



# Heating & Cooling After Peak Oil

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# What is heat?



- A British thermal unit (Btu) is the energy needed to raise a pound of water 1 degree F
- 1,000,000 Btus (1 MBtu) is roughly the equivalent of one person year of labor
- Retail cost of 1 MBtu of gas in Boulder is \$8.50
- Retail cost of 1 MBtu of electricity is \$25
- 1 gallon of gas is the energy equivalent of about 2 person months of labor at the oil well & 6 weeks at the pump
- Annual consumption of an average home in Boulder is roughly 100 MBtu

# What is 1 Million BTUs?



- The amount of energy necessary to heat 100,000 pounds of water 10 degrees Fahrenheit
- One billionth of a quadrillion
- 1 Quad is  $10^6 * 10^9 = 10^{15}$

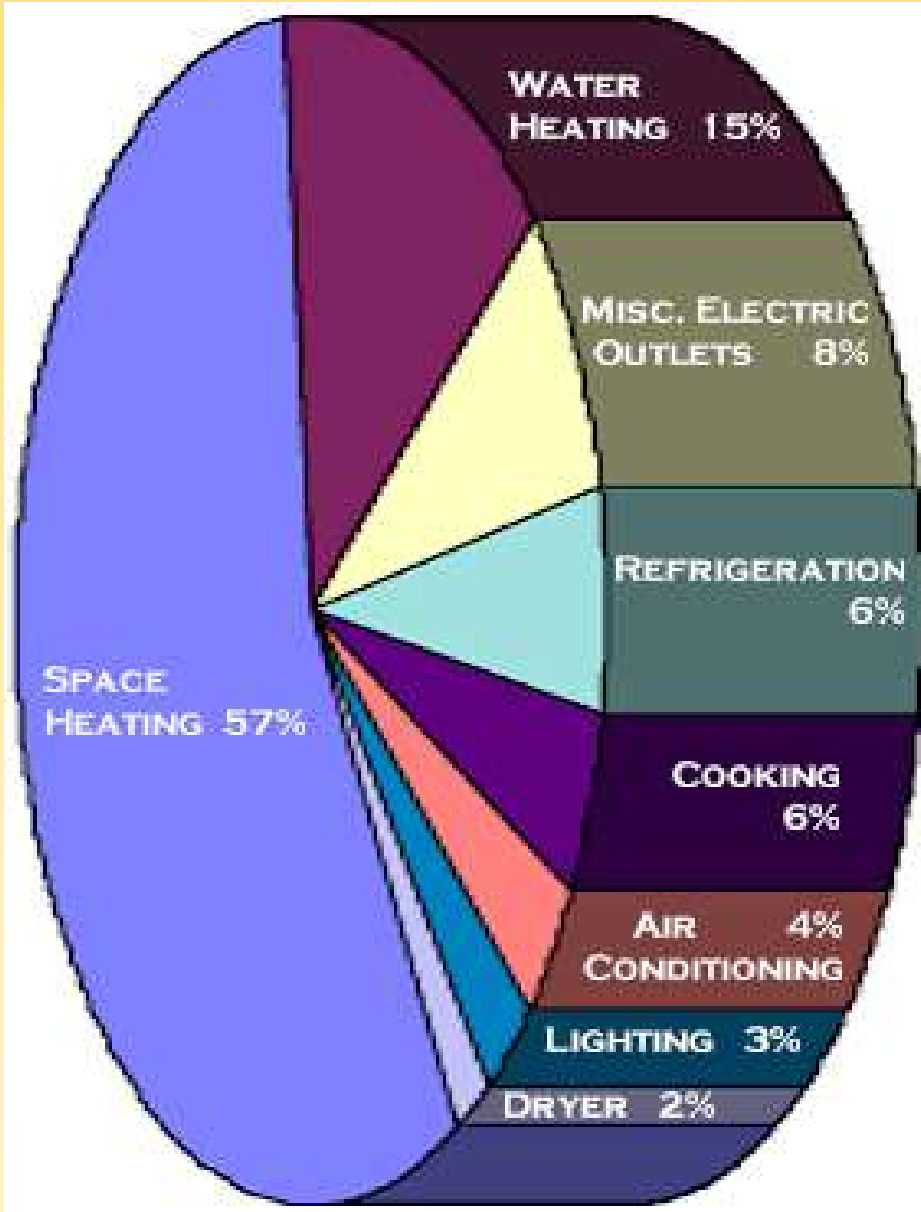
# Some Global Energy Numbers

- Worldwide annual energy consumption: 400 Quads (equal to 400 Billion person years of labor)



