Energy Innovations in Residential Buildings

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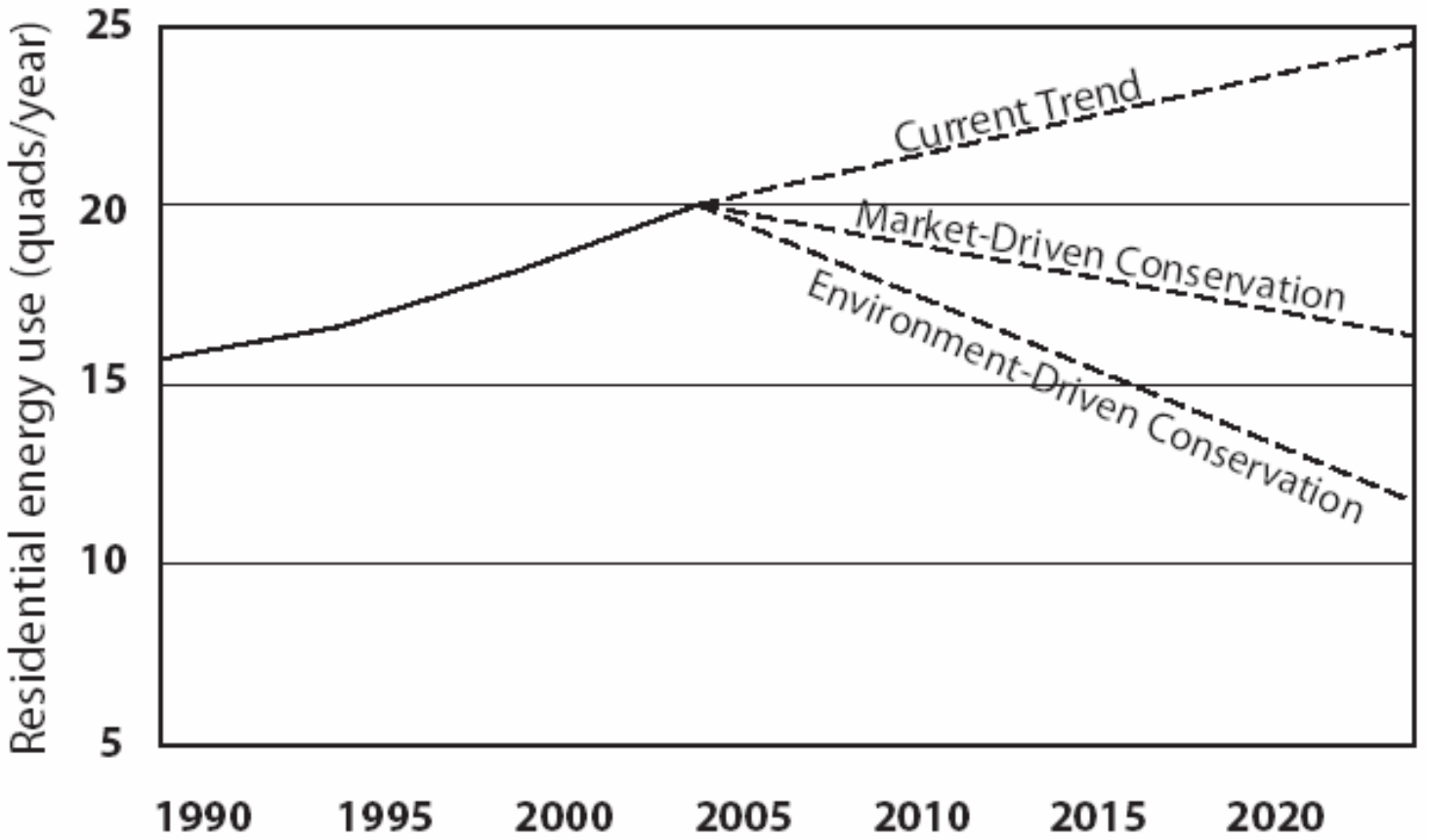
Energy conservation vs. energy efficiency

- Energy conservation focuses on lifestyle changes that result in less energy use. While effective in the short-term, most people are unwilling to make dramatic or long-term lifestyle changes.
- Energy efficiency focuses on doing more with less energy through innovative design and technology.

