



It's What's Underneath that Counts!

Geothermal Systems – Introduction & Overview

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Intro to Geothermal Systems

- What's the technology?
- How does it work?
- What are the components?
- Who's involved in the industry?

Traditional Energy Sources

- Fossil fuels – gas, oil, coal
 - Non-renewable
 - Green House Gas emissions
- Hydro-electric
 - Environmental damage from construction
- Nuclear
 - Waste disposal problems
 - Danger (or perception of danger)

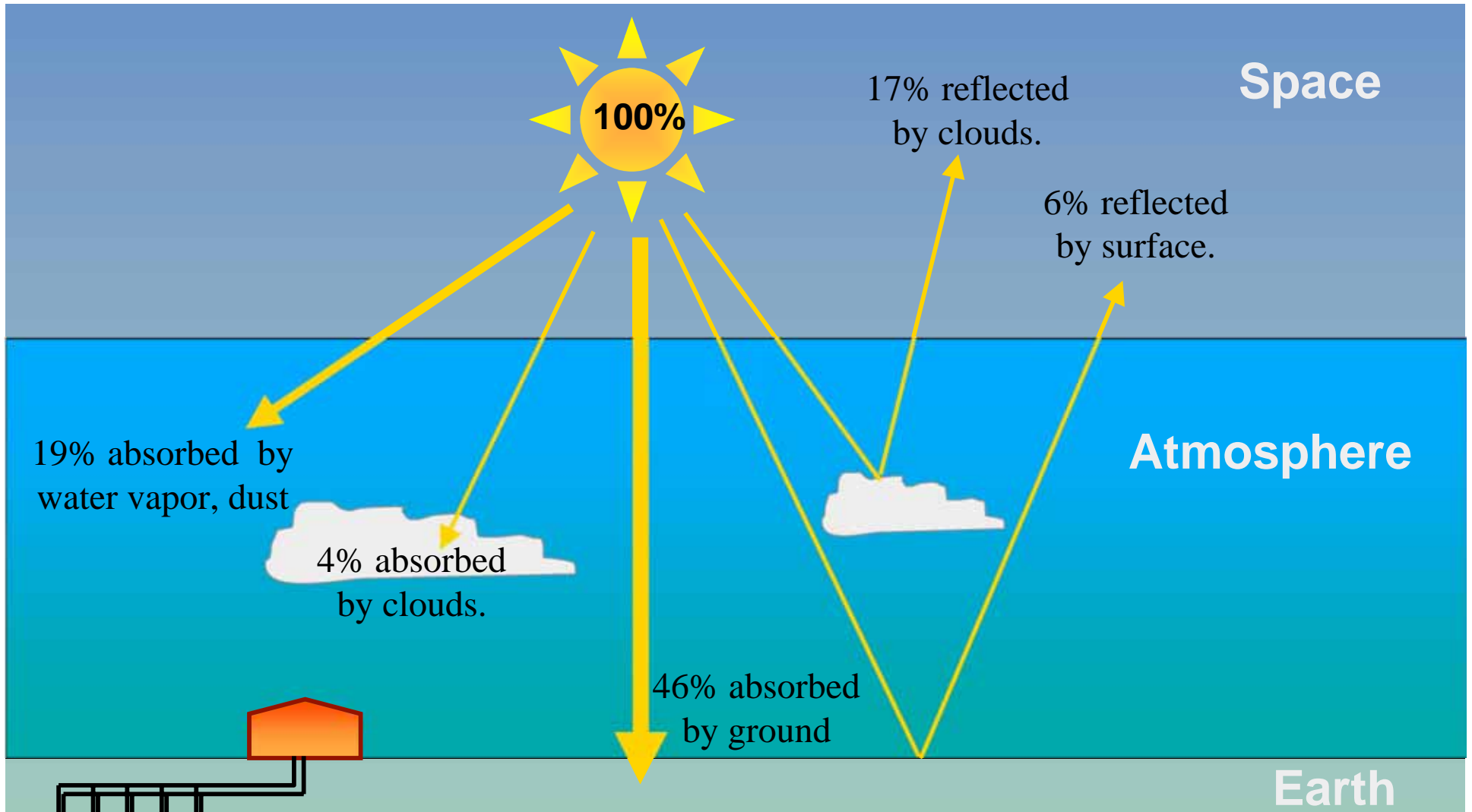
Renewable Energy

- Solar
- Wind
- Biomass
- **Geothermal Systems** (also known as ground source heat pumps, Earth Energy Systems, GeoExchange Systems)

Earth Energy Systems...

- are recognized as “the leading space conditioning technology in all locations & from most perspectives – operating performance, annualized cost, environmental impact & attractiveness to utilities as a DSM measure” (*U.S. EPA report 430-R-93-004*)
- “have a higher mitigating effect on GHG emissions and global warming impacts than any other market-available technology” (*NRCan market analysis*)

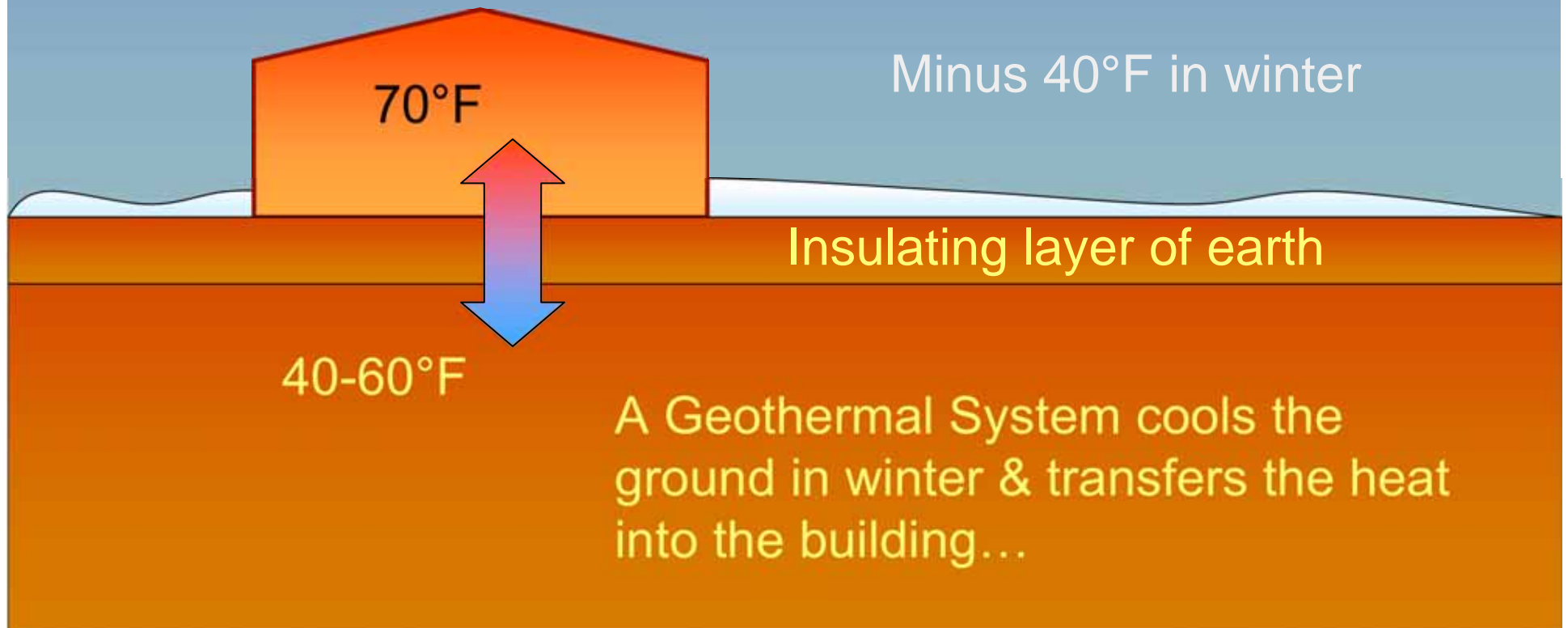




The earth is like a solar battery absorbing nearly half of the sun's energy. The ground stays a relatively constant temperature through the seasons, providing a warm source in winter & a cool heat sink in summer.

U.S. Dept. of Energy

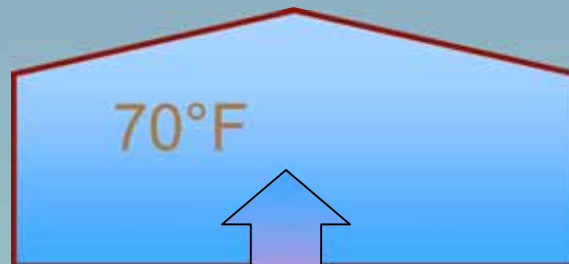
It's a Heat Source in Winter...