- US annual consumption in 2002: 100 Quads (equal to 100 billion person years of labor)
- With less than 5 % of the world's population the US consumes about  $\frac{1}{4}$  of the world's energy and produces almost  $\frac{1}{2}$  of the world's garbage.

# Where does the energy go?

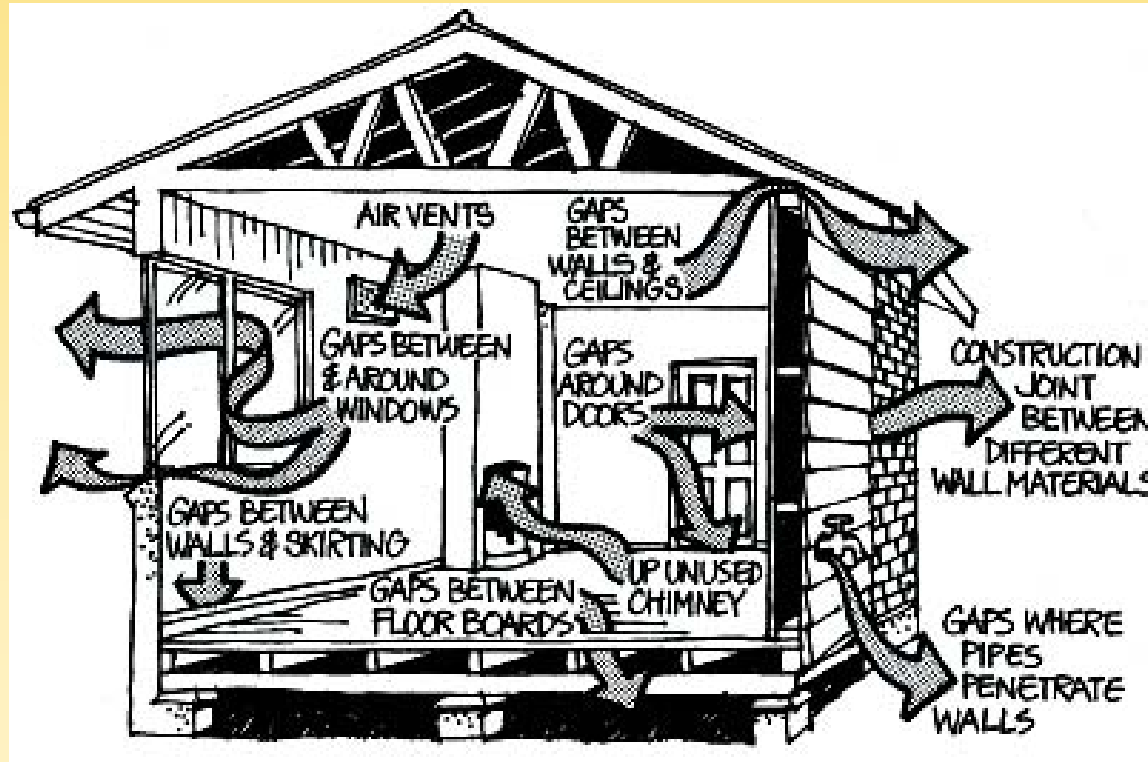


## **EPA recommends five places to target energy improvements:**

- sealing and insulating;
- heating and cooling efficiently;
- changing lights;
- powering down home electronics; and
- looking for the Energy Star on new products.

