Geothermal Heat Pumps:
Harnessing On-Site Renewable Energy to Meet Energy-Efficiency and Climate Change Goals

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TRIBAL COMMUNITY

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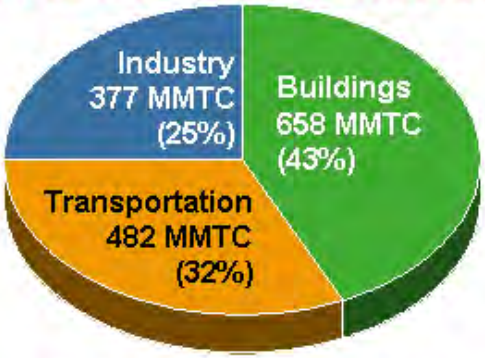
Director

Buildings Dominate U.S. Energy Use and Carbon Emissions

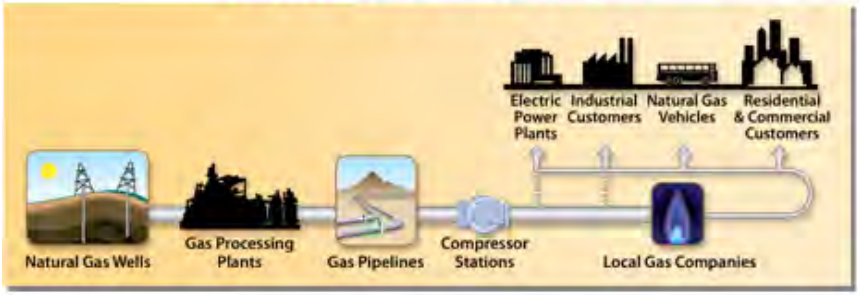
with thermal loads within them being the Largest Contributors

43% of U.S. Carbon Emissions

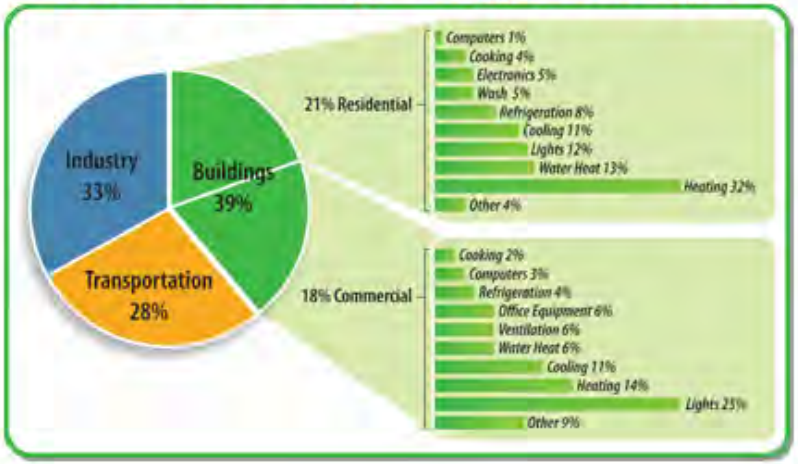


71% of U.S. Electricity

53% of U.S. Natural Gas



39% of U.S. Primary Energy Consumption

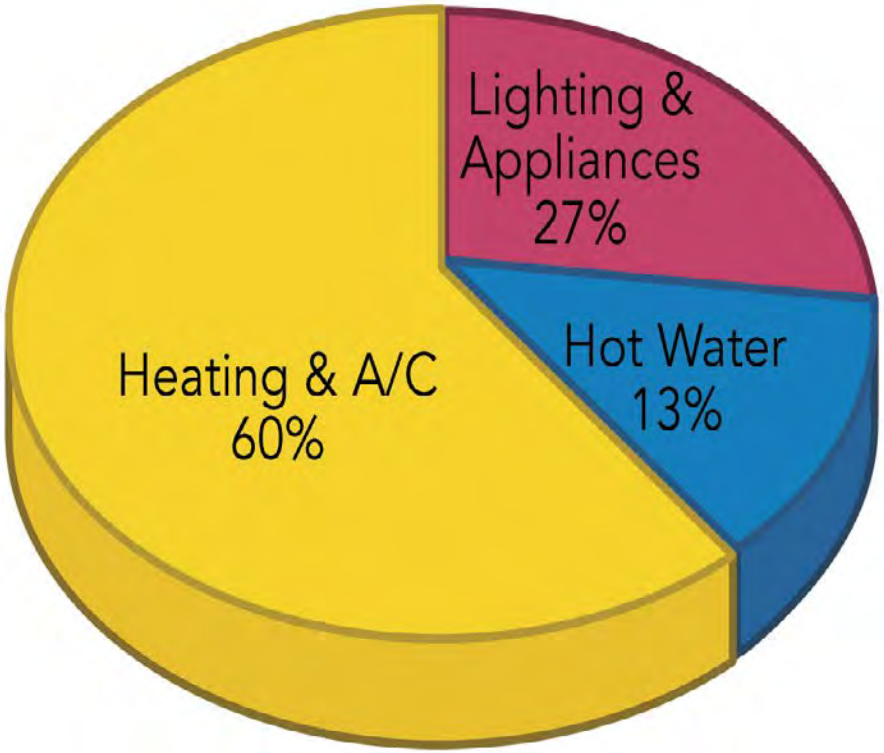


Heating	9.2%
Cooling	4.3%
Hot Water	3.8%
Total	17.3%

Thermal Loads are a large segment of U.S. Energy Consumption

Residential Site Energy

Conventional System

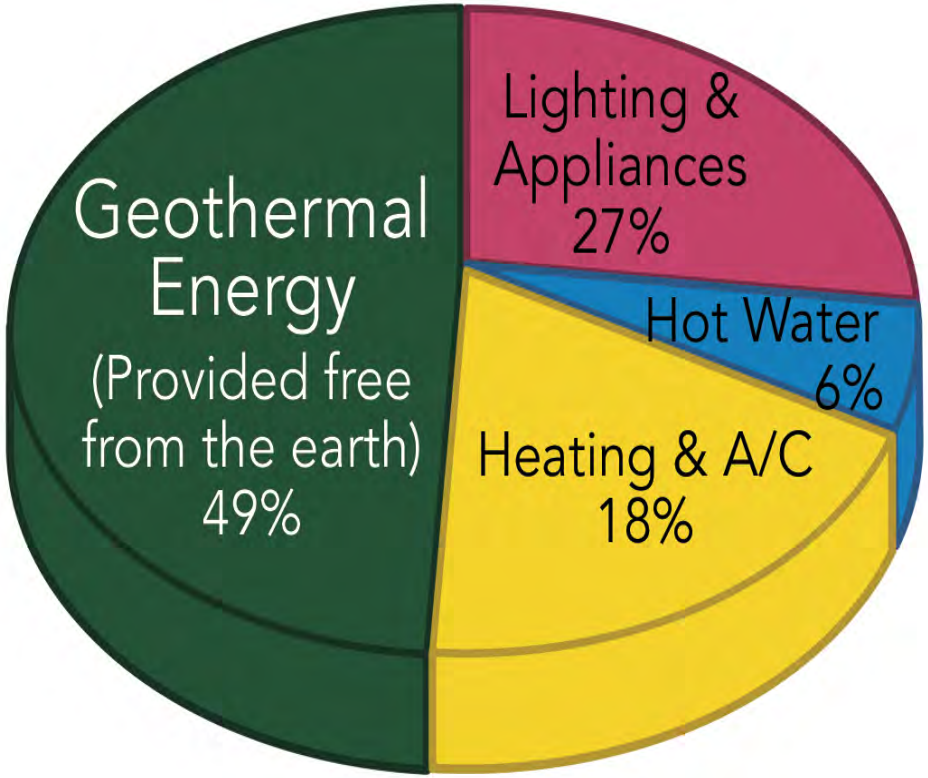


Over 70% of the energy consumed by a typical single-family home is used to meet thermal loads