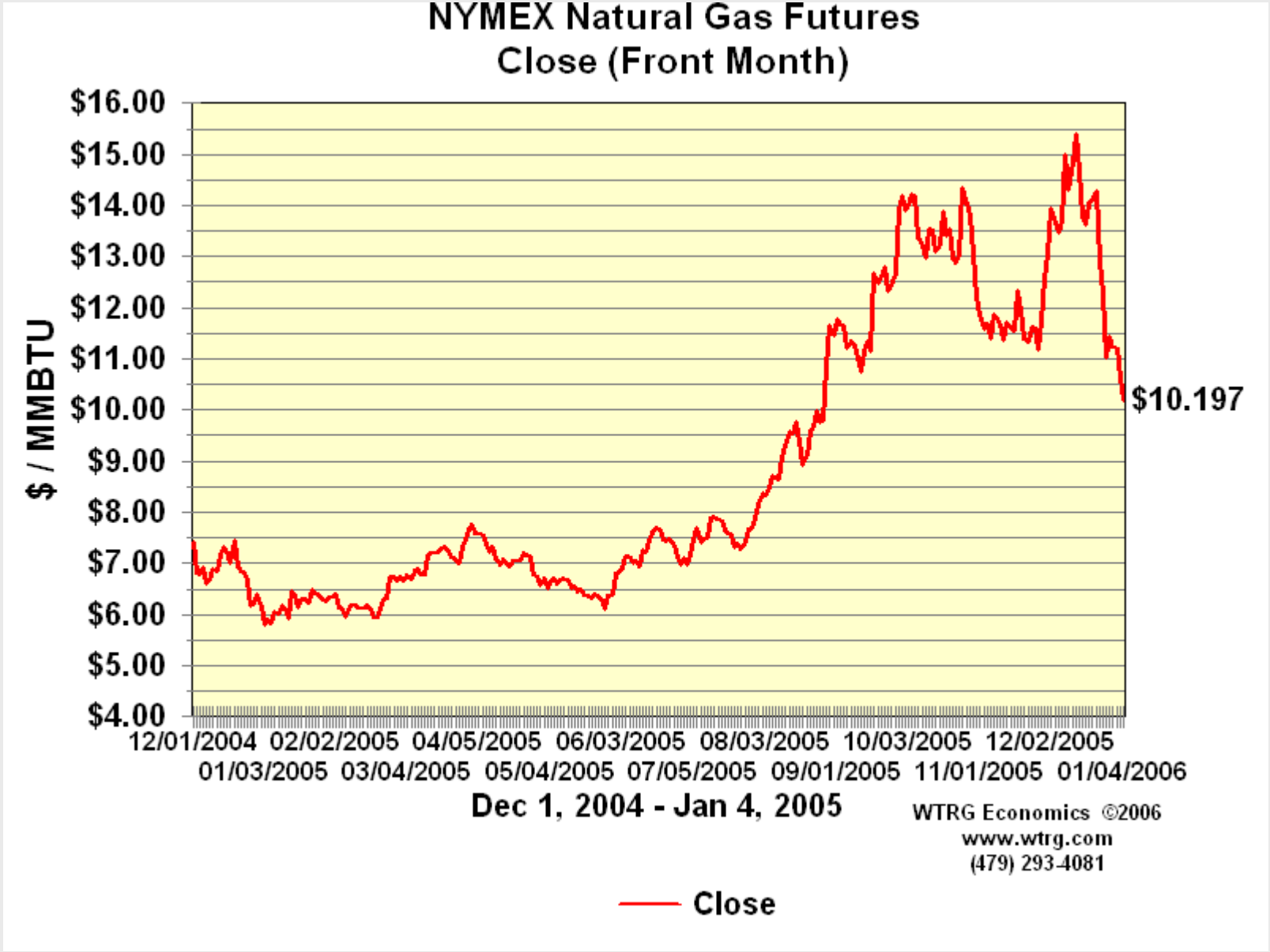
Past, Present, and Future Energy Consumption



From Energy Infomation Administration, DOE Energy Efficiency and Renewable Energy Division, and American Council for an Energy Efficient Economy

Each citizen helps make the decision about which energy path we will follow in the future. International standards favor returning to 1990 annual energy consumption.

Residential Energy, John Krigger


NYMEX Natural Gas Futures
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Potential for efficiency

- Typical residential buildings use 1.5 to 2 times as much energy as is necessary.
- Energy Star homes today use 30 to 50 percent less energy than homes built to the 1993 Model Energy Code.
- “Zero Energy” homes are being built as demonstrations in many parts of the country.