It's A Cool Place to Dump Heat in Summer



Plus 100°F in summer

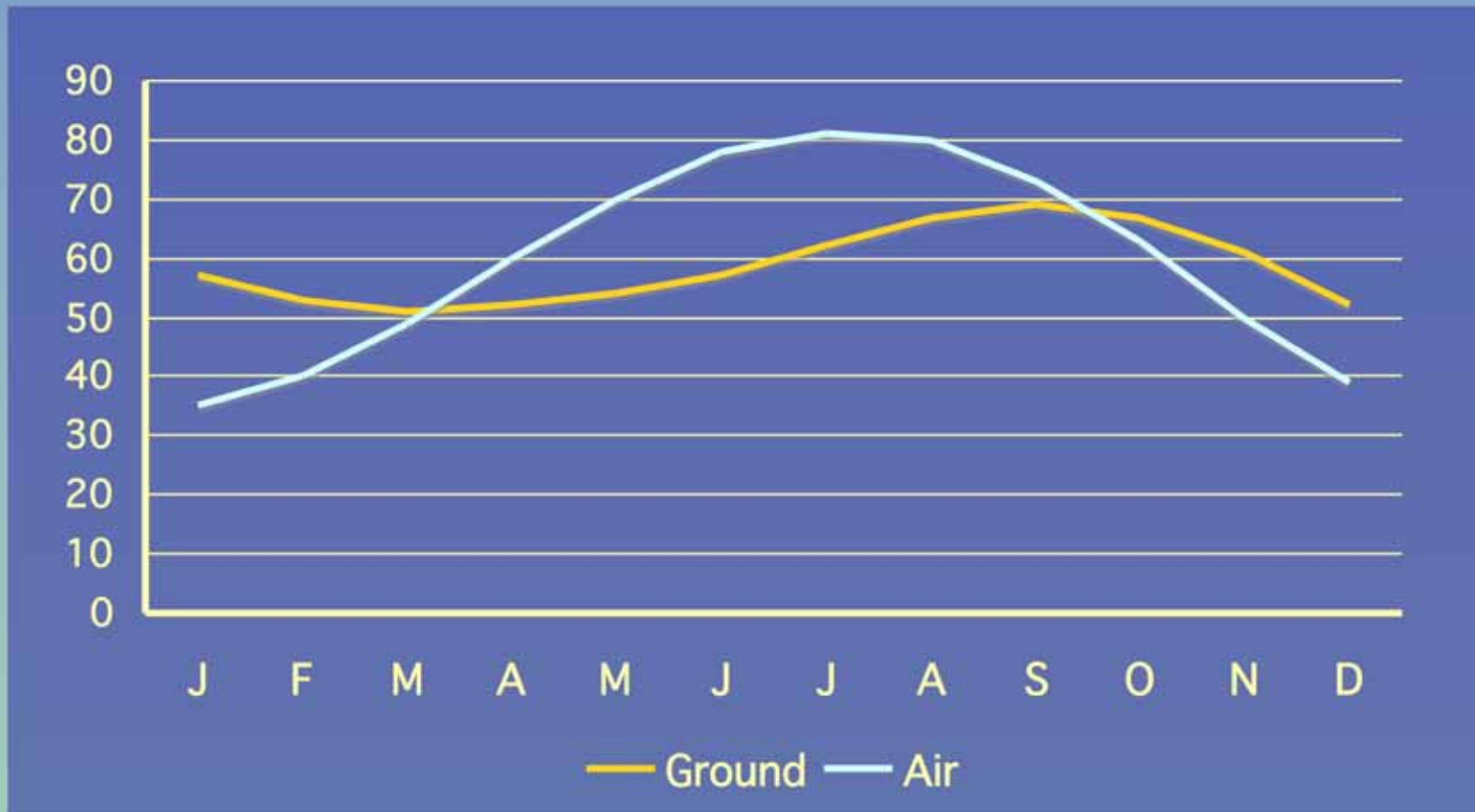


Insulating layer of earth

40-60°F

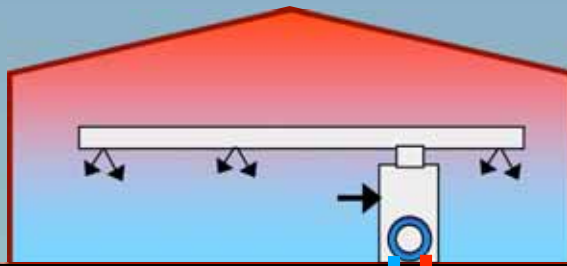
...and cool the building in summer
by rejecting heat to the ground

Air Temperature vs. Ground Temperature



Heat Is Transferred Through an Earth Loop

Plastic pipe is buried in the earth around the building

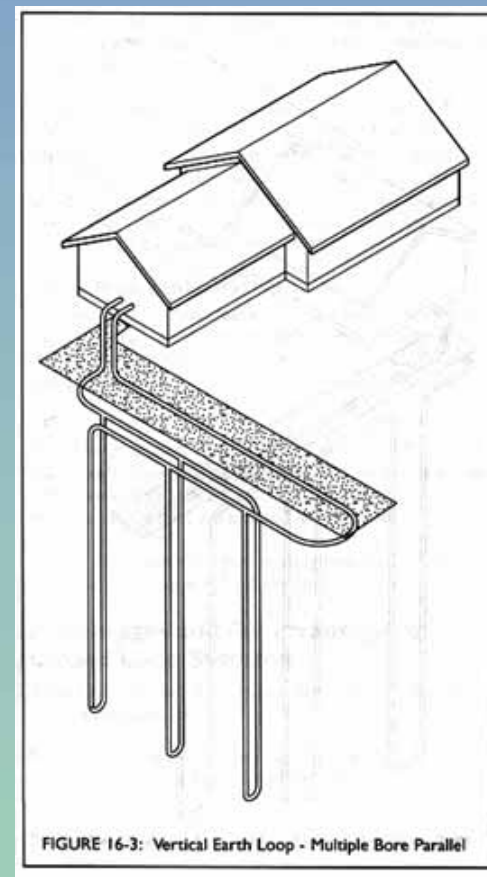
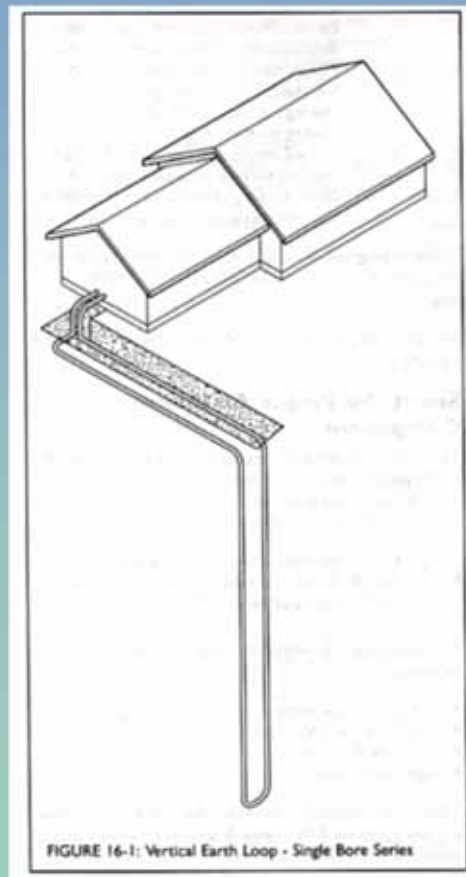


Insulating layer of earth

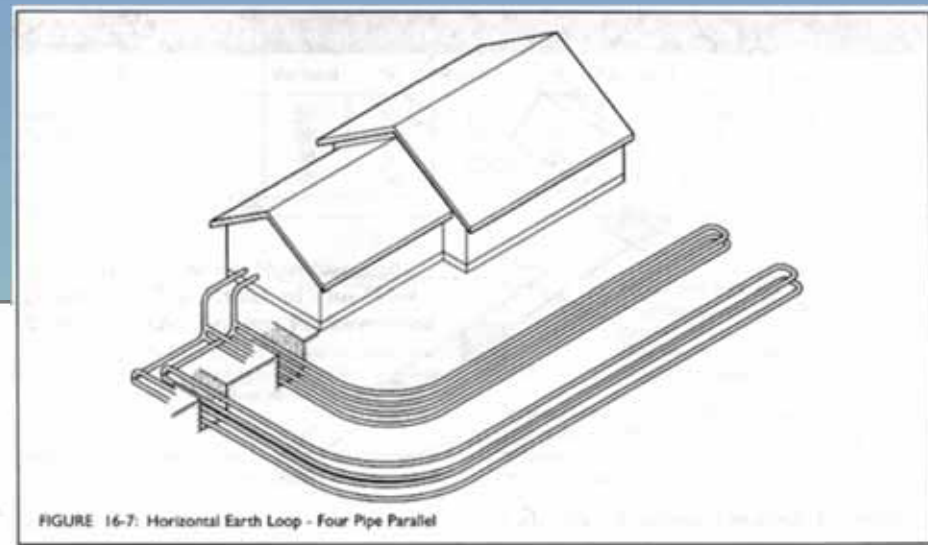
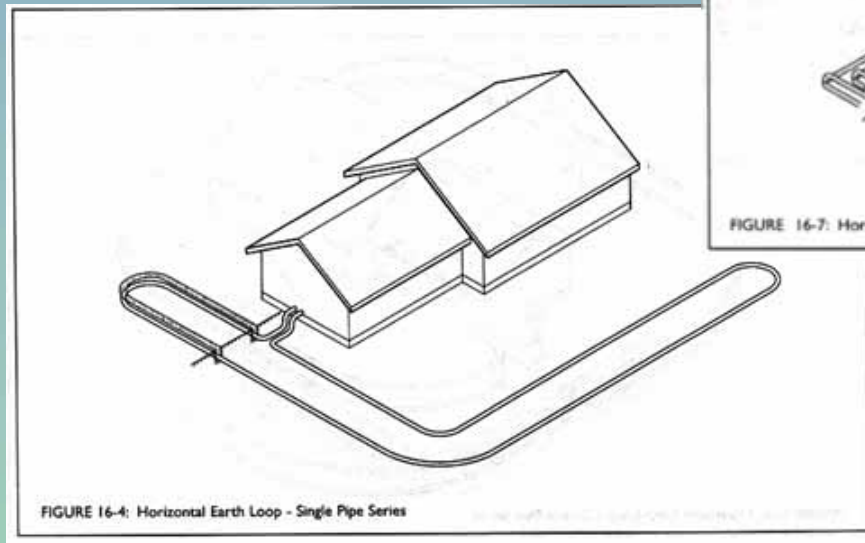
When hot or cold liquid is pumped through the pipe, it warms or cools the earth around it