Residential Site Energy

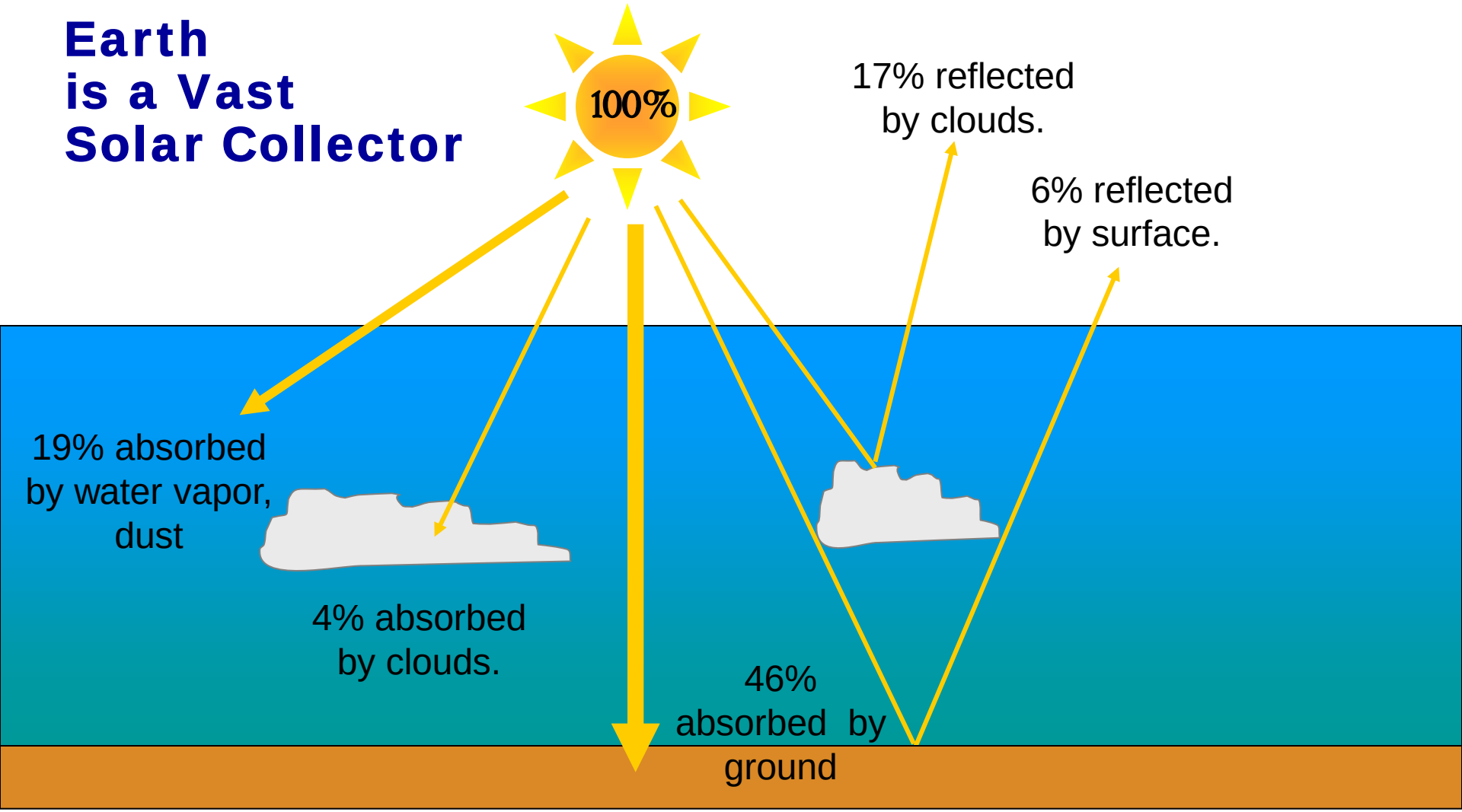
Geothermal Heat Pump System

Total site energy consumption is cut in half using a GHP



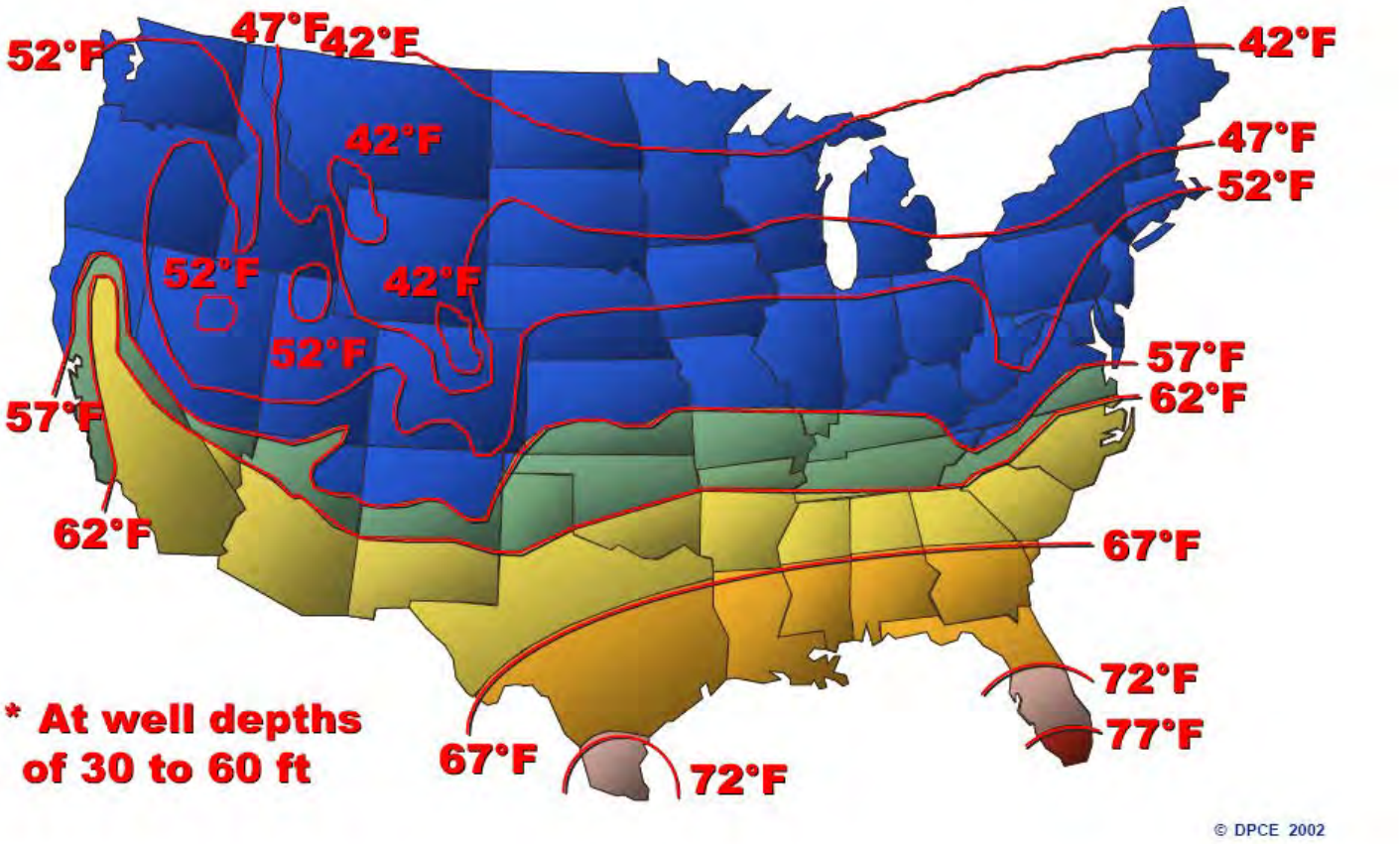
Geothermal Heat Pump
Basic Principles

Earth is a Vast Solar Collector

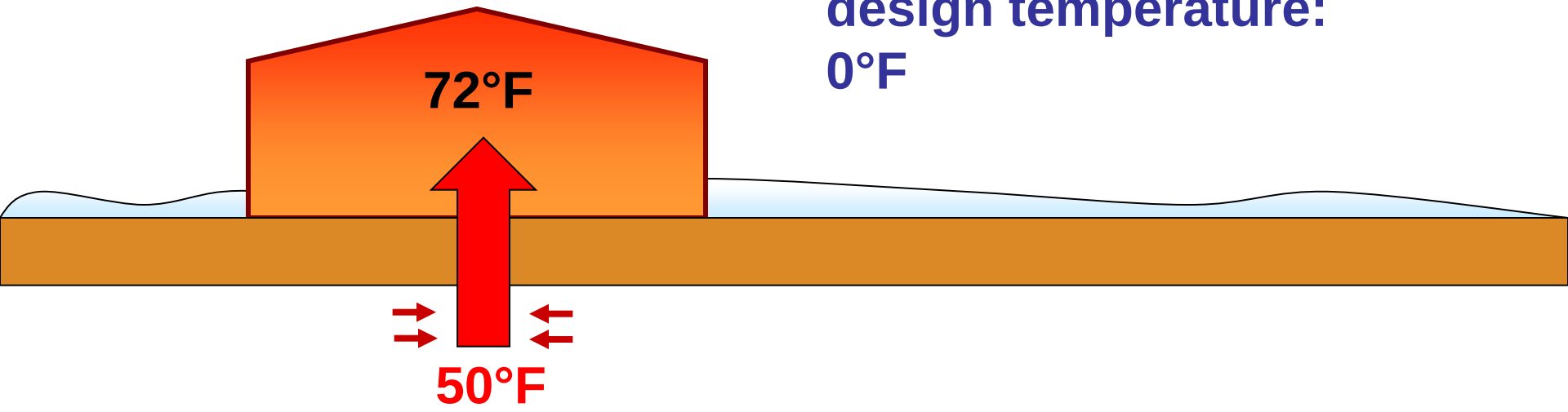


Solar energy maintains a nearly constant temperature throughout the year just below ground