Characteristics of today's energy-efficient homes

- Very tight construction
- High-performance insulation products
- Insulation of entire building envelope (including floors, foundations & basements)
- High-performance windows
- Air-tight ducts
- High-efficiency HVAC equipment
- High-efficiency lights and appliances
- Mechanical ventilation
- Limited solar (passive, DHW, PV)

The benefits:

- High comfort level
- Healthy indoor air quality
- Comfortable, but not excessive, RH
- High durability and low maintenance
- Added initial cost easily offset by lower energy costs

Tight construction

- All building connections sealed with appropriate materials during construction.
  - Between window or door frames and wall assemblies
  - Between wall assemblies and ceilings and floors
  - Between sill plates and foundations
  - All openings for utility and service penetrations
  - All openings for electrical or plumbing connections


A
B

Blower door testing

Foundation insulation

- Foundation insulation is cost-effective and represents the largest untapped opportunity for energy savings for otherwise energy-efficient homes.
- Foundation insulation improves comfort.

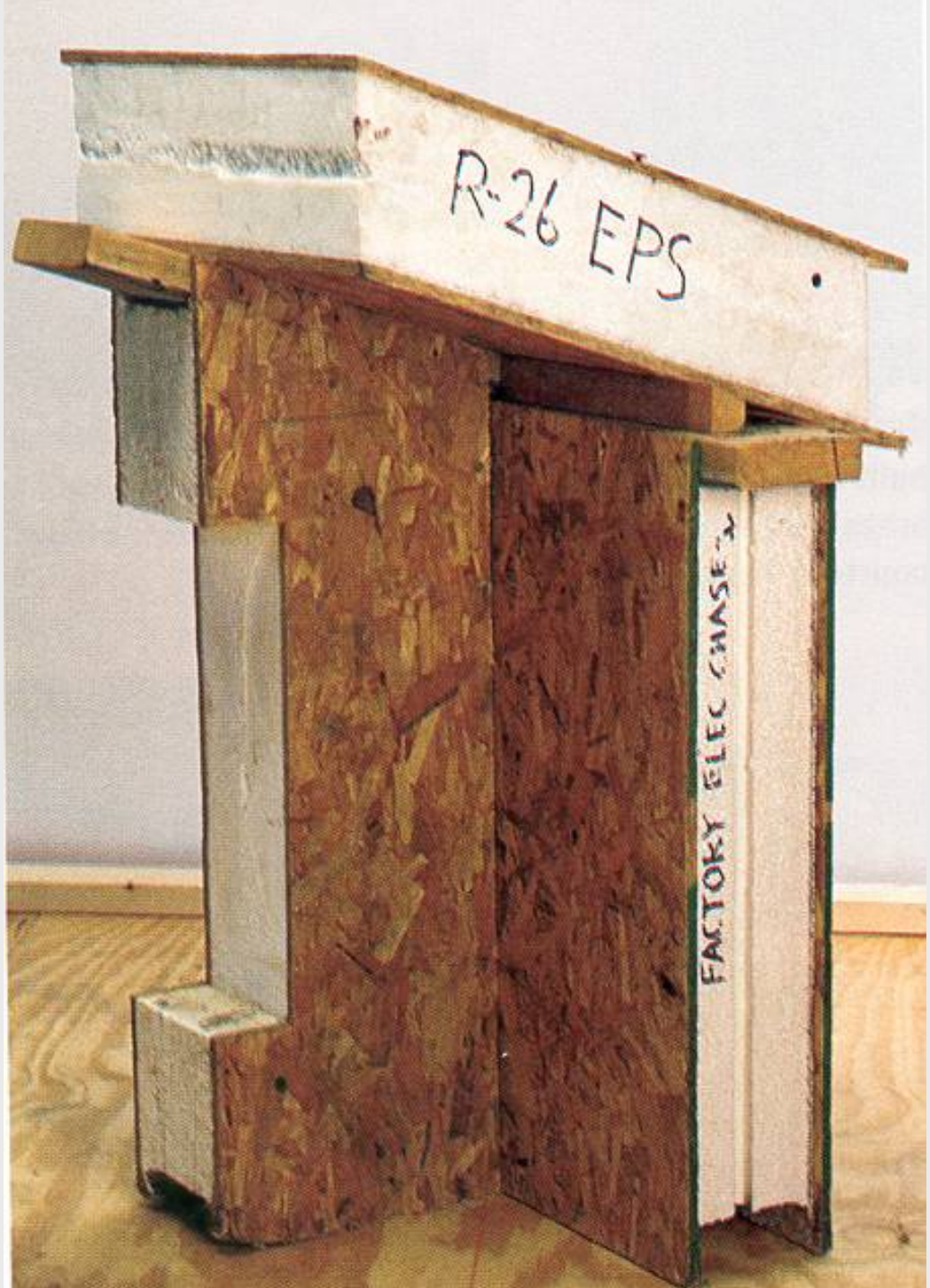
Foundation Insulation R-value			
	Southeast	Central	Northwest
Basement Walls			
Minimum	8	9	10
Better	10	10	15
Crawlspace Walls			
Minimum	10	10	10
Better	15	15	15
Slab-on-Grade			
Minimum	6	6	6
Better	8	8	8


