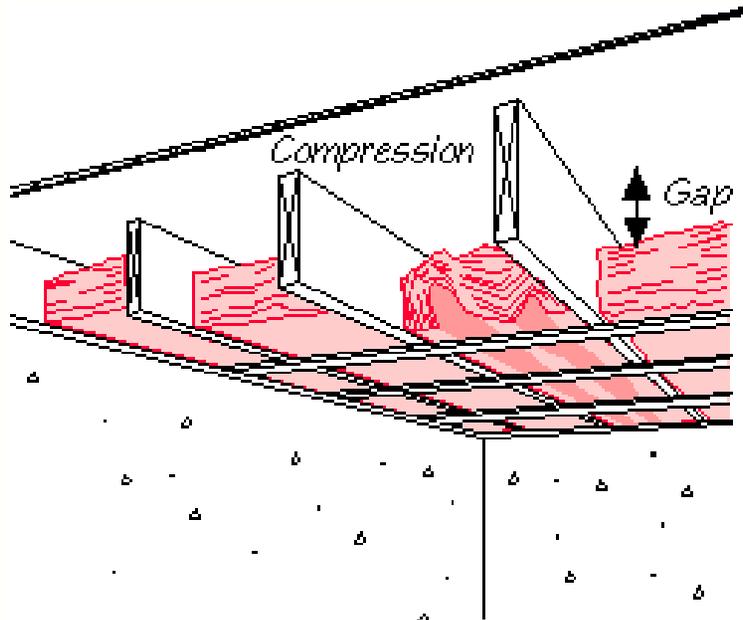


This knee- wall **WAS INSULATED!!!**
(See attic photo on right)



Insulation is not secured and has fallen off...

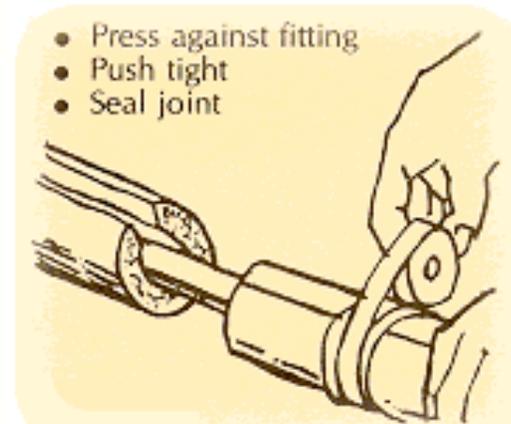
Insulate Under First Floor



Two common flaws in floor insulation are gaps above the batt and compression of the batt in the cavity.



Insulate Hot Water Lines



4. Seal & Insulate Ducts

Duct leakage: “20-40% losses, if located outside conditioned space — Like having 3 registers going outside.”

Max Sherman, Lawrence Berkeley National Laboratory, Green Living Forum (Aug. 30, 2007).

“You can lose up to 60% of your heated air before it reaches the register if your ducts aren’t insulated and they travel through unconditioned spaces such as the attic or crawlspace.”

Energy Saver\$ at 12.

Seal & Insulate Ducts



Seal your heat ducts, return ducts, air handlers, register boots, and connections between the boots and the floor or wall, and insulate the entire duct system to R-6 or R-8.