U.S. Underground Temperatures

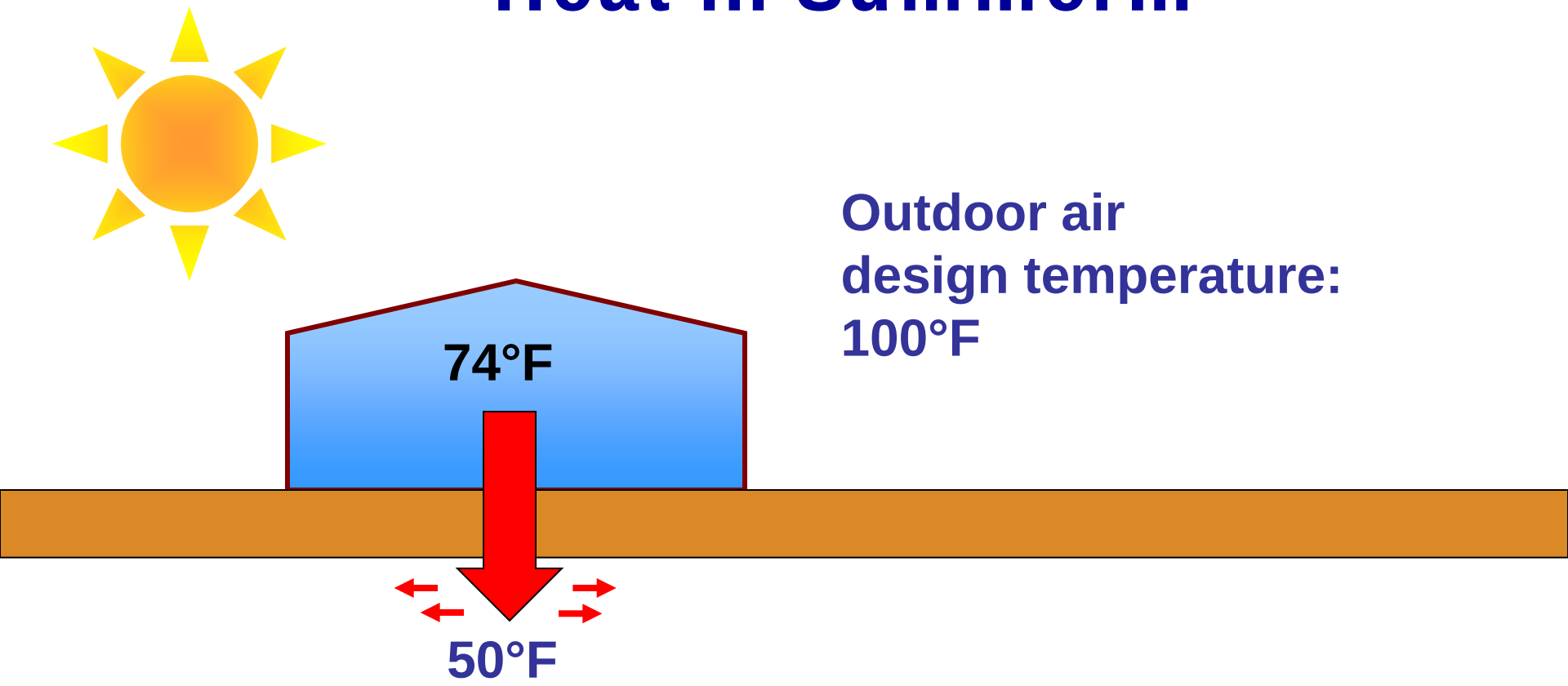


The Earth is a Source of Heat in Winter…



Geothermal heat pumps transfer underground heat into buildings to provide heating

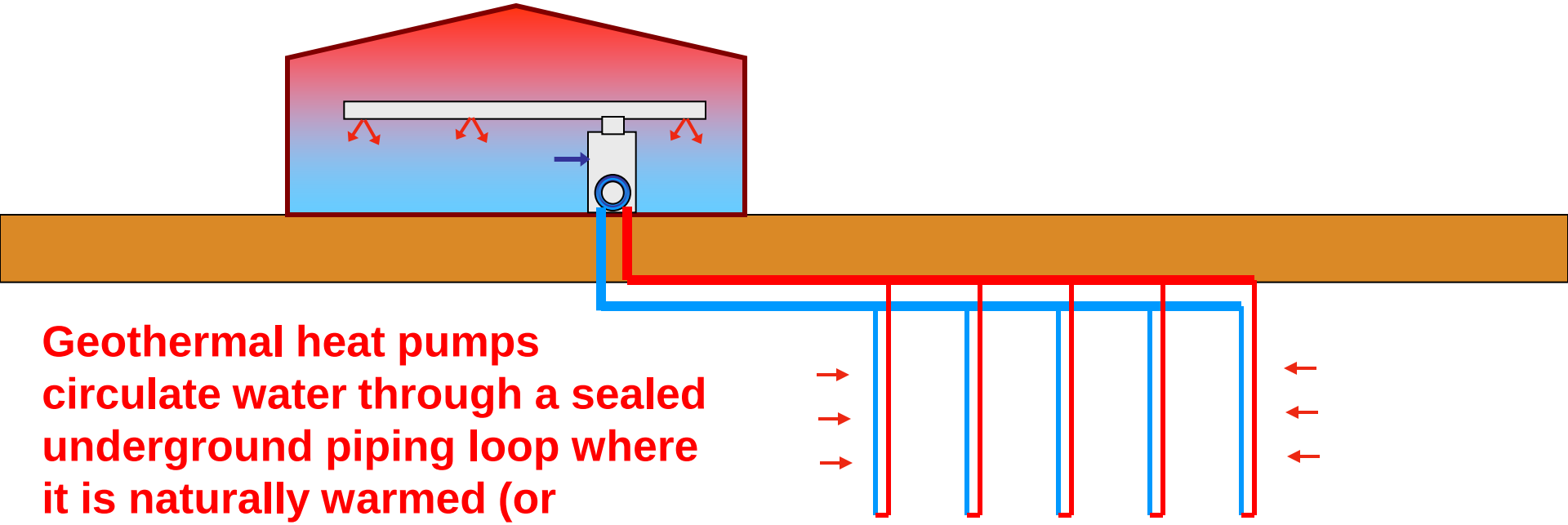
...and an Efficient Place to Reject Heat in Summer...



Outdoor air design temperature: 100°F

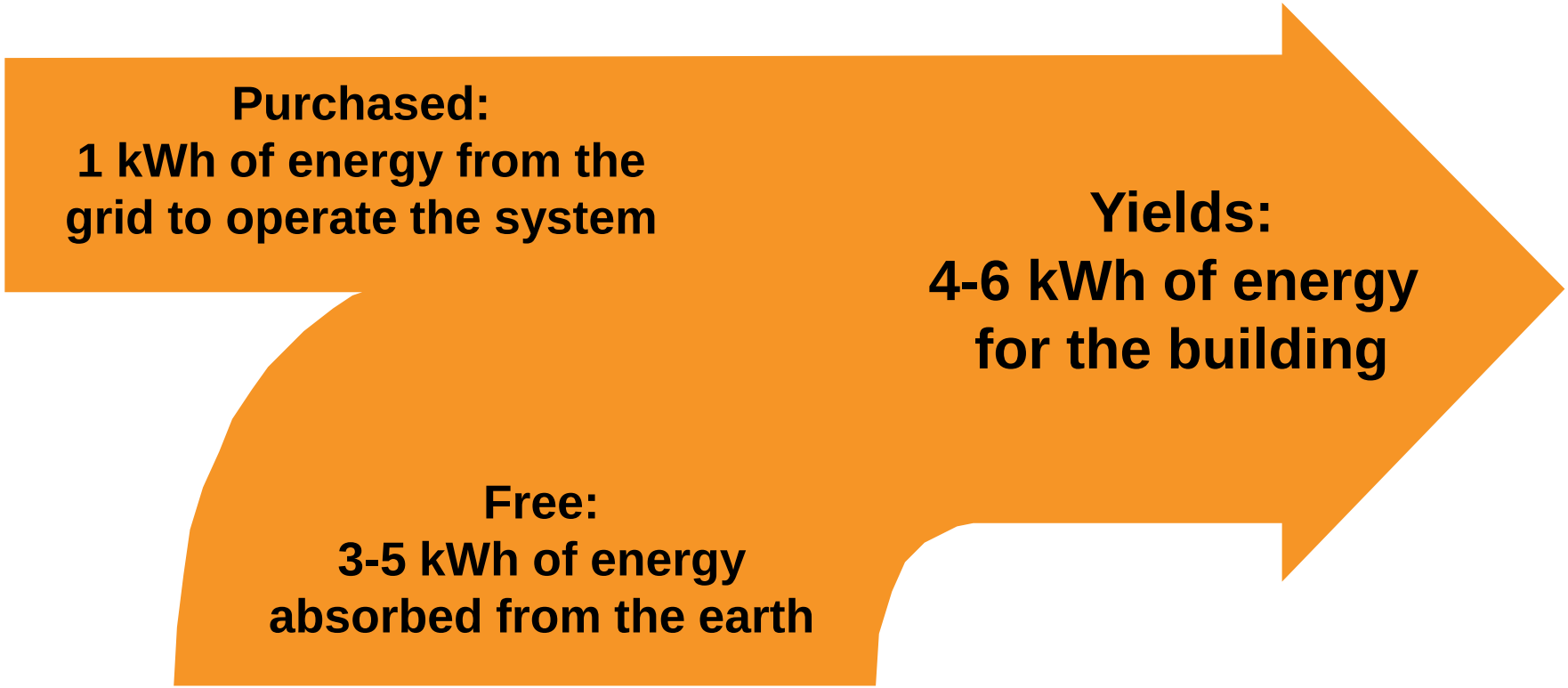
Geothermal heat pumps transfer heat from buildings into the ground to provide cooling

...using Heat Pump Technology



Geothermal heat pumps circulate water through a sealed underground piping loop where it is naturally warmed (or cooled) by the Earth

Geothermal Heat Pumps Transfer Heat Efficiently



400-600% Efficient

Geothermal Heat Pumps (GHPs) Exchange Heat between Air and Water

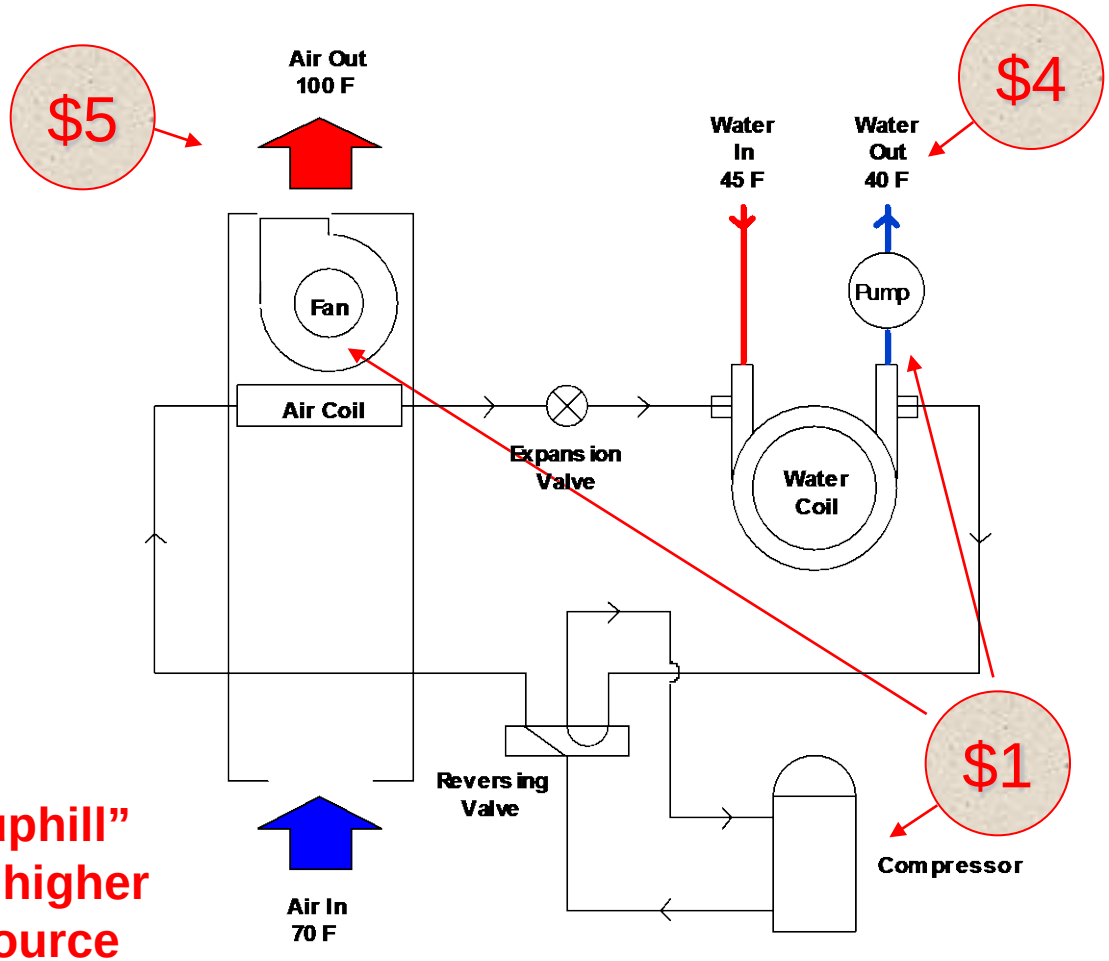
$1 Worth of Electricity to Operate the Compressor and Fan