40-60°F

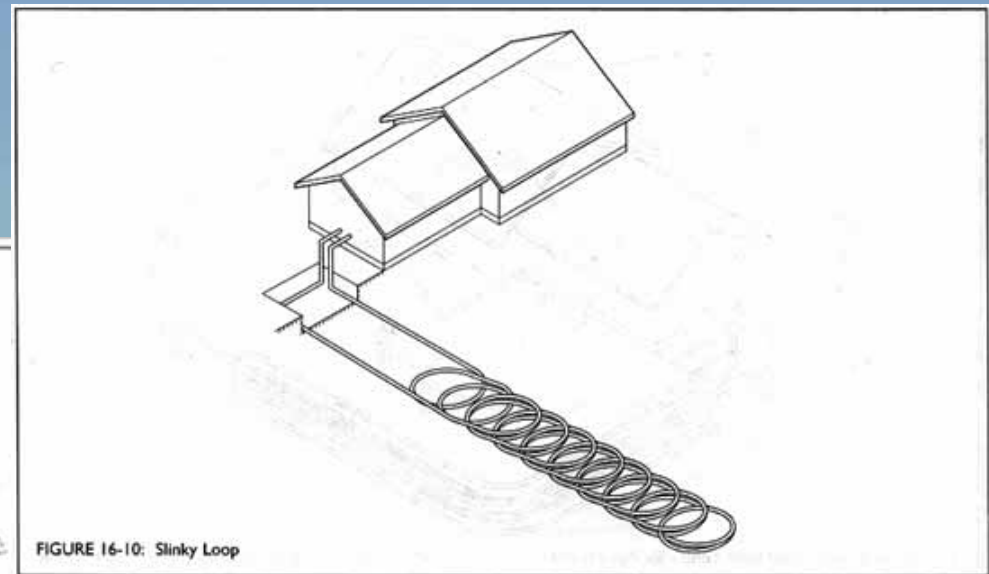
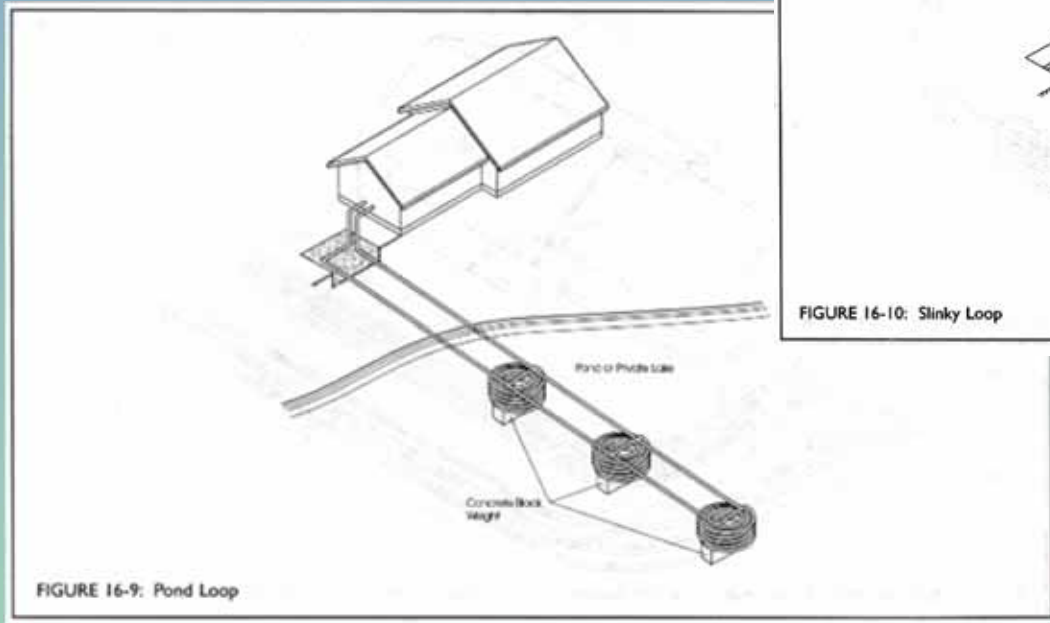
Vertical Loop Configurations



Horizontal Loop Configurations



Lake Loop Configurations



Earth Loops



A horizontal, vertical & lake loop being installed.

A gas pipeline isn't needed to bring the energy to your building...only a small pump to transfer free heat from the earth

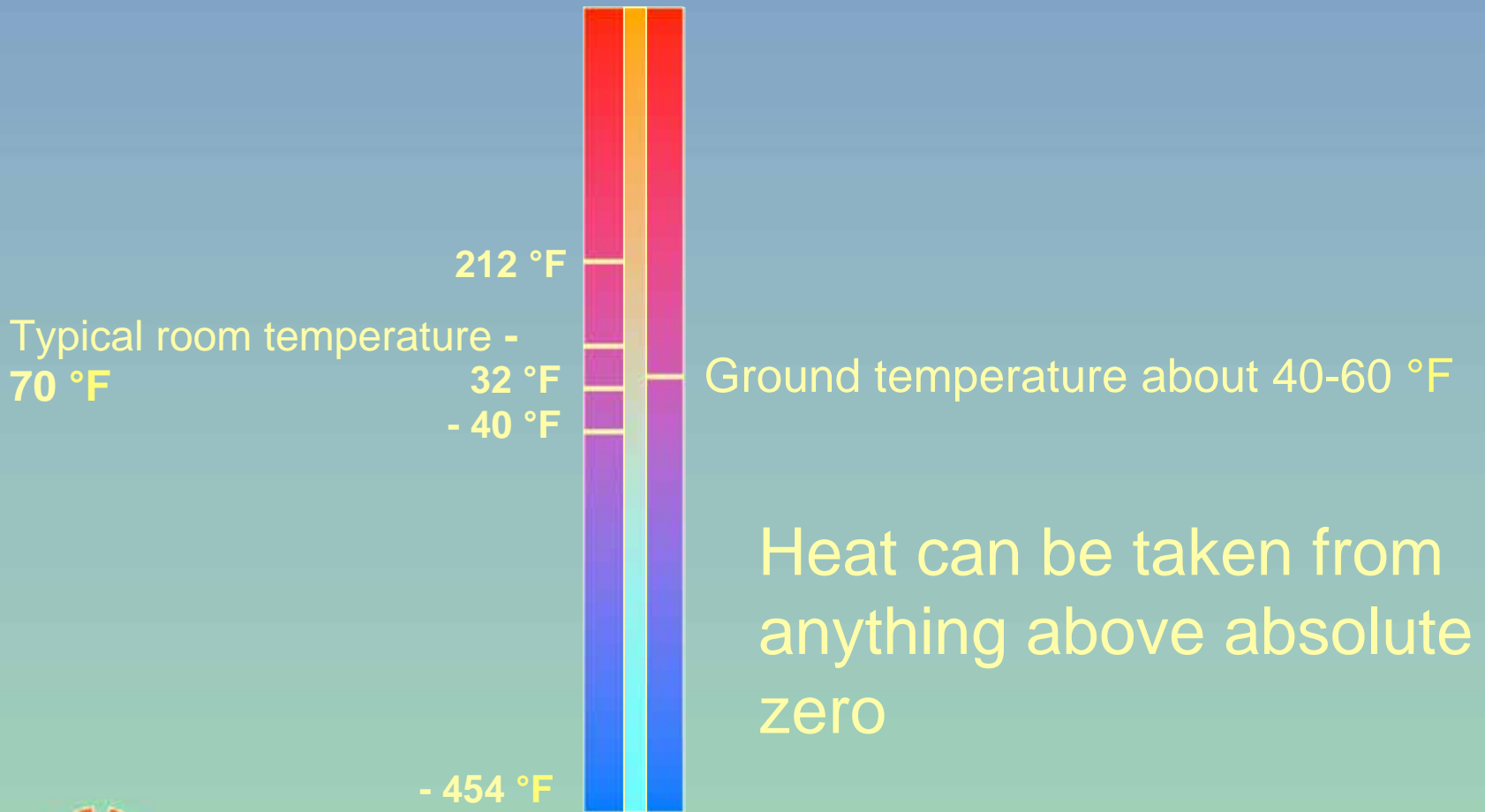


It's Like Having Your Own Energy Well, But...