# What you can do:

- Insulate
- Seal & strip
- Passive solar
- Ventilate
- Solar thermal
- Thermal mass



*Avoid a leaky home like this by building tight and ventilating right to improve heating and cooling efficiency....*

# Insulation: Preparing for HVAC

*Spend a dollar on insulation, save \$12 in energy costs.*



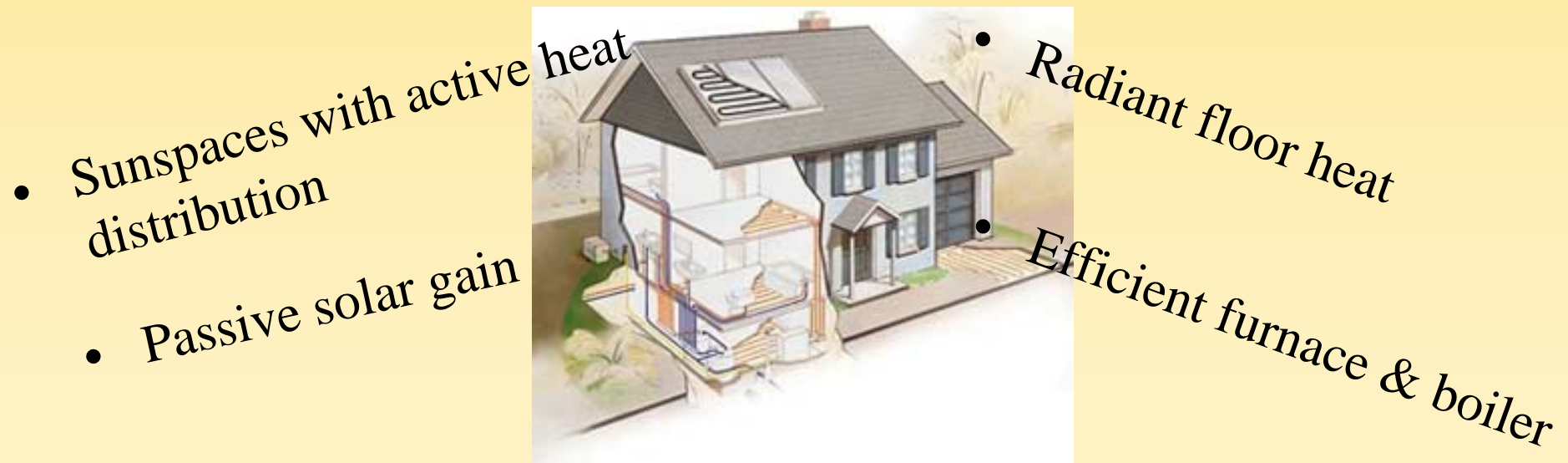
- **Tight building envelope**  
*“if you want to fill a bathtub with hot water, first you have to put in the drain plug”*
- **Walls**  
*At least R-22 to R-30*
- **Attics & ceilings**  
*At least R-40 to R-50*
- **Windows**  
*Maximize solar gain and minimize heat loss by strategically placing high-performance designs*
- **Basements & crawl spaces**  
*Often overlooked as a major hole in the building envelope and can serve as conduits for heat loss*

FIBER INSULATION		R / inch
Cellulose	Loose-fill wall-spray (damp), dense-pack, stabilized	3.0 - 3.7
Fiberglass	Batts, loose-fill, semi-rigid board	2.2 - 4.0
Mineral wool	Loose-fill batts, semi-rigid or rigid board	2.8 - 3.7
Cotton	Batts, loose-fill, semi-rigid board	3.0 - 3.7
Perlite	Loose-fill	2.5 - 3.3
Straw bale	Tightly stacked & plastered	1.45 - 2.2
FOAM INSULATION		
Polyisocyanurate (Icynene)	Foil-faced rigid board, nail-base with OSB sheathing	6.0 - 6.5
Extruded polystyrene (XPS)	Rigid board	5.0
Expanded polystyrene (EPS)	Rigid board	3.6 - 4.4
Closed-cell polyurethane	Spray-in cavity-fill or spray-on roofing	5.8 - 6.8
Open-cell low-density polyurethane	Spray-in cavity-fill	3.6 - 3.8
Air-Krete	Spray-in cavity-fill	3.9
COMBINED & OTHER METHODS		
1887 Orchard Ave.	7" icynene in 2 x 6 stud walls, 7/16" OSB, 1" XPS	3.78
Insulated concrete forms	Concrete block insulated with foam	4.0 - 8.0