Moves $4 Worth of Heat from the Water

Delivering $5 Worth of Heat into the Air

Heating Mode Shown

Heat can be "pumped uphill" meaning delivered at a higher temperature than the source

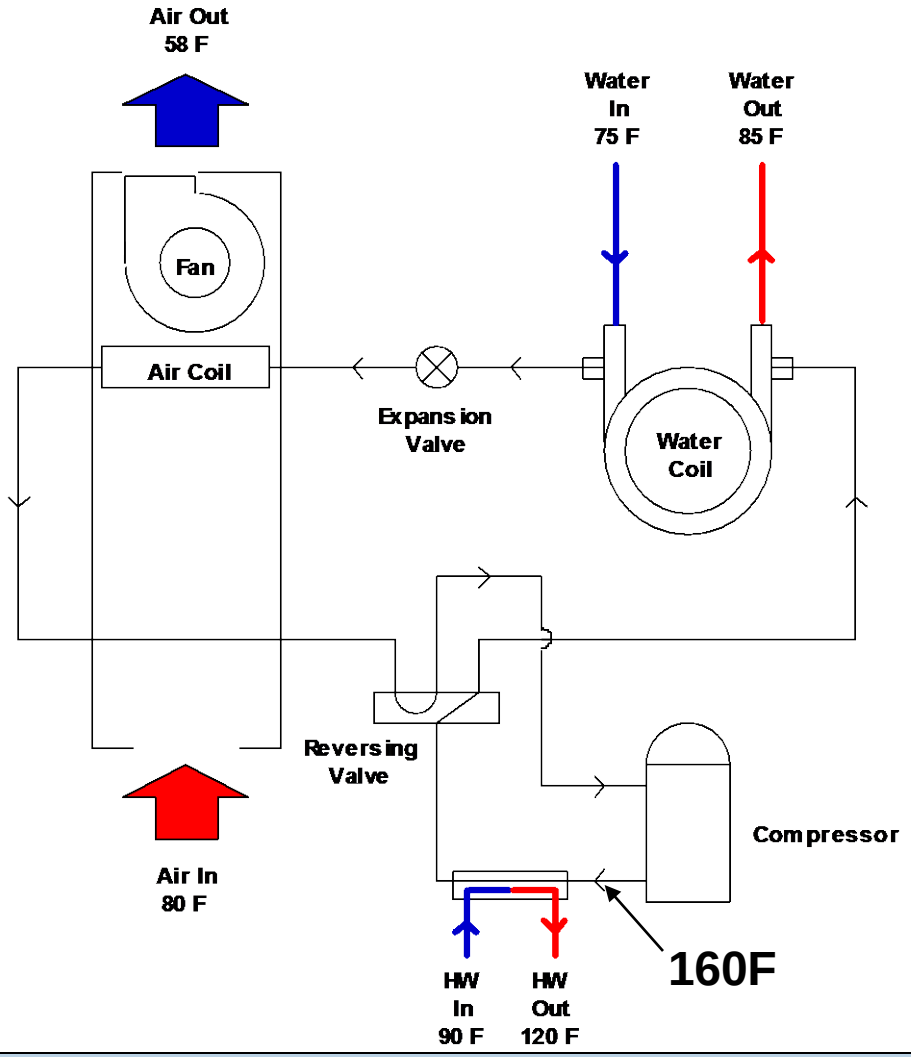


GHPs also Produce Hot Water

Operates on the Same Principle as a Refrigerator

Cooling Mode Shown

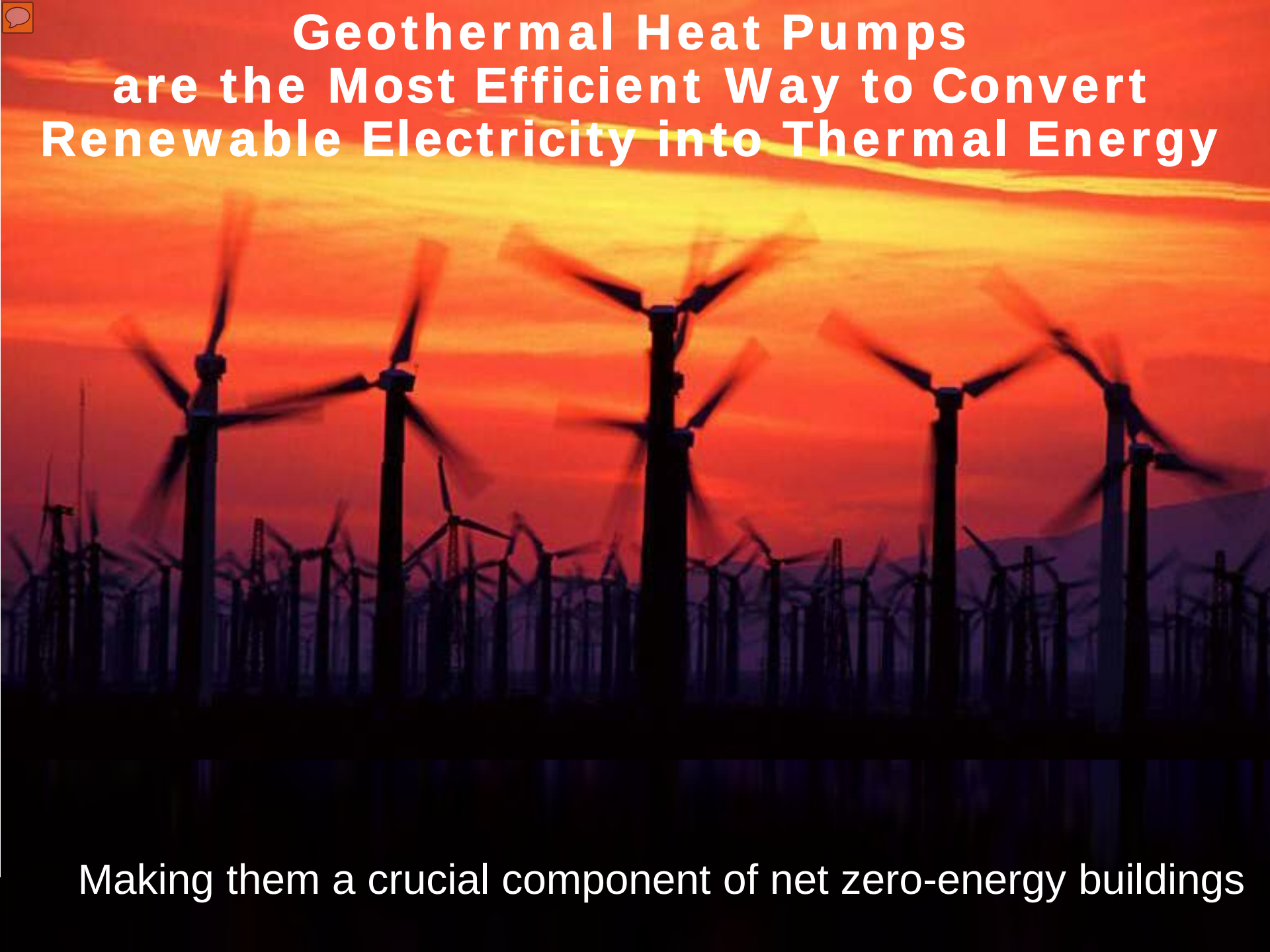
Hot water is produced whenever the unit is operating