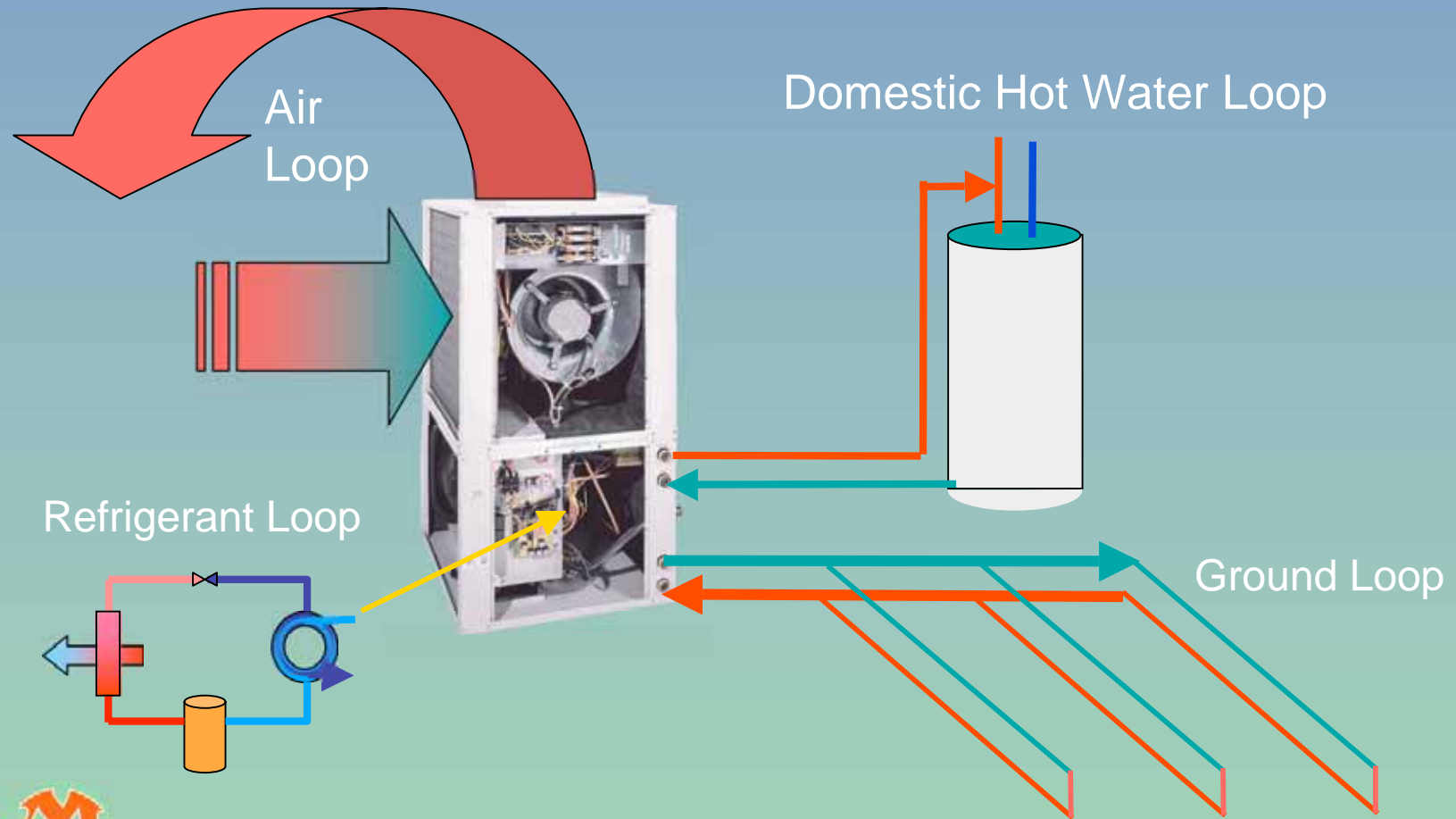


- It comes from your own backyard (no transportation cost)
- It's free & renewable
- It produces no Green House Gasses
- It's available everywhere
- It heats and cools & heats water

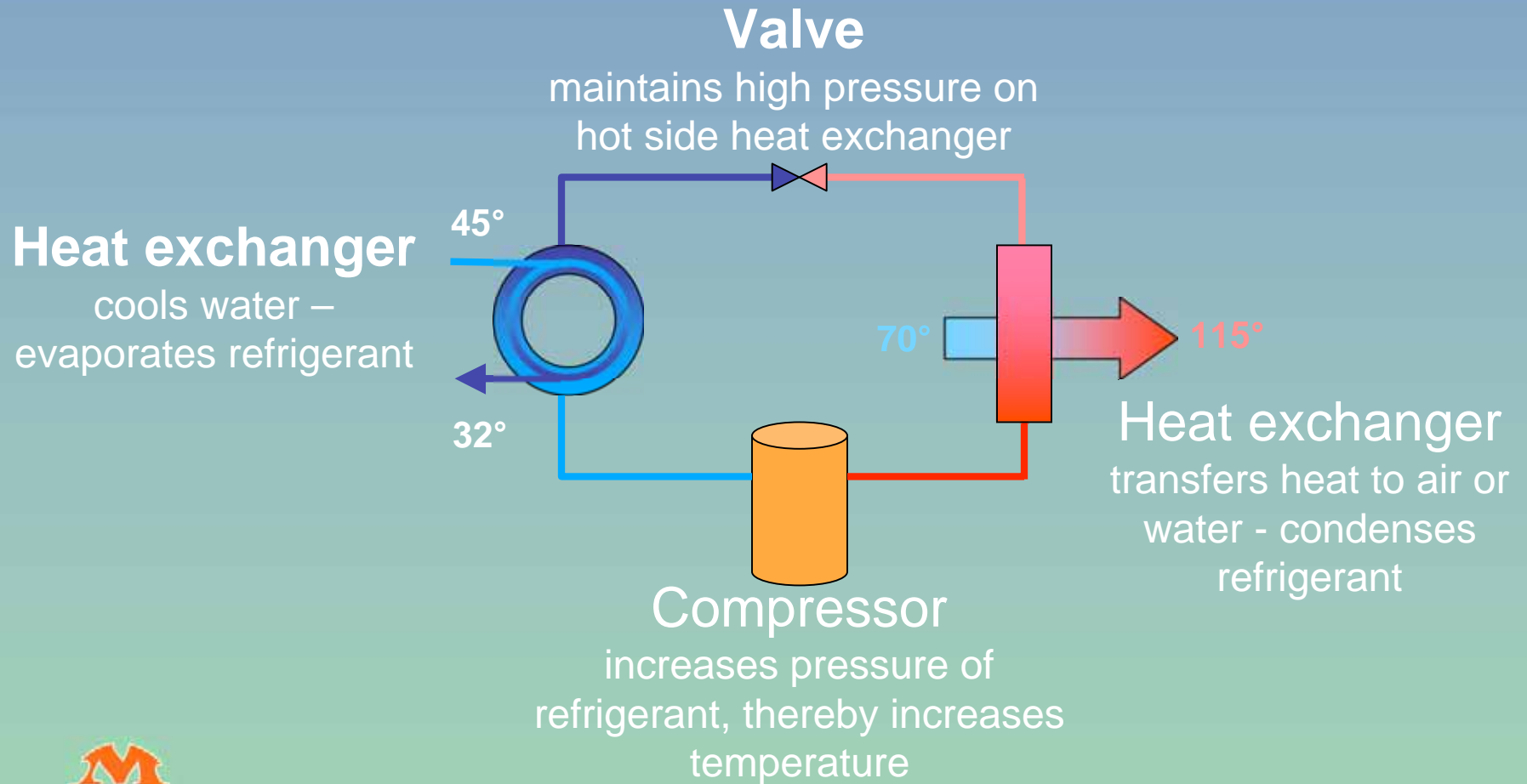
How Can Heat be Taken from Frozen Ground?