*The average home uses 57.3% of its annual energy budget for space heating*

# Basic Strategy for Space Heating

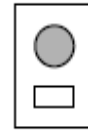
1. Orient house – solar-smart design
2. Minimize heat losses
3. Install zoned & efficient heating system



*The ideal system: a superinsulated structure with super windows and excellent passive solar gain*

# Sunspaces for Space Heating

Thermostats in high-use zones enhance temperature control and prevent wasted heat



Fans and ducts carry warm air to interior spaces

Motorized dampers prevent backdrafts

Fresh air warms to comfortable temperatures to be delivered to living spaces

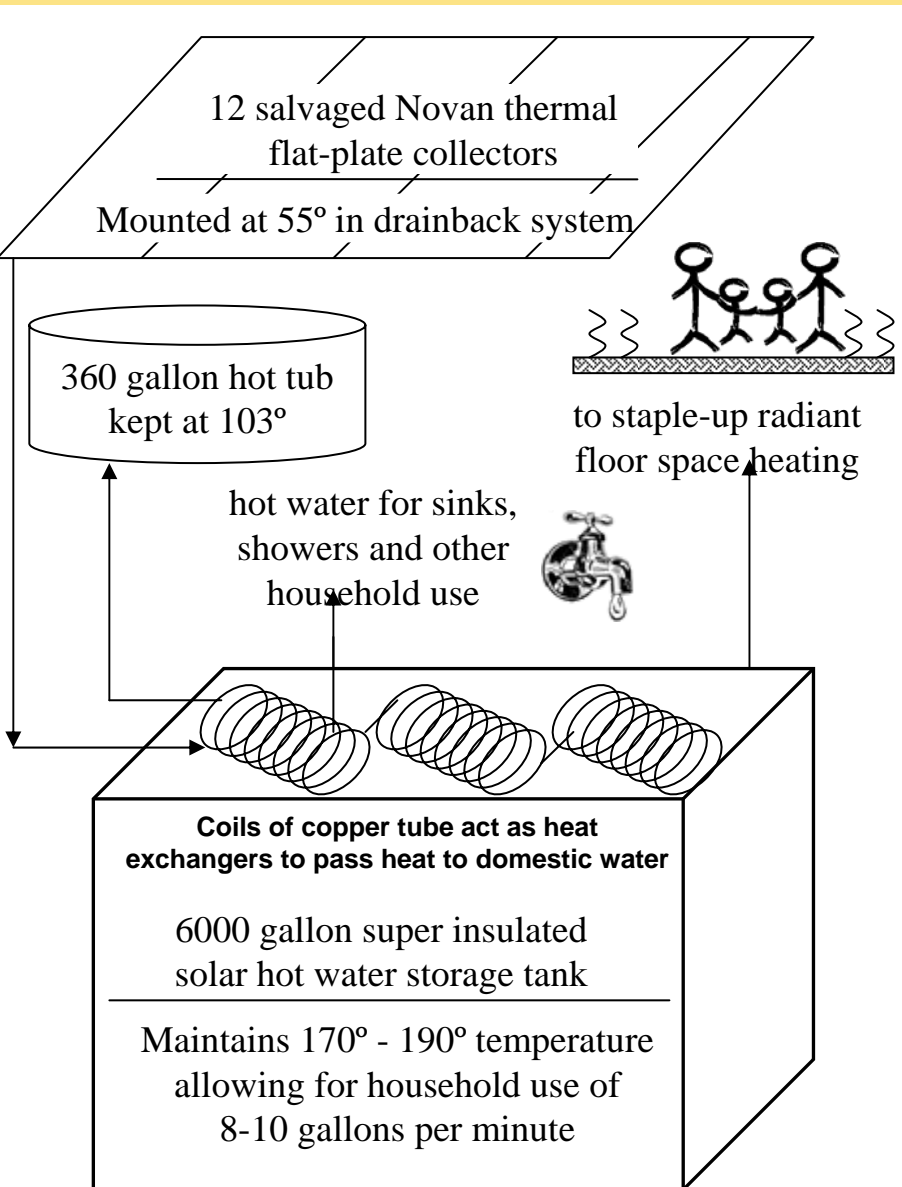
275 square feet of south glazing on sun space for optimum solar gain