Geothermal Heat Pumps

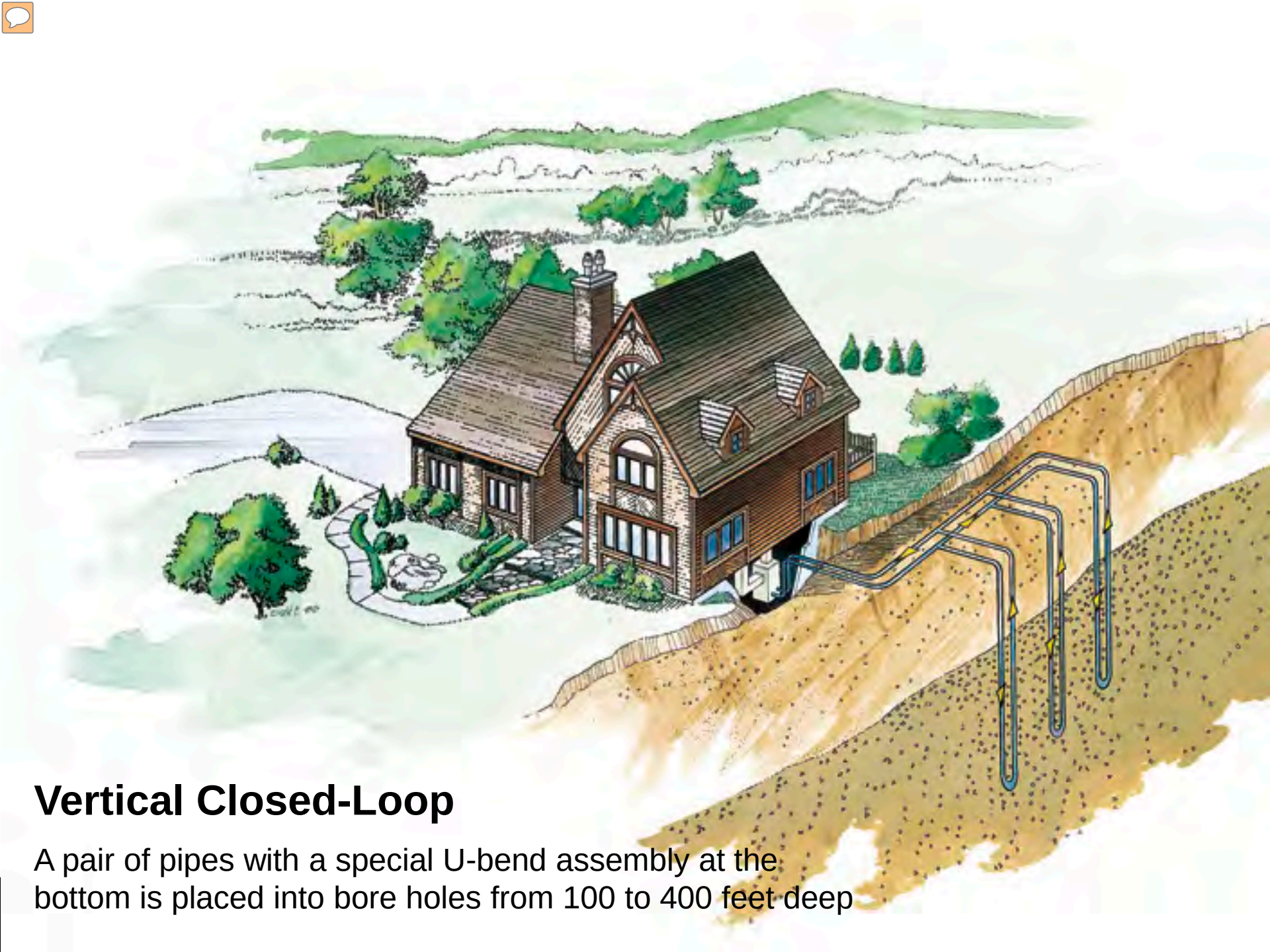
Self-contained unit for heating, cooling and hot water that operates with standard thermostat and duct system

Geothermal Heat Pumps are the Most Efficient Way to Convert Renewable Electricity into Thermal Energy



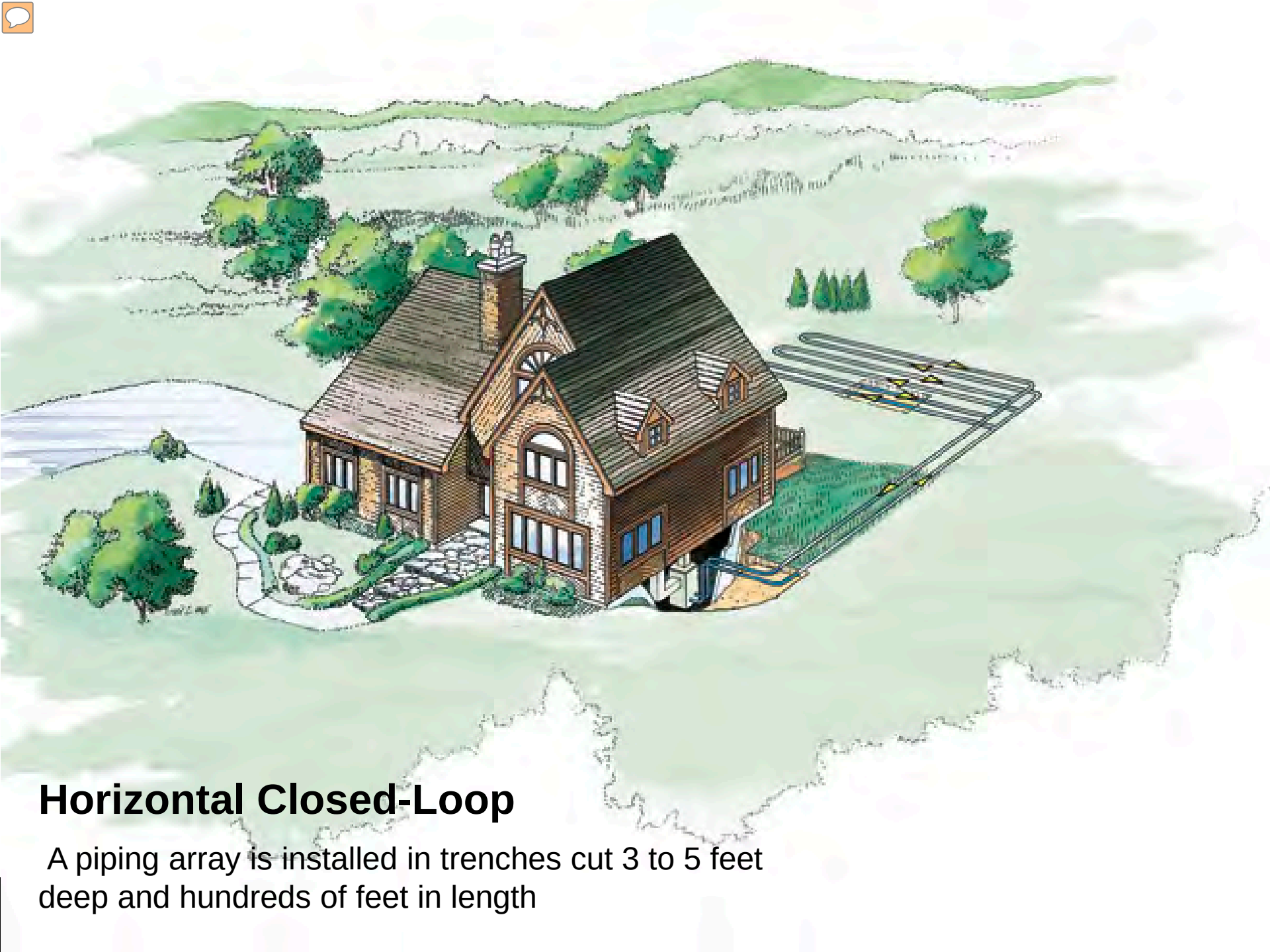
Making them a crucial component of net zero-energy buildings

Geothermal Heat Pump Installation Methods



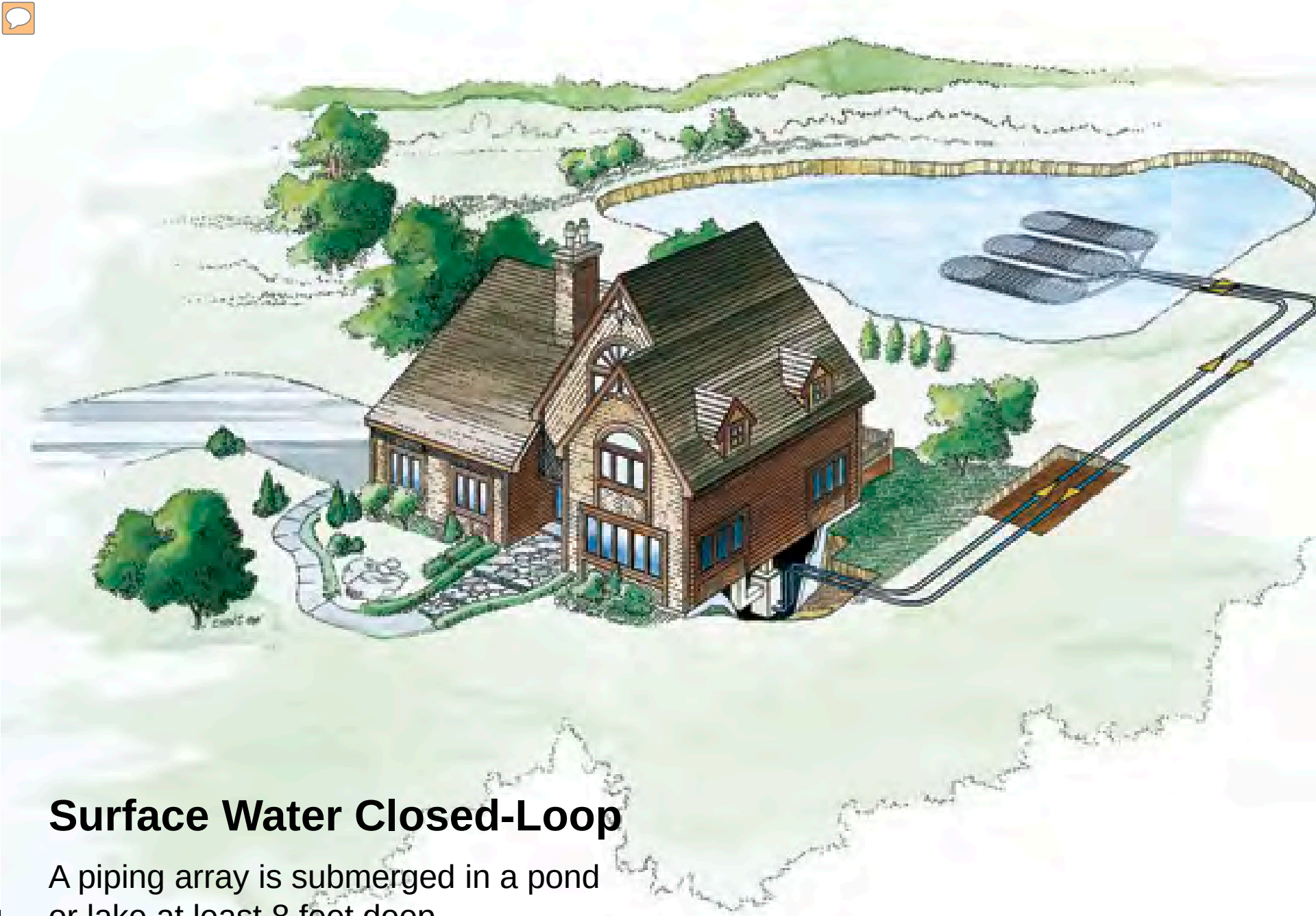
Vertical Closed-Loop

A pair of pipes with a special U-bend assembly at the bottom is placed into bore holes from 100 to 400 feet deep