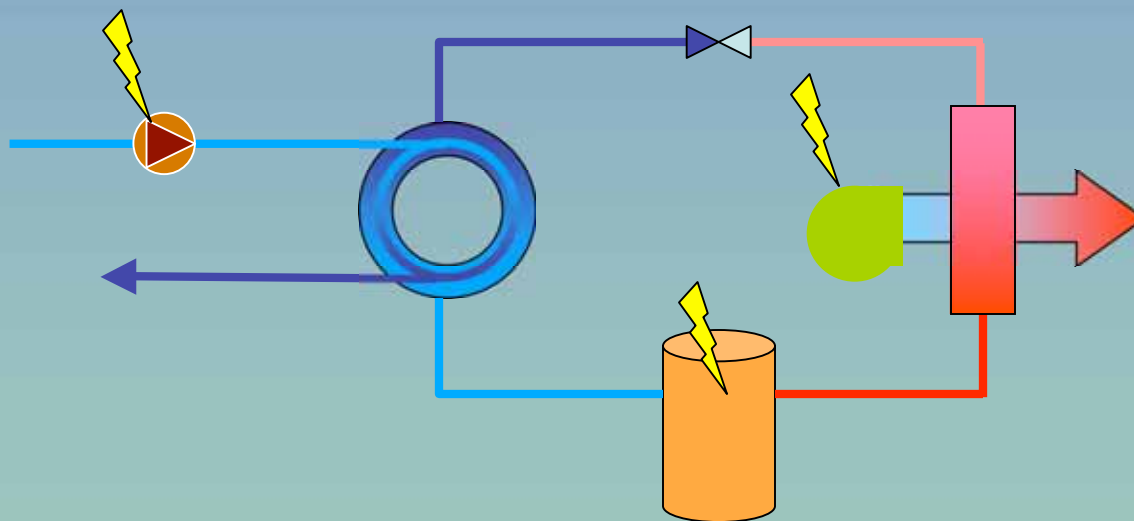
Geothermal System



Geothermal System Warms or Cools Air or Liquid

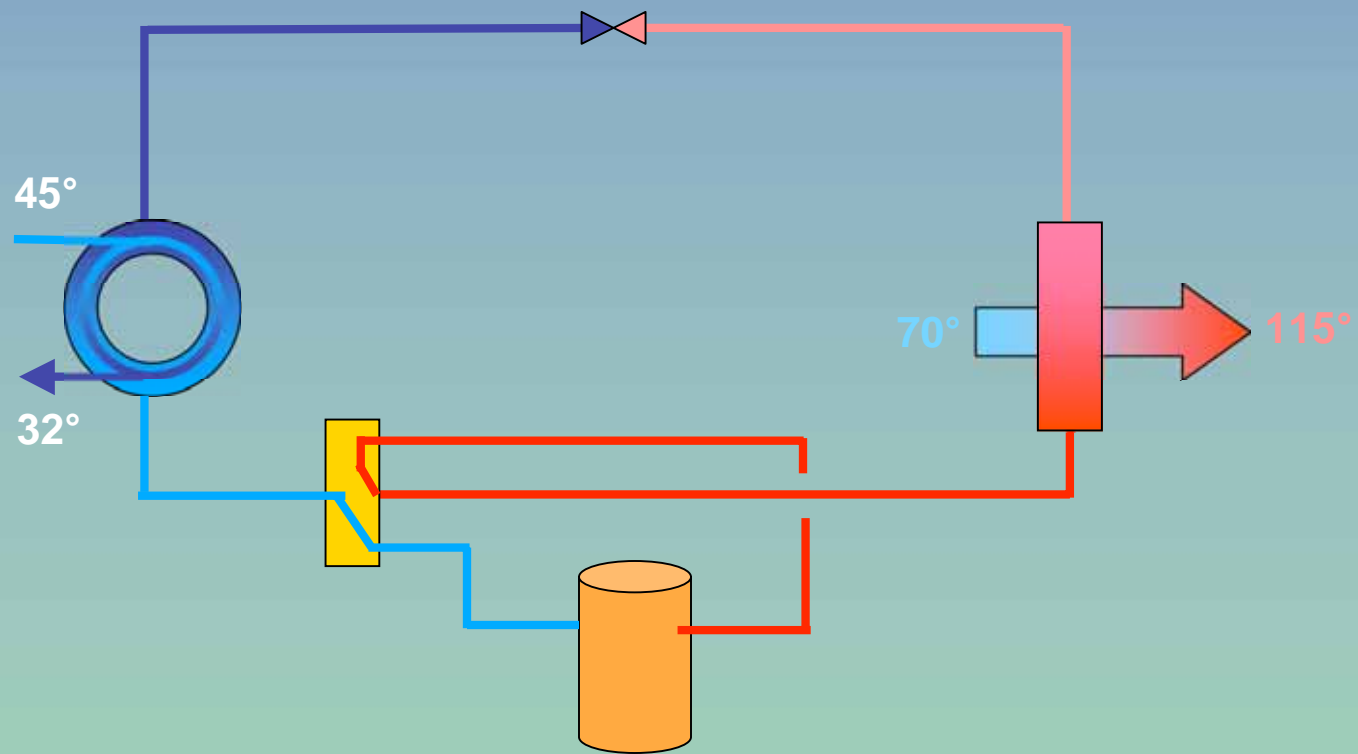


How is Energy Used?