## Keys to successful design:

- Effective, and enough, shading
- Create enough solar glazing for building footprint
- Know the glass-to-mass ratio
- Use region-specific design
- Know the use: living space or heat generation zone



# The “Big Tank” Solution: seasonal storage for space heat and hot water



## Function:

- Provide thermal mass
- Provide hot water as a “solar boiler”

## Size:

- Must be several thousand gallons

## Key:

- Super-insulated (R-55 to R-75)
- Waterproof

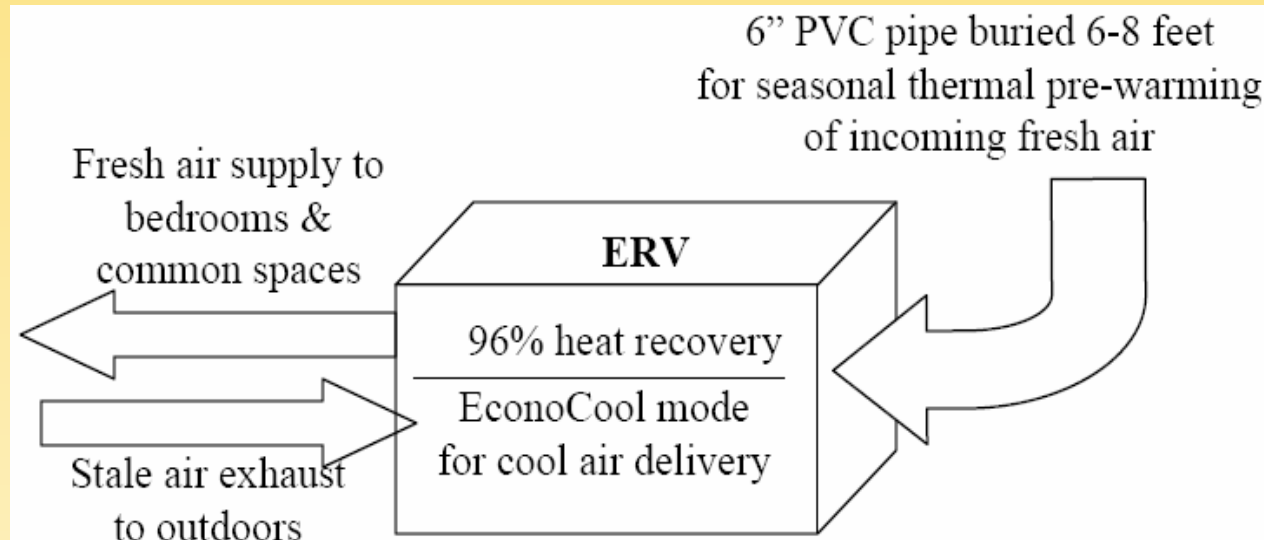
# Solar Tank at 1887 Orchard

Because Lexan access hatch may leak some steam, exhaust fan provided -- controlled by humidistat