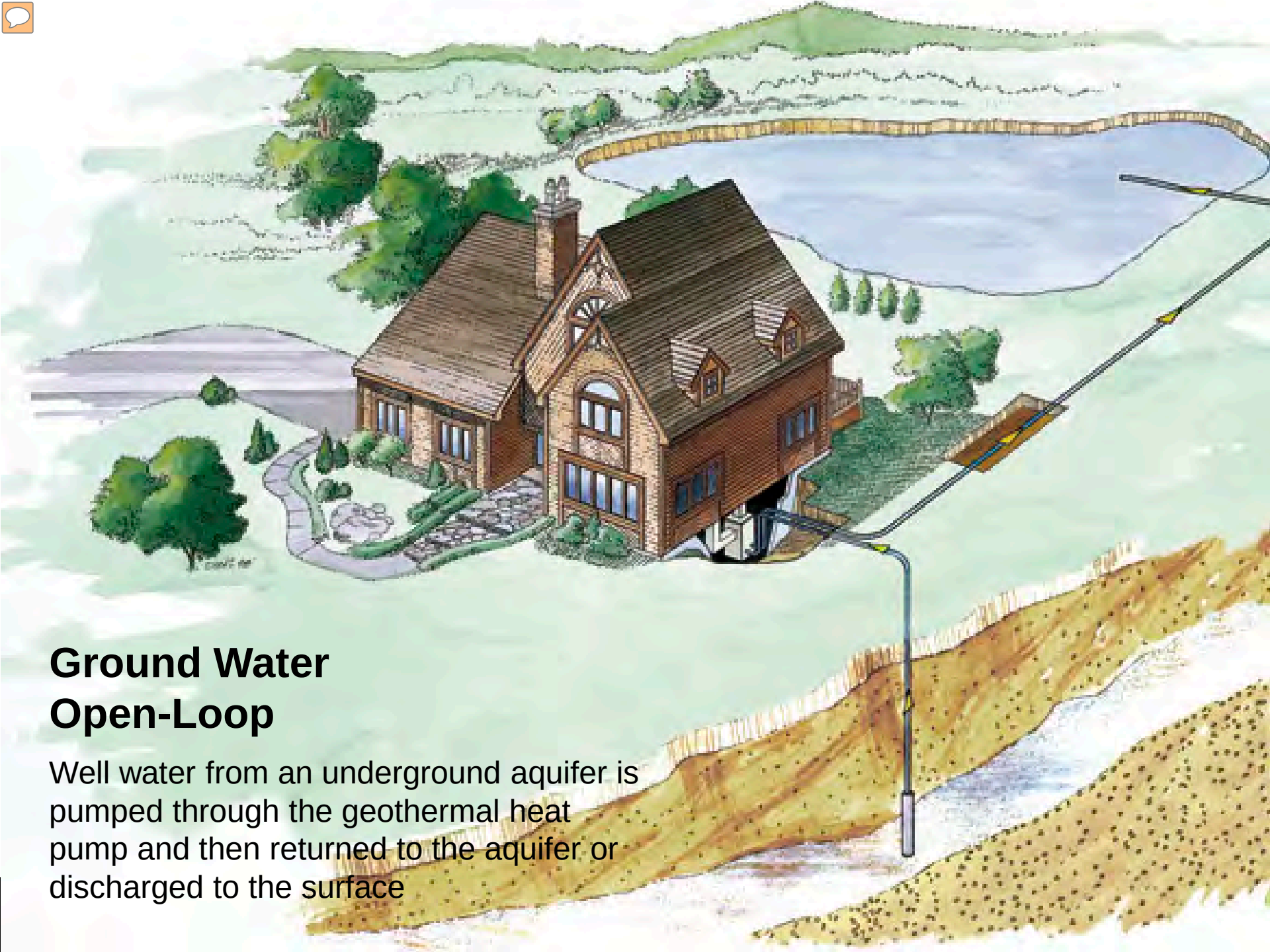
Horizontal Closed-Loop

A piping array is installed in trenches cut 3 to 5 feet deep and hundreds of feet in length



Surface Water Closed-Loop

A piping array is submerged in a pond or lake at least 8 feet deep



Ground Water Open-Loop

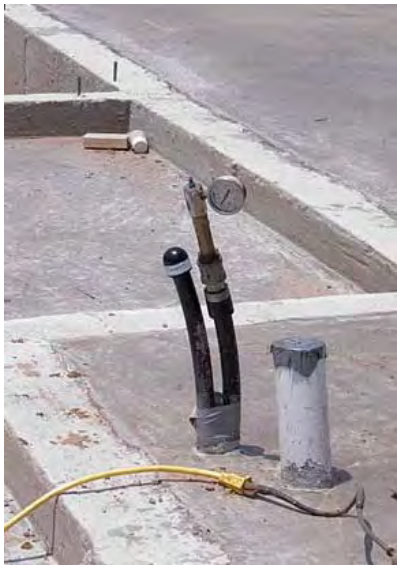
Well water from an underground aquifer is pumped through the geothermal heat pump and then returned to the aquifer or discharged to the surface

Vertical Closed-Loop Installation

Drilling

Pipe Loop Insertion

Heat Fusing



Inside Connection

Geothermal Heat Pumps Are a Scalable Technology

GHPs are used in Small Homes

1300 Sq. Ft. Low Energy Habitat for Humanity Homes

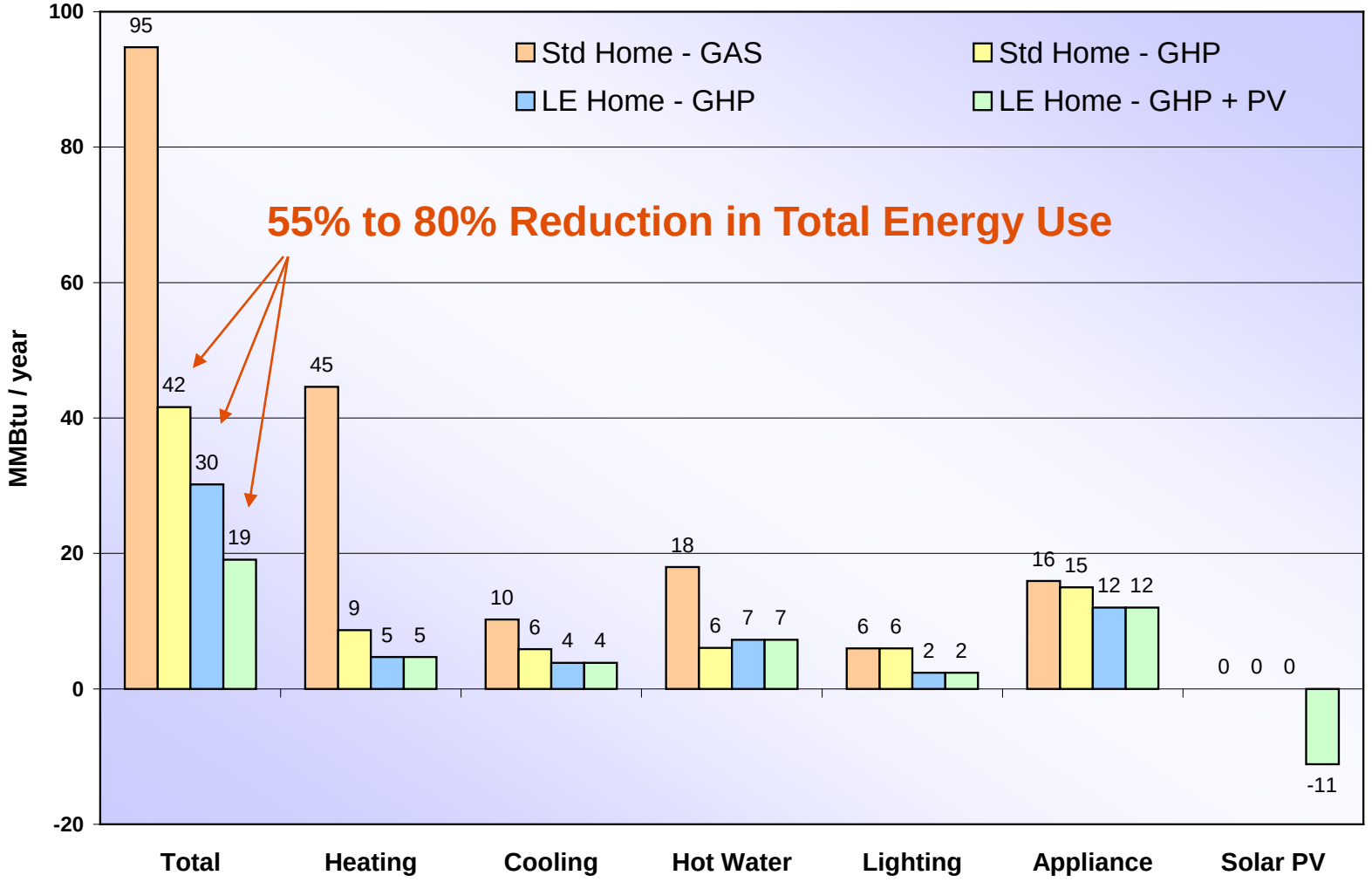
Habitat for Humanity

Low Energy Home Construction Details

Geothermal Heat Pump / Foam Insulation / Low-E Glass / CFL Lighting / Energy Star Appliances