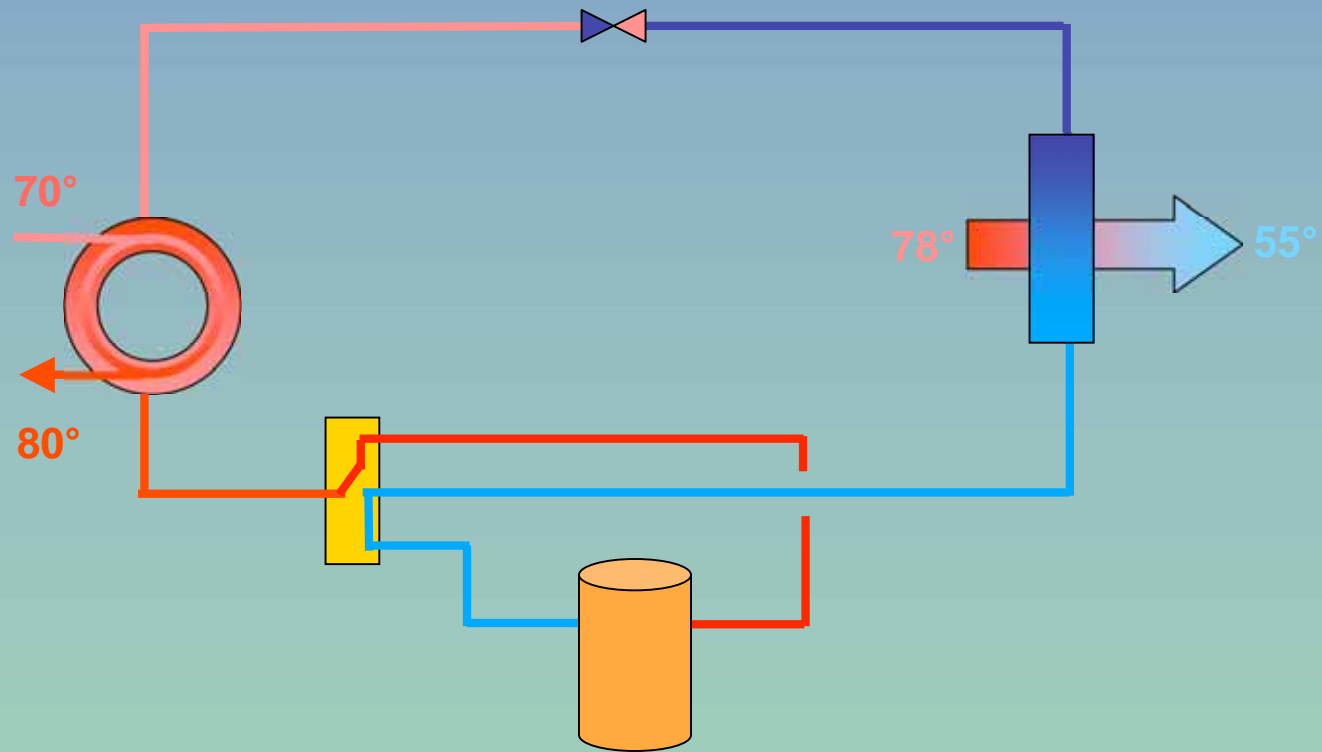


Electricity is used to power
compressor & pump & fan

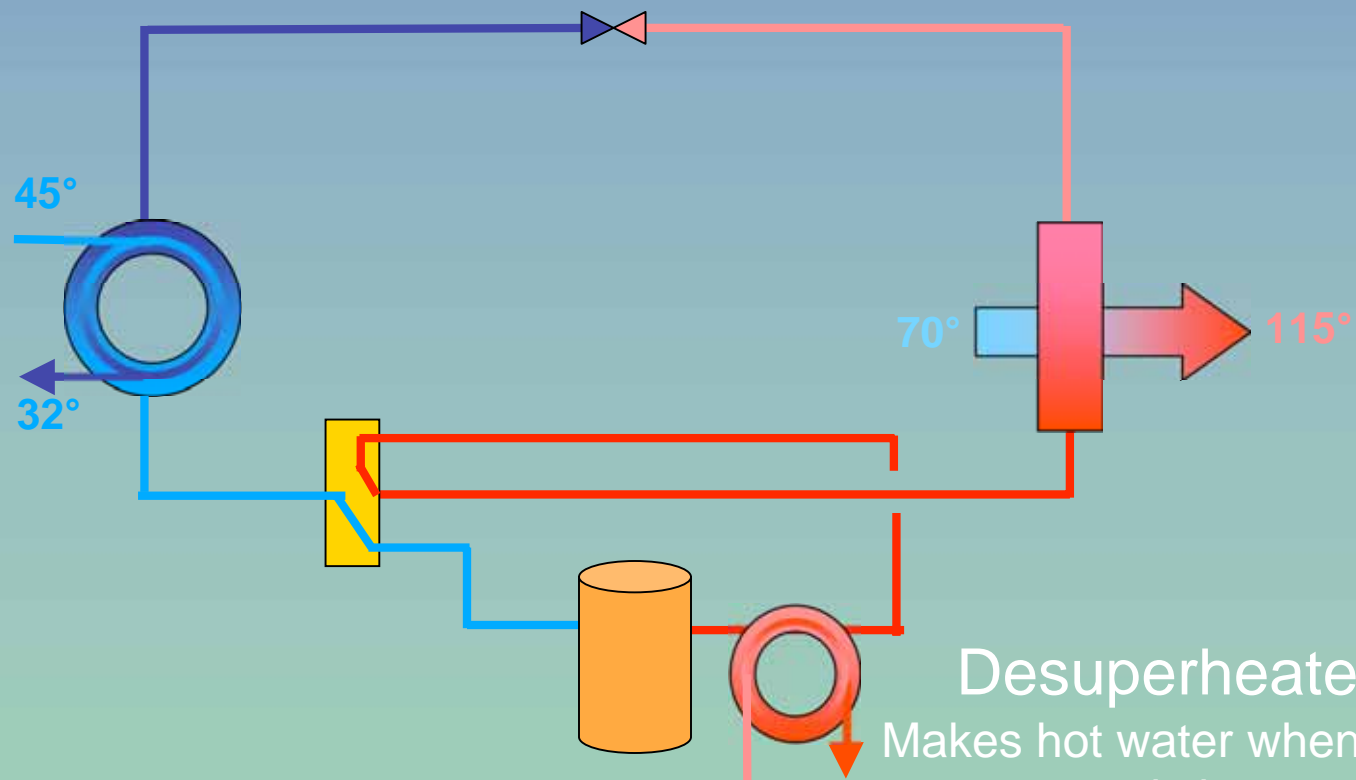
Heating Mode



Cooling Mode

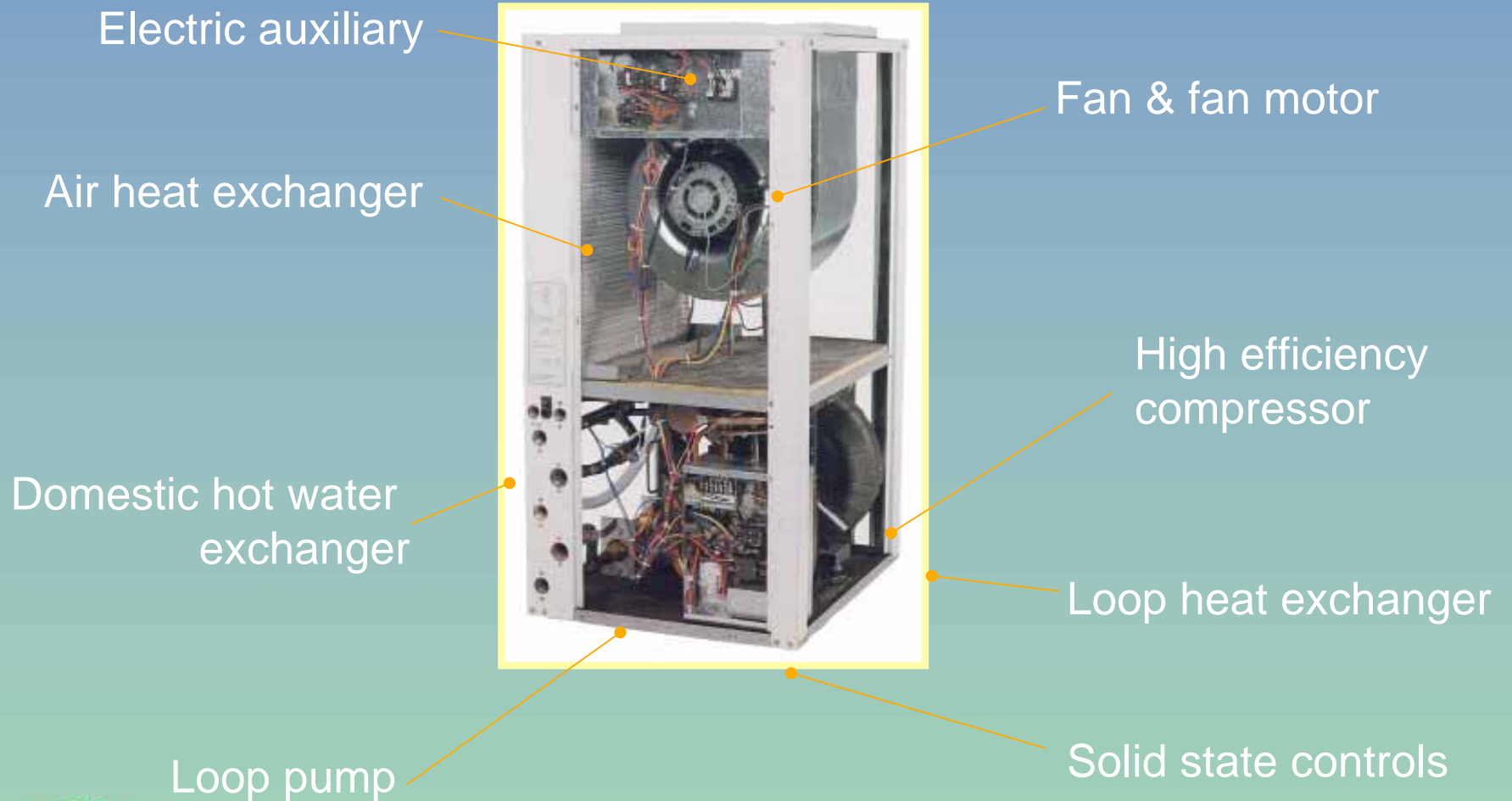


Domestic Hot Water



Desuperheater
Makes hot water whenever
compressor is in operation

Typical Geothermal Unit



Unit Configurations

- Forced air units
 - Packaged unit
 - Split units
 - Console units
- Hydronic Units

Packaged Upflow Unit



Packaged Downflow Unit



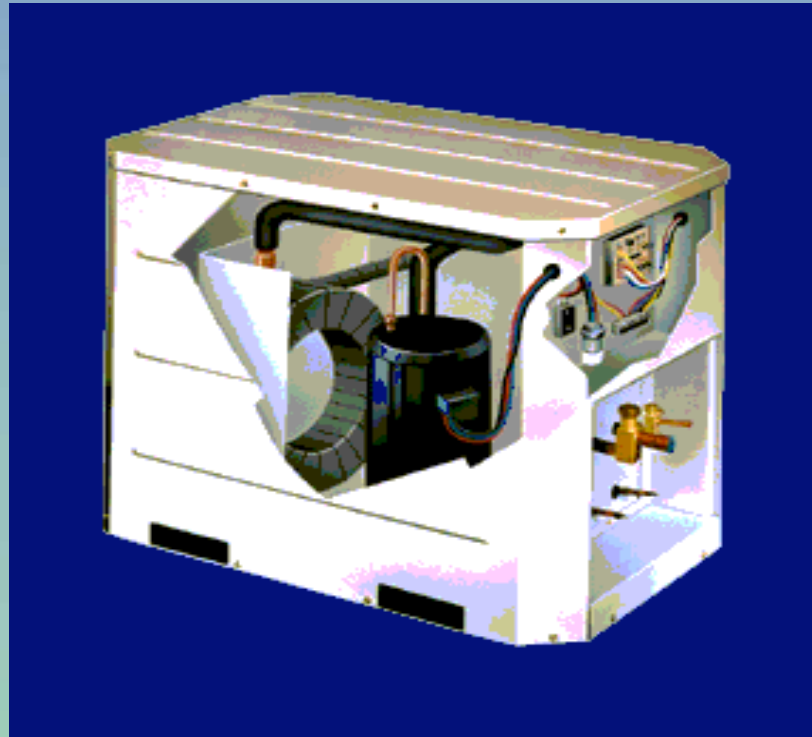
Packaged Horizontal Unit



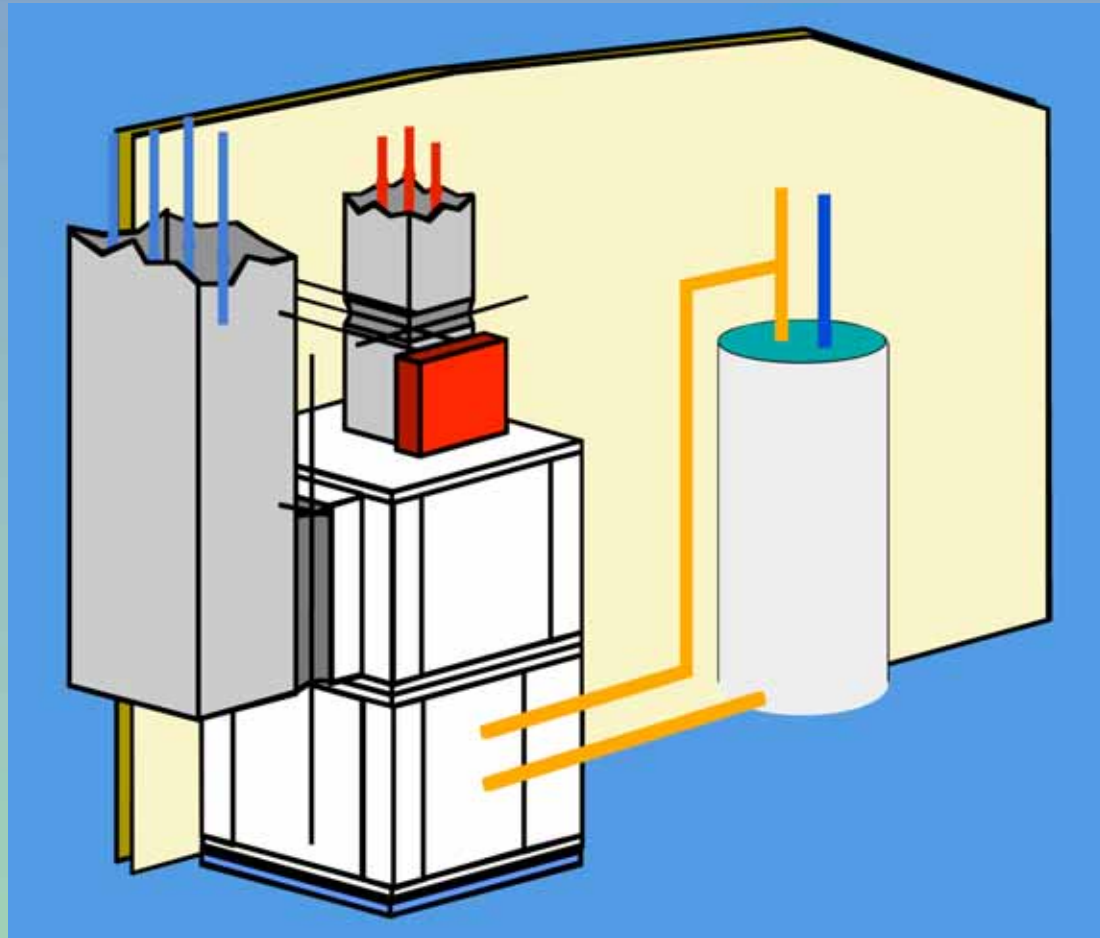
Indoor Split Unit (Compressor Section)