LITE-FC
ORM

Wall insulation

Wall Insulation R-value			
	Southeast	Central	Northwest
Minimum	13	13	15
Better	16	18	20

- Air seal all construction joints.
- If window area exceeds 18 percent of wall area, better windows or higher levels of wall insulation should be used.


R-26 EPS
FACTORY ELEC CHASE

Attic insulation

Attic Insulation R-value			
	Southeast	Central	Northwest
Minimum	38	38	42
Better	40	42	48

- Seal all wiring, plumbing, and other penetrations into the attic.
- Insulation in cathedral ceilings should also meet these standards.
- Use raised-heal trusses to achieve recommended R-values above exterior wall top plates.

Windows

Window U-value			
	Southeast	Central	Northwest
Minimum	.45	.40	.35
Better	.35	.34	.33

- The lower the U-value, the better.
- Standard double-pane windows have a U-value of about .55.
- High-performance windows use low-e coatings, argon gas between the glass, and high-performance spacers.

Characteristics of Glass Assemblies

Glazing Type	U-value	R-value	Transmittance	
			Solar	Visible
Single Glass	1.1	0.9	84%	90%
Single Glass with Storm Window	0.50	1.5–2.0	70%	81%
Insulated Glass	0.56–0.50	1.6–2.0	70%	81%
Low-e Insulated Glass	0.40–0.29	2.5–3.5	58%	76%
Low-e Insulated Glass with Argon	0.34–0.23	2.9–4.4	58%	76%
Insulated Glass with Suspended Film	0.23–0.12	4.1–8.1	41%	71%

Solar transmittance measures heat energy that passes through a window. Visible transmittance measures the percentage of visible light transmitted by the glass.

Floor insulation

Floors Over Unheated Spaces R-value			
	Southeast	Central	Northwest
Minimum	19	19	19
Better	30	30	30

- Floors over outside air should be insulated to the same level as ceilings.

Duct Tightness

Duct sealing with mastic

Duct sealing with mastic

Duct sealing with mastic

Heating/Cooling Equipment

Heating and Cooling Equipment			
	Southeast	Central	Northwest
Warm-Air Furnace (AFUE)			
Minimum	.78	.78	.78
Better	.93	.93	.93
Air Conditioner or Heat Pump in the Cooling Mode (SEER)			
Minimum	10	10	10
Better	14	14	12
Air-Source Heat Pump (HSPF)			
Minimum	6.8	6.8	6.8
Better	8.5	8.5	8.5
Ground-Loop Heat Pump – Cooling (EER)			
Minimum	13	13	13
Better	18	18	18
Ground-Loop Heat Pump – Heating (COP)			
Minimum	3.1	3.1	3.1
Better	3.9	3.9	3.9
Ground-Water Heat Pump – Cooling (EER)			
Minimum	16.2	16.2	16.2
Better	22	22	22
Ground-Water Heat Pump – Heating (COP)			
Minimum	3.6	3.6	3.6
Better	4.4	4.4	4.4