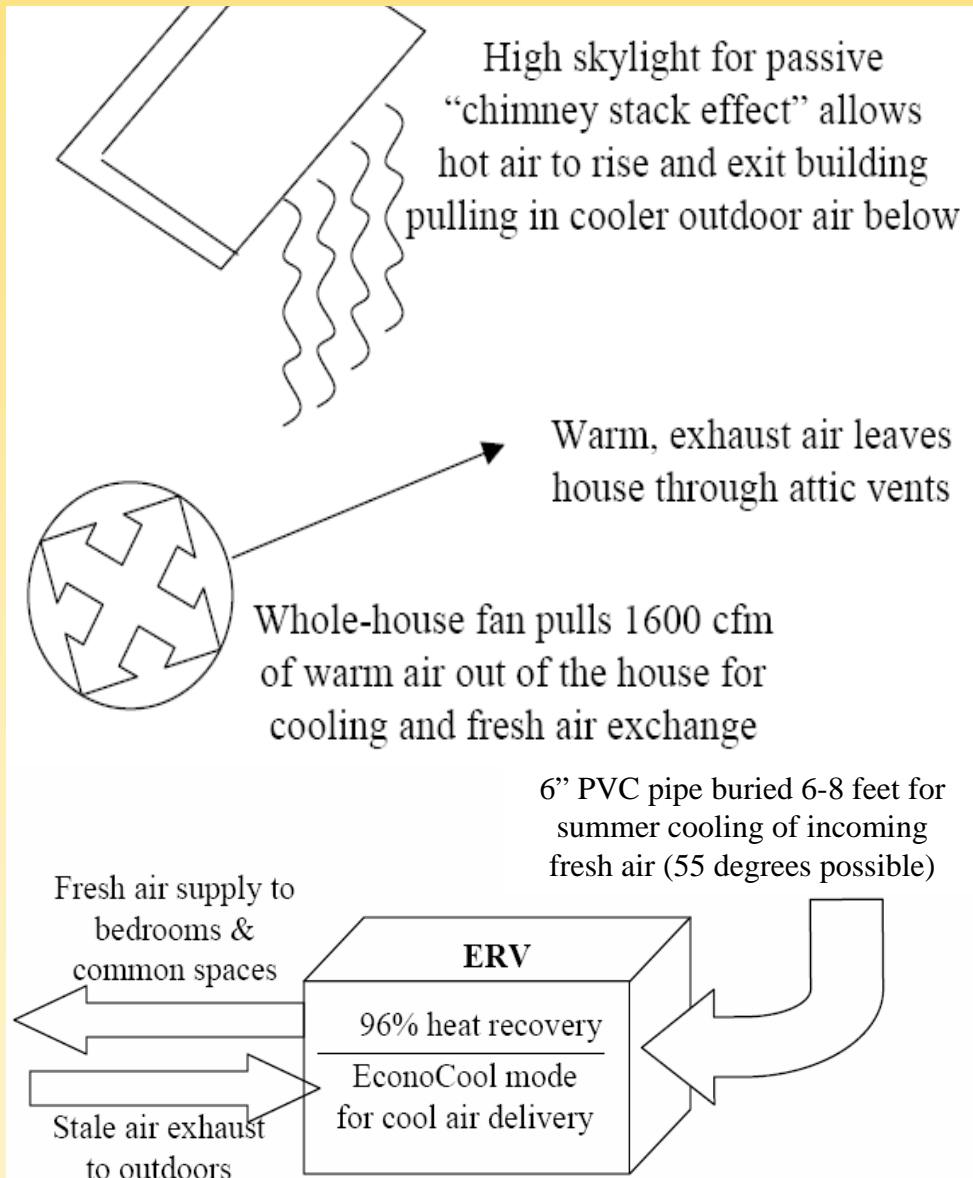
Each Heat Exchanger is simply a roll of  $\frac{3}{4}$ " flex copper

# Heat & Energy Recovery with Geothermal Pre-heating



- For good indoor air quality, ventilate right while saving precious Btus

# Summer Cooling



## Other Frontiers:

- Run pipes with water below ground and circulate this cooled water through under-floor radiant tubing
- Geothermal with heat pump
- Photonicfuel systems