Outdoor Split Unit (Compressor Section)



Domestic Hot Water Option



Domestic Hot Water Options

- No hot water option
- Supplemental water heating (desuperheater, hot water generator)
- Dedicated water heating option – heat pump is designed to provide 100% of domestic hot water on demand, in addition to providing space heating and cooling

System Materials & Components

- Ground loop
 - Plastic pipe – high density polyethylene
 - Fusion fittings

Antifreeze

- Salts
 - Calcium Chloride (used in farm tires for weight)
 - Sodium Chloride (table salt)
- Glycols
 - Propylene glycol (food grade glycol)
 - Ethylene glycol (similar to car antifreeze)
- Alcohols
 - Methanol (Methyl hydrate, wood based alcohol)
 - Ethanol (grain alcohol – the good stuff)
- Potassium Acetate

Good Antifreeze Characteristics

- Must be safe
- Non toxic
- Non-corrosive
- Good heat transfer medium
- Low cost
- Long lasting

Heat Pumps

- Entering liquid temperature limits
- Features (dom. hot water, insulated water lines, fan motor types)
- Safety listings (UL, ETL, CSA)
- Configurations (split, packaged, water-water etc)
- Warranty
- Performance Ratings (ARI, ISO)



Heat Pump Types

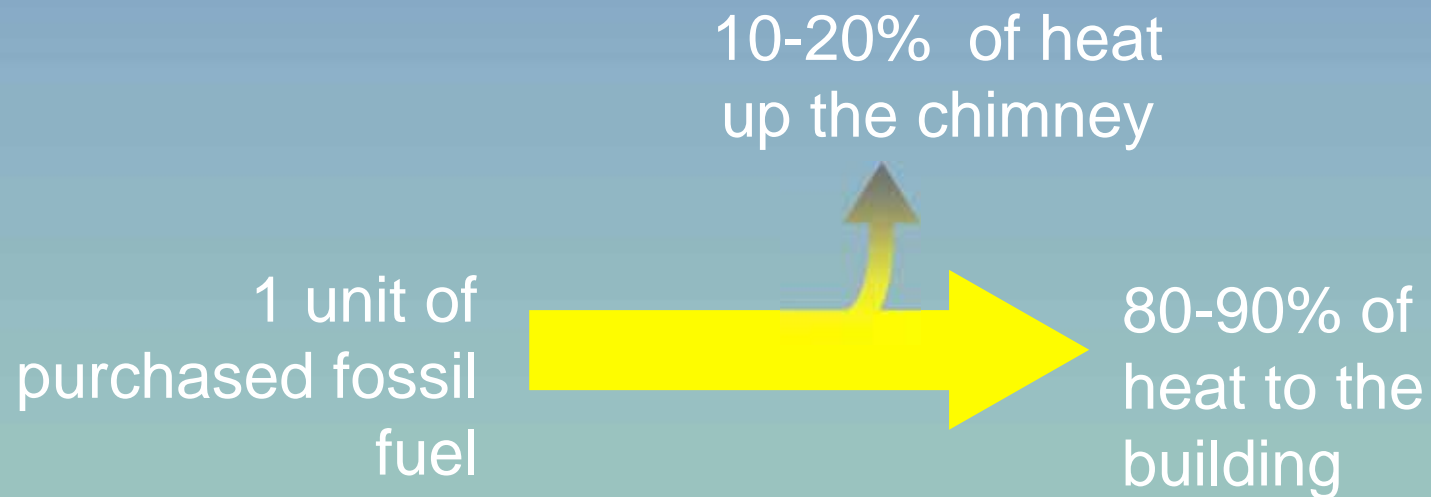
- Water source
 - Boiler/tower applications (ewt: 60-95 deg. F)
 - Well water (ewt: 40-110 deg. F)
- Ground coupled
 - Closed loop (ewt: 20-110 deg. F)

Benefits to Homeowner

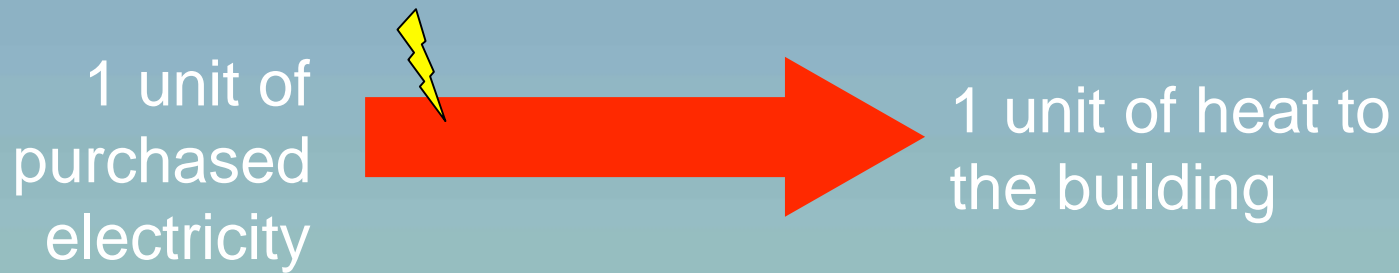
- Increased home comfort
- Safety
- Less impact on the environment
- No chimney
- No outdoor air conditioning unit
- Reduced maintenance
- Longer life expectancy
- Reduced utility bills