Equipment Performance Ratings

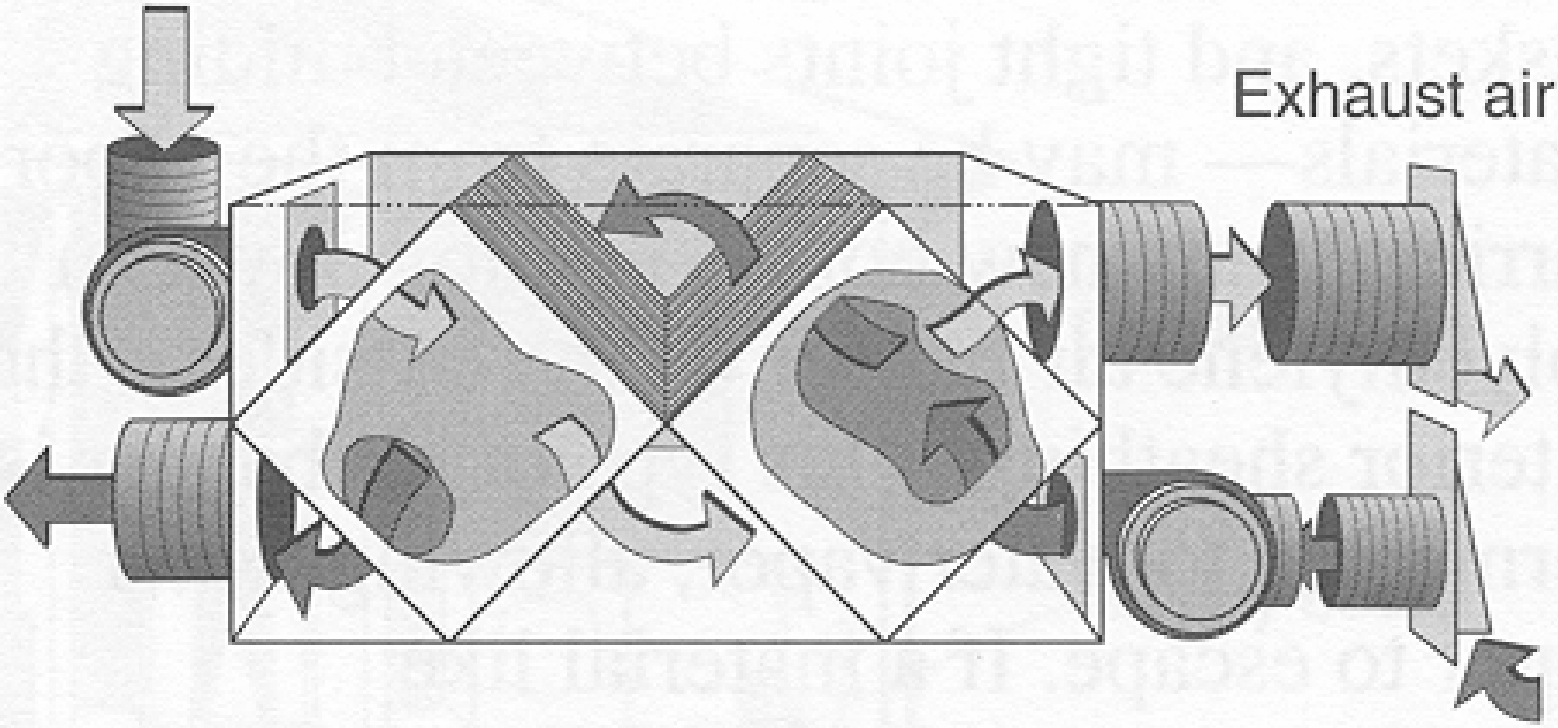
- *Annual Fuel Utilization Efficiency, AFUE* – used to rate gas or propane warm-air furnaces and small boilers.
- *Seasonal Energy Efficiency Ratio, SEER* – performance indicator for residential air conditioners and air-source heat pumps.
- *Heating Seasonal Performance Factor, HSPF* – measures heating performance of air-source heat pumps.
- *Energy Efficiency Ratio, EER* – used to rate window air conditioners and ground-loop or ground-water heat pumps in the cooling mode.
- *Coefficient of Performance, COP* – used to rate ground-loop or ground-water heat pumps in the heating mode.

Water Heaters

Water Heater			
	Southeast	Central	Northwest
Gas or Propane (Energy Factor)			
Minimum	.55	.55	.55
Better	.60	.60	.60
Electric (Energy Factor)			
Minimum	.88	.88	.88
Better	.92	.92	.92