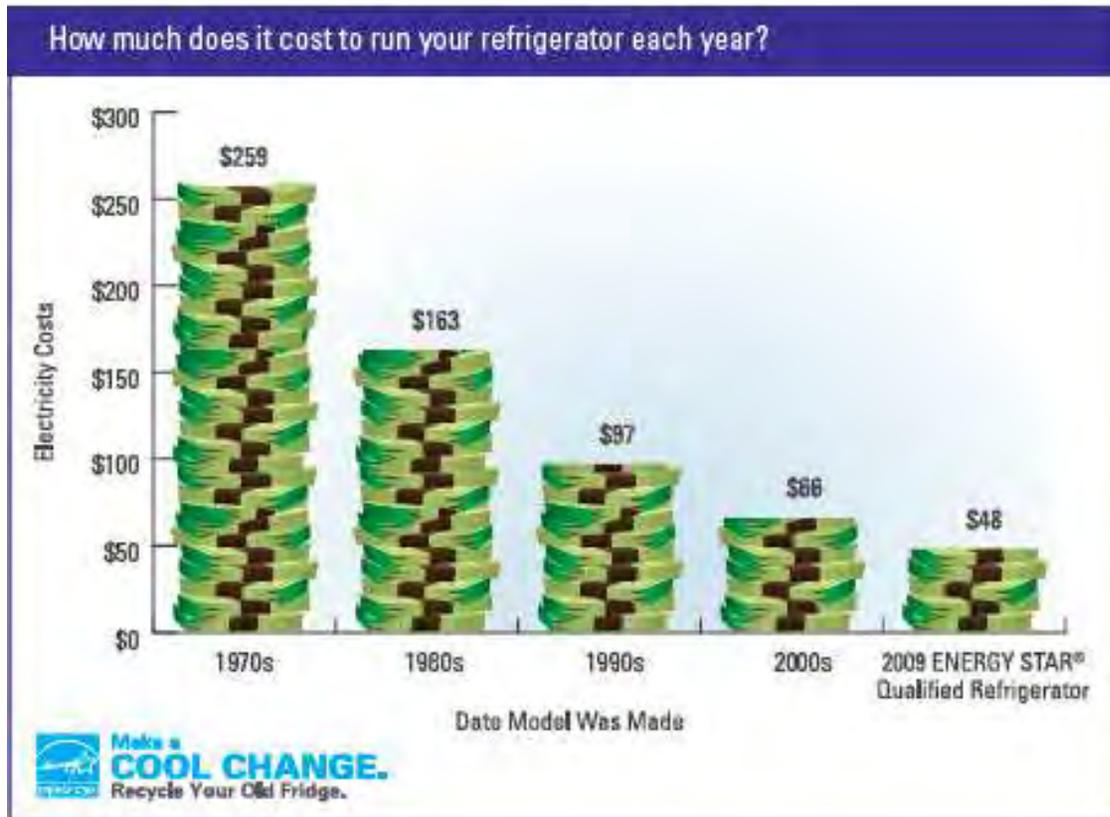
5. Pumps & Appliances: Pool & Spa

- 2-speed or variable speed pumps are more efficient than single-speed pumps.
- Include aesthetically-pleasing cover



The Energy Roadmap, 9/15/2010 -- City of Foster City/Environmental Sustainability Task Force "Go Green" Speaker Series

Refrigerator Replacement



Shopping list:
Energy Star or
CEE Super-
Efficient Home
Appliances lists
www.cee1.org

“If you have an old style, inefficient refrigerator, it may be costing you as much as \$280 a year in electricity in areas with high electrical rates. That means that a new, more efficient model will pay for itself just from the energy savings alone.” Cal. Energy Commission, <http://www.consumerenergycenter.org/home/appliances/refrigerators.html>.

Dishwasher Efficiency



Look for a model with a high Energy Factor. Energy Star web site lists Energy Factor for dishwashers.

Clothes Washer



Look for an Energy Star rated front-loading washer, to reduce water use and spin more water out of the laundry, reducing energy use by dryer. Chose a model with a low Water Factor. <http://www.cee1.org/resid/seha/rwsh/rwsh-prod.pdf>

“[N]ew washers on the market today can cut your energy use by as much as 70 percent.”

California Energy Commission,
<http://www.consumerenergycenter.org/home/appliances/washers.html>.

Toilet Flow Rate

Replace toilet if flow is over 1.6 gallons per flush. Preferably install a 1.28 gpf max or dual-flush toilet. See Cal. Urban Water Conservation Council for MaP test results:

<http://www.cuwcc.com/resource-center/products/toilet-fixtures/MaP-UNAR.aspx>



Think of water as energy.

Energy is used in water supply and conveyance, pre-use treatment, distribution and system pressurization, heating and cooling, and wastewater treatment.

Water-related energy use consumes 19% of California's electricity and 30% of its natural gas.