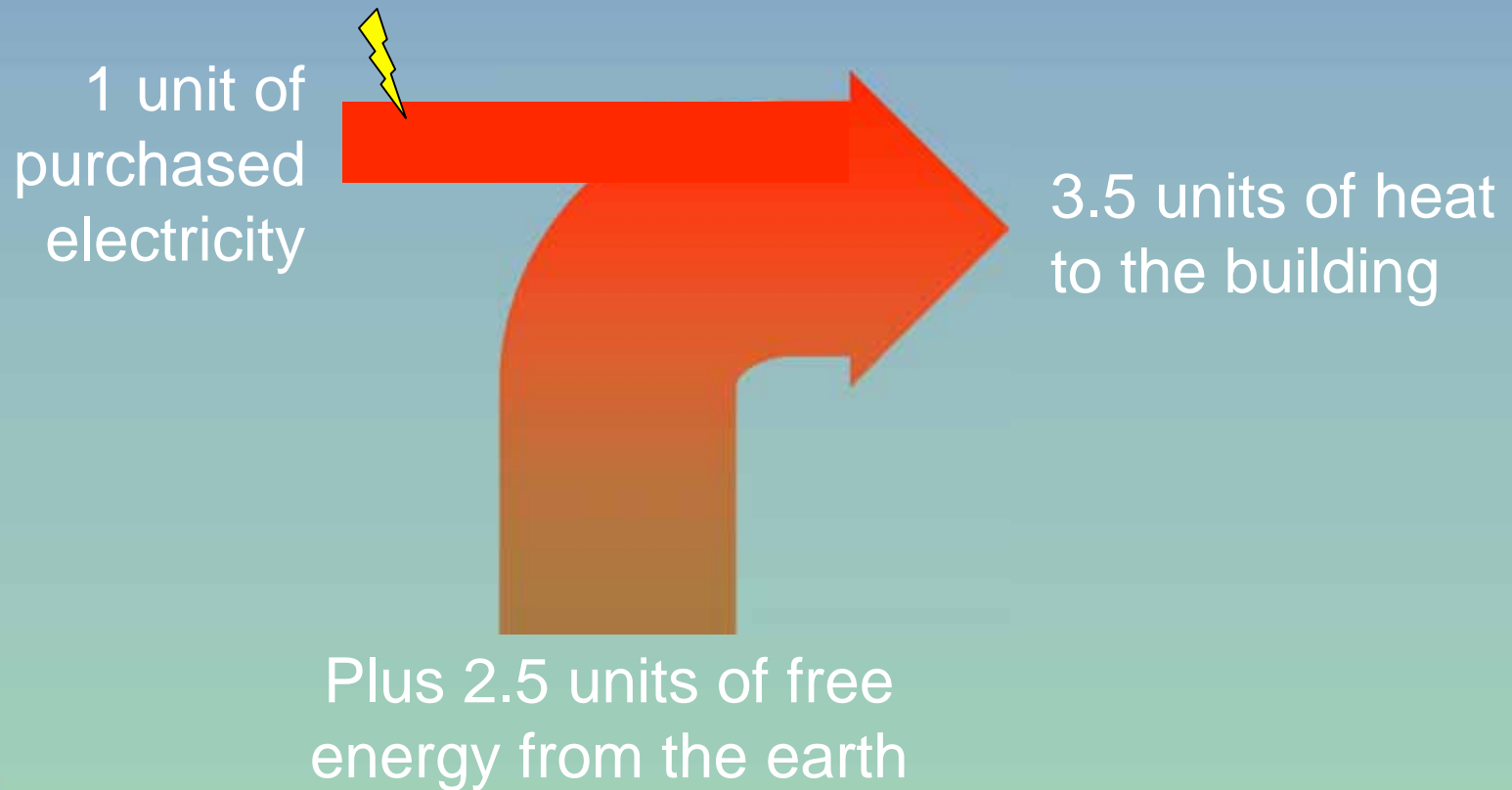
Fossil Fuels



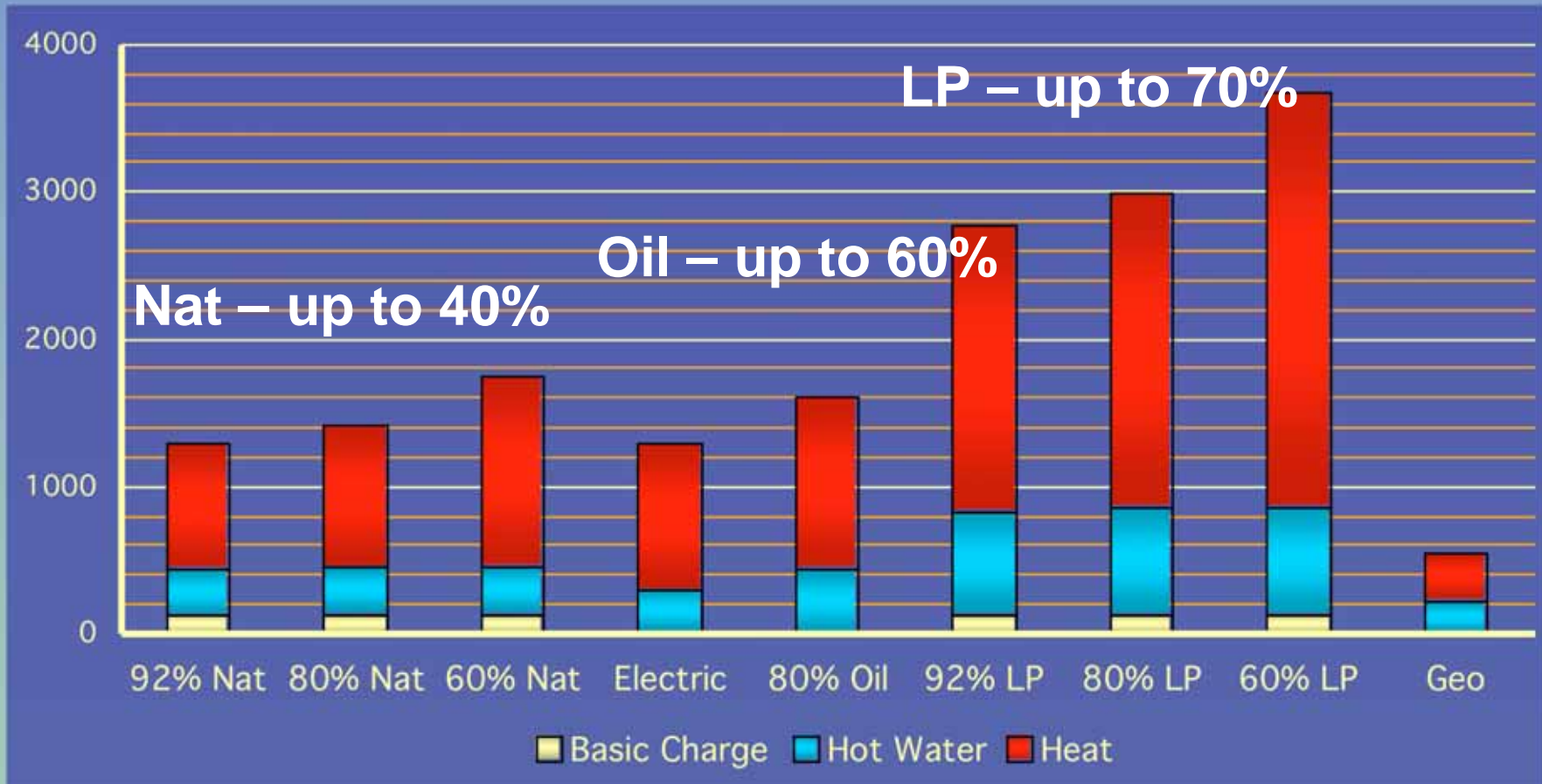
Electric Heat



Free, Renewable Energy From the Earth



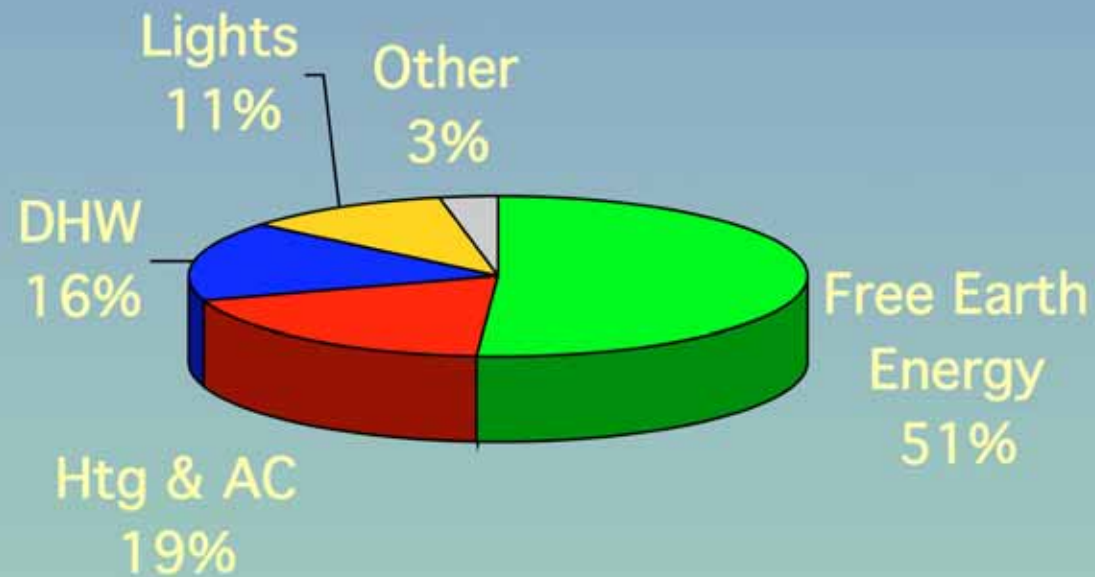
Fuel Cost Comparison



Energy cost comparison figures based on the cost of Natural Gas & Electricity – February 1, 2001 – Costs shown are based on a typical 1,000 – 1,200 sq. ft. home



Benefit of Geothermal Energy



Vertical Loop on City Lot



12 boreholes
drilled to rock
at 55' – total
of 660'

1,500 square foot home

A Typical Residential Geothermal Systems

Residential Closed Loop

- Closed loop
 - Contains 50-100 gallons of fluid
- Open loop
 - Requires water flow of approximately 1.5 – 2 gallons per minute per nominal ton
 - Example: 4 ton system using 9 gpm will use about 1,500,000 gallons per year

Energy Cost Comparison



Basic Charge Heating Cooling DHW



GHG Reductions



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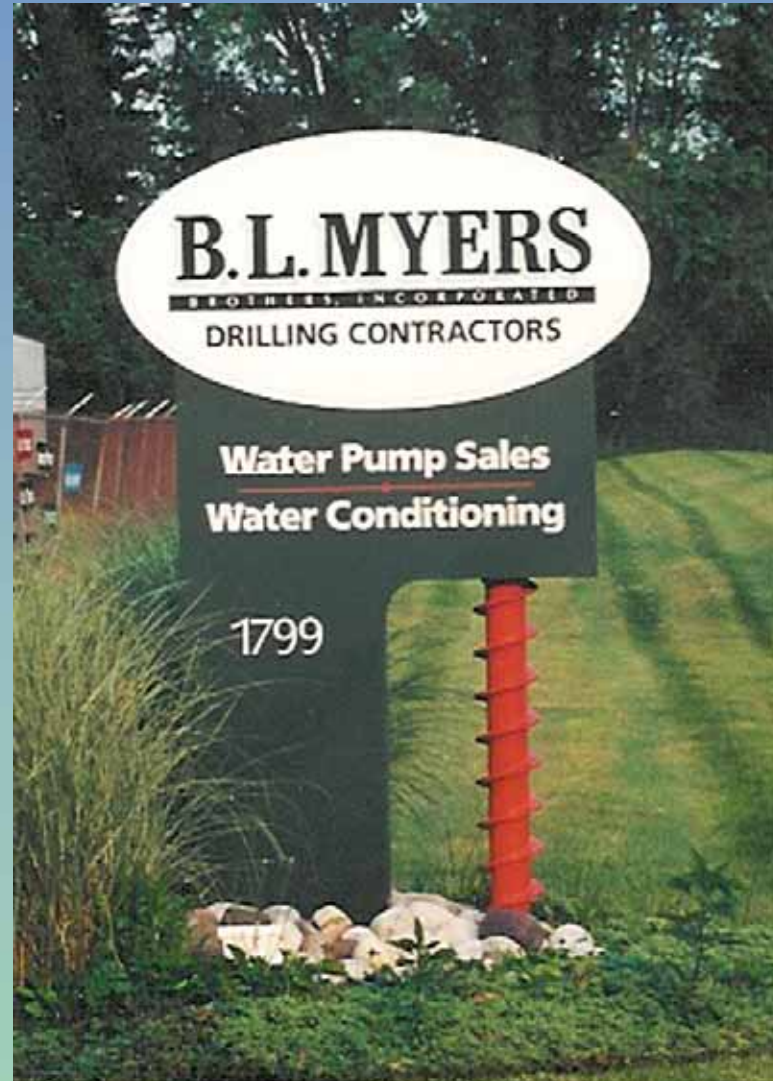


Replacing a gas furnace with A Geothermal System in an average home reduces GHG emissions by about the same amount as removing one car from the roads

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