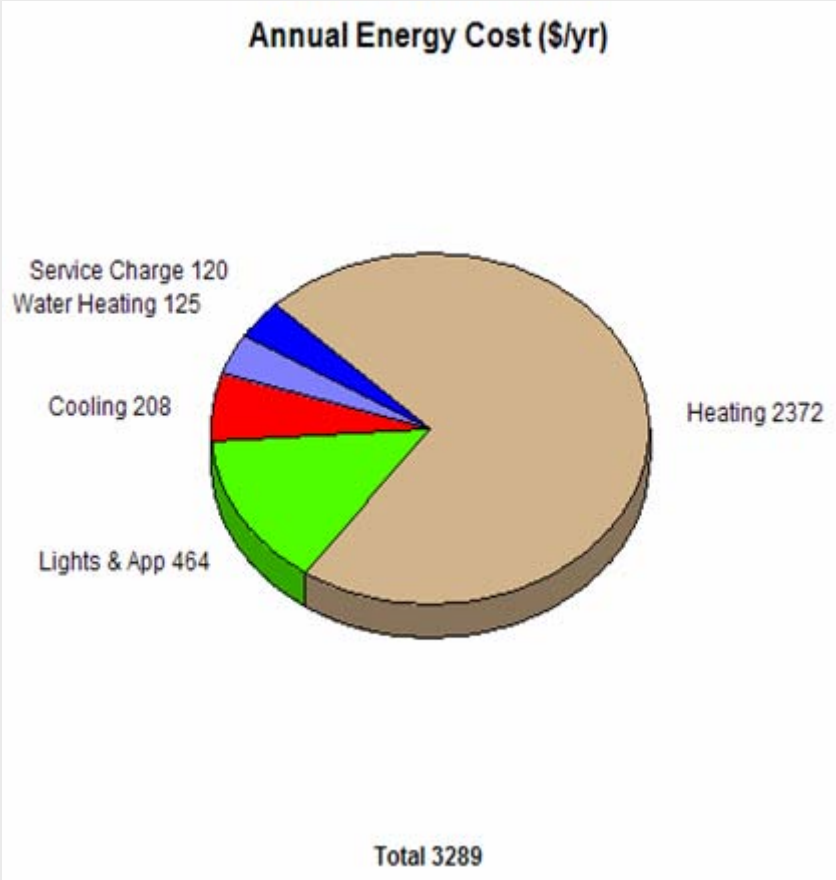
Water Heaters

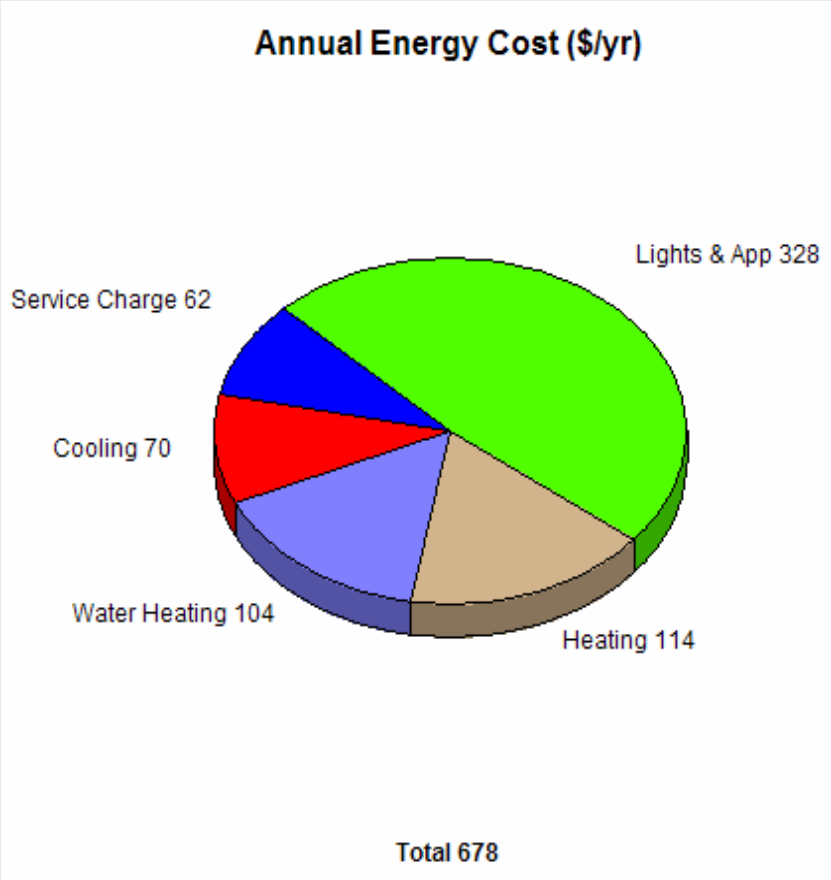
Heat Recovery Ventilator



Heat exchanger plates separate the two airstreams while transfering heat from exhaust to intake

Lights and Appliances





Lighting

Annual Refrigerator Energy Use (kwh)