California Energy Commission, "California's Water-Energy Relationship" at 1, 8 (Nov. 2005) (2001 data). The Energy Roadmap, 9/15/2010 -- City of Foster City/Environmental Sustainability Task Force "Go Green" Speaker Series

6. Furnace Sizing & Efficiency

Your Car:

Each vehicle reaches its optimal fuel economy at a different speed. Gas mileage usually decreases rapidly at speeds above 60 mph (See Chart).

Aggressive driving (speeding, rapid acceleration and braking) wastes gas. **It can lower your gas mileage by 33 percent** at highway speeds and by 5 percent around town.



Your Furnace:

National surveys have determined that well over half of all HVAC contractors do not size heating and cooling systems correctly. The most common sizing mistake is over-sizing. Oversized heating and cooling equipment causes short run-time cycling which creates discomfort, more power draws and uneven conditioning throughout a home.

You can assume that each 5 mph you drive over 60 mph is like paying an additional \$0.24 per gallon for gas.

<http://www.fueleconomy.gov/feg/driveHabits.shtml>

Furnace Sizing & Efficiency

Properly sized heating and cooling systems should always be designed based on the climate zone you live in, and the actual heating and cooling needs of your home (loads).

The Air Conditioning Contractors of America have created standards that have been in practice for years!

- Manual J (equipment sizing loads)
- Manual D (duct design and sizing)
- Manual S (equipment selection)
- Manual T (air velocity, throw, drop and spread)



Duct Sizing & Effects

In order for home owners to be comfortable, a duct system must be designed to carry the right amount of air, at the right speed, into the right room. If the ducts are the wrong size then the wrong amount of air will enter the room and may cause:

- The room to be too warm or too cool
- The air to be too drafty
- The air to be too noisy
- The air to be too slow – causing poor circulation and mixing
- The fan to work harder, fail sooner, and use more energy to move air
- The furnace or air conditioner safety devices to stop equipment operation
- Pressure differentials that may increase energy costs by pushing out conditioned air or drawing in unwanted air



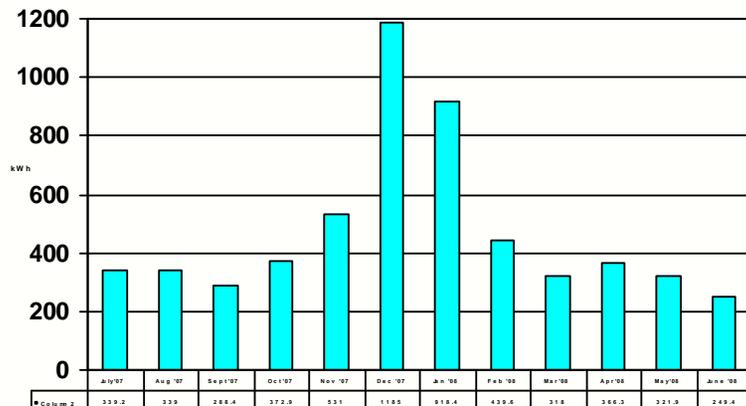
Example Suggested Retrofit



All-electric 1979 townhouse
Recommended:

- Replacement of Baseboard electric heaters with heat pump
- Increased attic insulation R-38
- Sealing of numerous air leaks
- Techniques for summer cooling
- Cost-effective appliance upgrades
- High-efficiency lighting
- Solar thermal hot water system

Electrical Usage by kWh



Basic air sealing with expansion foam



© Energy Beyond Design Inc. 2010

Basic air sealing with expansion foam and plywood



© Energy Beyond Design Inc. 2010

Duct insulation and sealing



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New insulation – Meeting Title 24 & Energy Star Standards

**R-38 Loose Fill
(14.5 inches)**



HVAC System Upgrade

R-8 Insulated Ducting

Demand H2O heater

Heat Pump (condenser outside)

SEER 17

Heat Recovery Ventilator (HRV)

High Efficiency Air Filtration



Crawlspace Sealed Vapor Barrier installed to control unwanted moisture and odors from entering home – Indoor Air Quality Improvement