Habitat for Humanity

Site Energy Consumption by End Use – Std and Low Energy (LE) Homes



GHPs are used in Large Commercial Buildings

Statue of Liberty Gift Shop

ASHRAE Headquarters - Atlanta, GA

Galt House Hotel - Louisville, KY

Black Point Inn - Prouts Neck, ME

Naval Observatory, Washington DC

Harvard Library – Cambridge, MA

French Laundry Rest.- Napa, CA

Whistler Village - BC, Canada

Yale Art Bld. – New Haven, CT

Gaillardia Offices – Okla. City

California University of PA

Hirschfeld Towers – Denver, CO

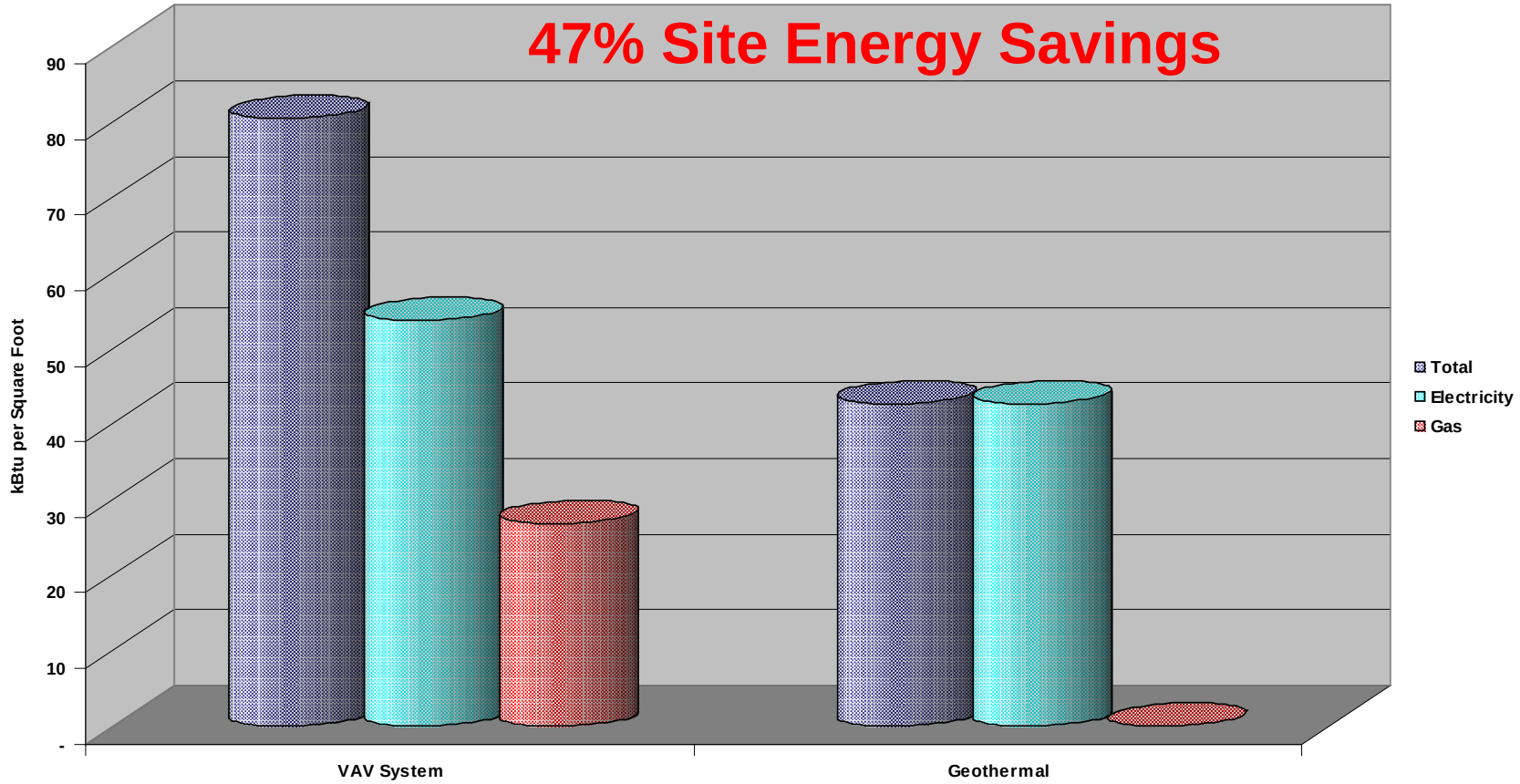
The Oklahoma State Capitol uses over 600 geothermal heat pumps

Garrett Office Buildings
Edmond, Oklahoma

One is Geothermal and the Other is Conventional HVAC (VAV)

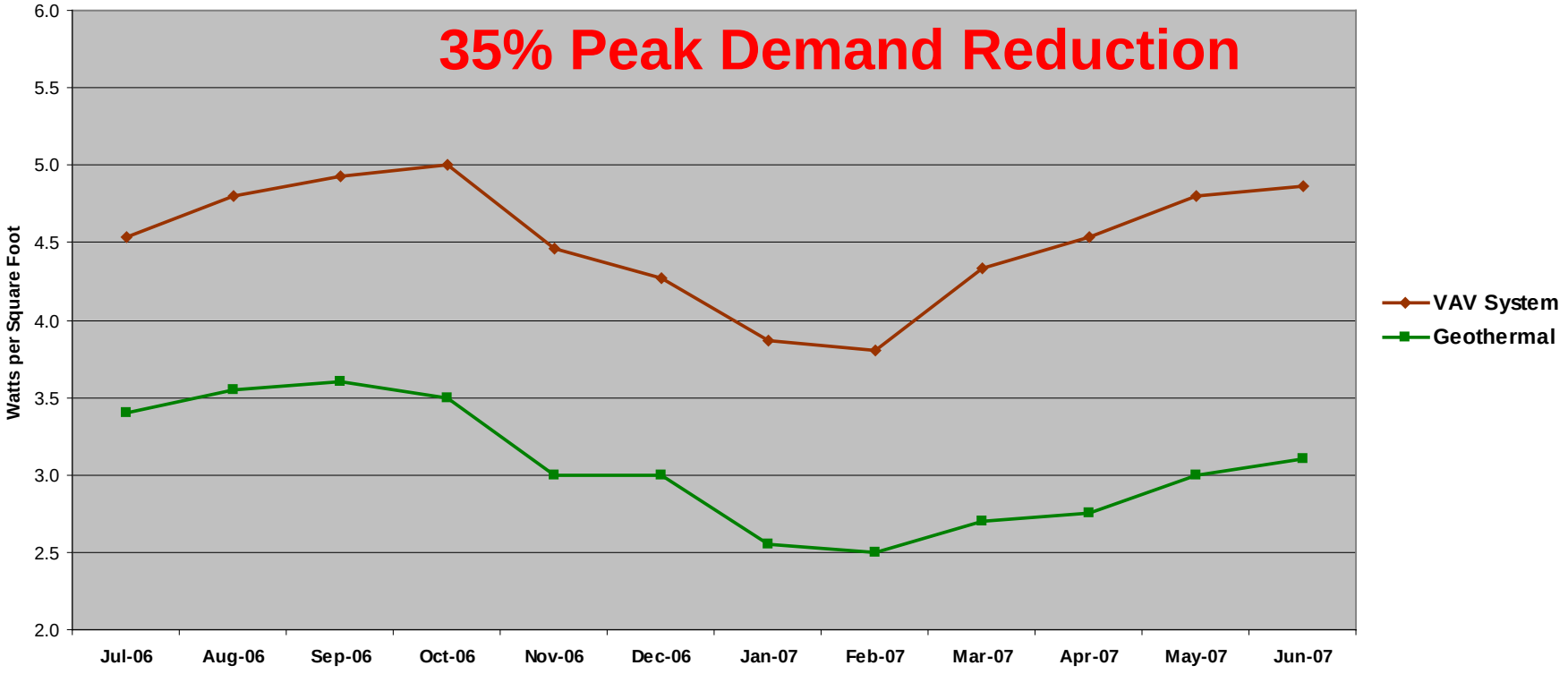
Garrett Office Buildings

Actual Metered Annual Energy Use 2006-2007



Garrett Office Buildings

Monthly Peak Demand



Geothermal Heat Pump Public Policy Perspective

Geothermal Heat Pump Residential Tax Incentives

Federal Income Tax Credit:

- 30% of total GHP system cost
- No cap on maximum credit
- Can be used to offset AMT tax
- Can be combined with other tax credits
- Can be used in more than one year

Eligibility:

- Home must be located in the U.S.
- Includes houses, cooperatives, condos, mobile homes
- Does not have to be your main home
- GHP must meet Energy Star requirements
- Placed in service before 2017

Geothermal Heat Pump Business Tax Incentives

Federal Income Tax Credit:

- 10% of total GHP system cost
- No cap on maximum credit
- Can be used to offset AMT tax
- Can be used in combination with subsidized financing
- Can be used in more than one year

Accelerated Depreciation:

- 5 year MACR depreciation for entire GHP system
- Eligible for bonus depreciation in 2011 (100% write-off in first year)

Eligibility:

- Building located in the U.S.
- Original use begins with taxpayer
- Placed in service before 2017
- Can be used by regulated utilities
- Must be claimed by the owner of the property (effects non-taxable)

Geothermal Heat Pump
Existing State Incentives

37 States have Financial Incentives for GHPs

- Many are new
- Sales tax and property tax exemptions, income tax credits, grants
- 17 States have tax credits or grants

28 States have Regulatory Incentives for GHPs

- Green public building requirements

36 States have Utility Incentives for GHPs

- Voluntary DSM
- Mandated RES and EES
- loans and rebates
- **Utility DSM is finally coming back!**

Geothermal Heat Pump Policy Talking Points

50 state technology

Uniquely addresses nearly 20% of US primary energy consumption

Incremental cost is the installation of the underground heat exchange piping

- **This can never be imported from China**
- **Local green-collar job creation**
- **Most of the investment cost remains in the local economy**

GHPs are "Made in the USA"

Reduces grid electricity demand

- **Defers the need for new power plants**
- **Extends the capacity of existing transmission lines**

Available 24/365

- **Benefits accrue whenever thermal energy is needed**
- **Provide the maximum benefits "on peak"**

How Should GHPs Fit Into Energy Policy?