# Technology

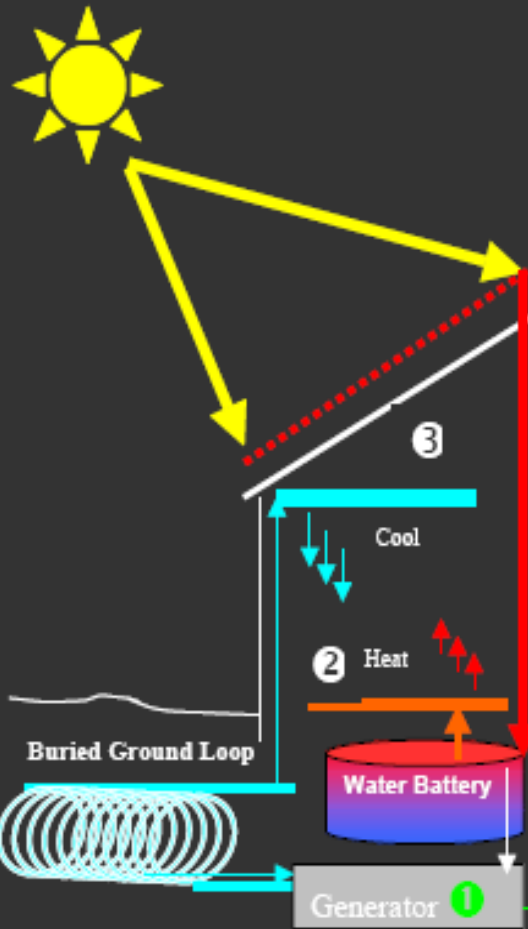
Imagine renewable Energy for heating, cooling, electrical needs and making 2 gallons of fuel for your car as you sleep. Photonicfuel has integrated the "best of breed" of today's technology to present an alternative that is available and affordable now with a 20-year life expectancy. The Sun's energy is stored in a Water Battery for night and peak use. Water tank & Collector sizing makes this technology very scalable to match your needs.



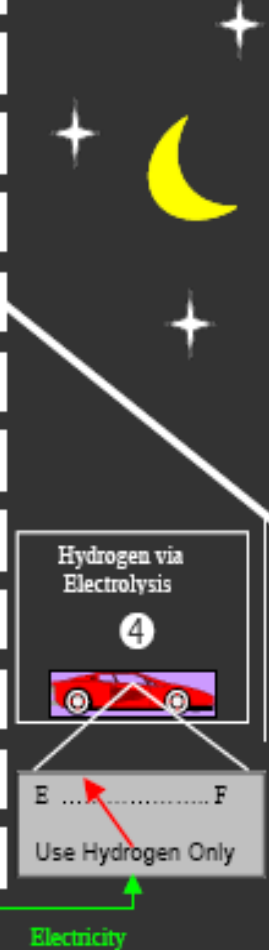
1 Generator in Scaleable form.

Heat from the Sun, with cold from the Earth makes Electricity and is stored as hot water for later use.

# Day



# Night

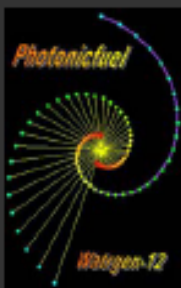


# Energy Problem

## Solved Problem

- ✓ 1 Electricity -20 year life, solid state fuel cell alternative available now
- ✓ 2 Heat- Known Hydronic in floor Heating
- ✓ 3 Air conditioning- Ground Loop Technology
- ✓ 4 Hydrogen - 2 gallons of gasoline equivalent each night

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# 4 -Hard Problems Solved

Photonicfuel.com (303-678-9454) has an **Affordable, Renewable, Zero Emission** Solution for You!

# Net-Zero Energy

## On this side of the rainbow!



# Solar Harvest



Source: Jonathan Moreno, Denver Post 2005

# What's Next?

- Elusive 100% goal is reachable
- City of Boulder and Boulder County Building Departments are revising and starting green building programs
- Building codes and officials are ever-more supportive
- For peak oil and beyond, lets plan to enjoy the inevitable!