GHPs Reduce Carbon Emissions

Annual CO_{2e} Emissions

2000 Sq. Ft. Existing Home

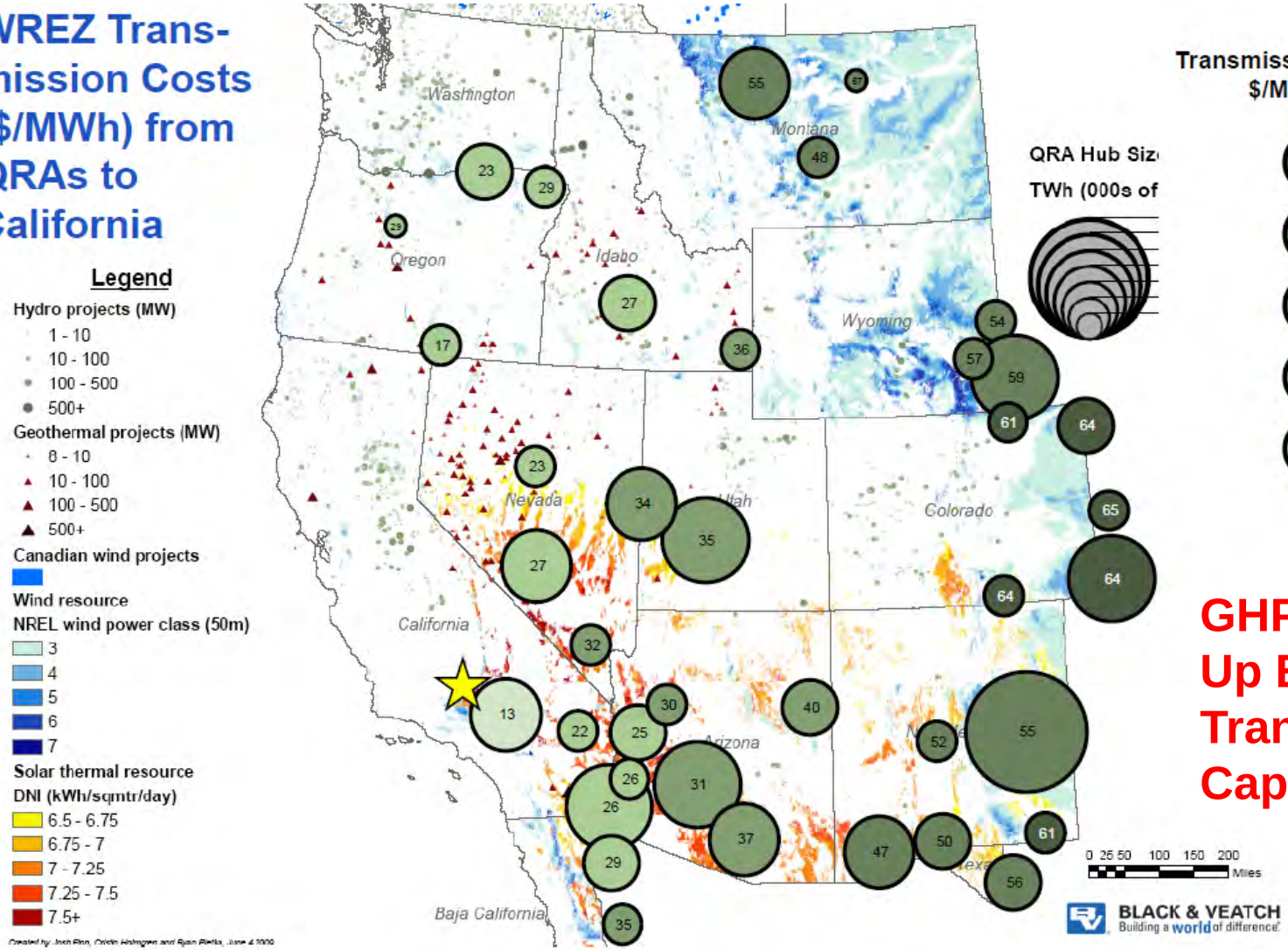
Census Region	**Housing Units** (millions)	**Baseline CO_{2e} Emissions** (Mtons/yr)	**Geothermal CO_{2e} Emissions** (Mtons/yr)
Northeast	19.6	16.5	7.7
Midwest	24.5	20.6	12.9
South	38.9	16.0	7.6
West	22.5	18.5	9.3
Weighted Average		**17.7**	**9.2**

Weighted national average annual reduction is 8.5 MT CO_{2e}

Under Cap and Trade this could be valued at $85 to $850 per year

GHPs have Zero Transmission Cost

WREZ Trans-mission Costs ($/MWh) from QRAs to California



GHPs Free Up Existing Transmission Capacity

Example of the Potential of Geothermal Heat Pumps to Reduce:

- Energy Consumption
- Carbon Emissions
- Electricity Demand

in Existing Housing

Existing Housing Stock (# Homes) - 2005

Gas – 5.3 million
Electric – 1.0 million
Propane – 800k
Heat Pump – 400k
Oil – 200k
Other – 200k

Gas – 13.1million
Electric – 1.3 million
Propane – 1.1 million
Heat Pump – 800k
Oil – 700k
Other – 700k

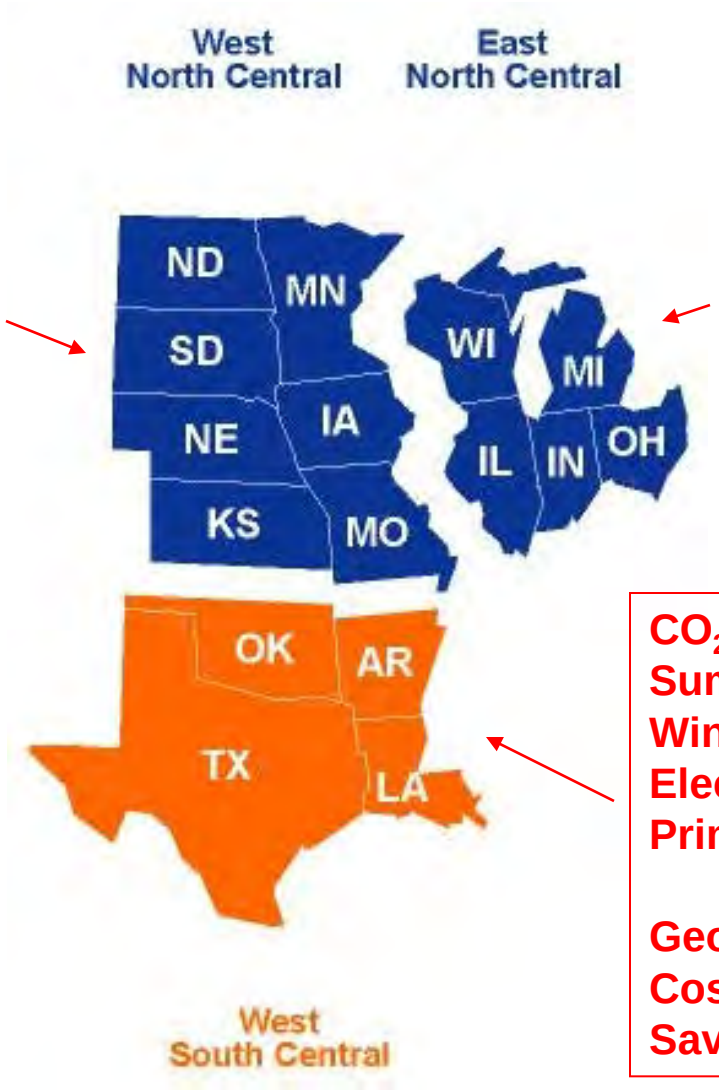
Gas – 5.7 million
Electric – 4.3 million
Propane – 800k
Heat Pump – 900k
Other – 400k

EIA 2005 Residential
Energy Consumption Survey

Annual Benefits of GHP Retrofits in Existing Homes

CO_2 – 8.4 MMT
Summer Peak – 1.2 GW
Winter Peak– 0.8 GW
Electric – 6.3 Billion kWh
Primary – 0.12 quad Btu

Geo Units – 0.6 million
Cost - $6 to $8 billion
Savings - $1.6 billion / yr



CO_2 – 10.0 MMT
Summer Peak – 1.9 GW
Winter Peak– 0.3 GW
Electric – 6.8 Billion kWh
Primary – 0.14 quad Btu

Geo Units – 1.0 million
Cost - $10 to $14 billion
Savings - $2.7 billion / yr

Assumed GHP Market Penetration:

25% of existing homes not using natural gas

CO_2 – 14.4 MMT
Summer Peak – 3.1 GW
Winter Peak– 9.7 GW
Electric – 25.4 Billion kWh
Primary – 0.21 quad Btu

Geo Units – 1.5 million
Cost - $15 to $21 billion
Savings - $3.3 billion / yr

Geothermal Heat Pump Market Perspective

MCN New Geothermal Housing Project

MCN Housing Unit Duplex

Solomon Morgan
Keith Bunner
Muscogee (Creek) Nation

MCN Housing Equipment Room

MCN Geothermal Loopfield Location

MCN New Student Housing Complex with Geothermal Systems

MCN Housing Loopfield Area

Large Geothermal Loopfield
Navajo New Mexico

Thank You!