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

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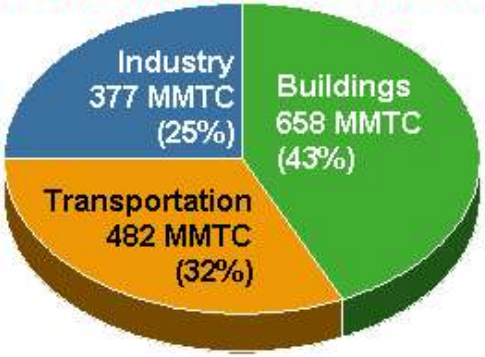
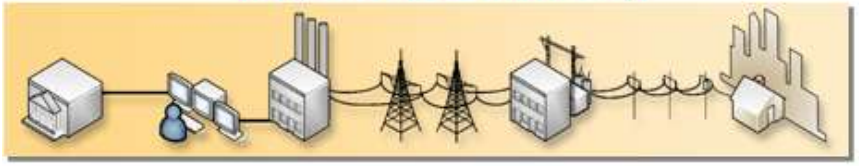
Buildings Dominate U.S. Energy Use and Carbon Emissions

with Heating, Cooling, and Water Heating being the Largest Contributors

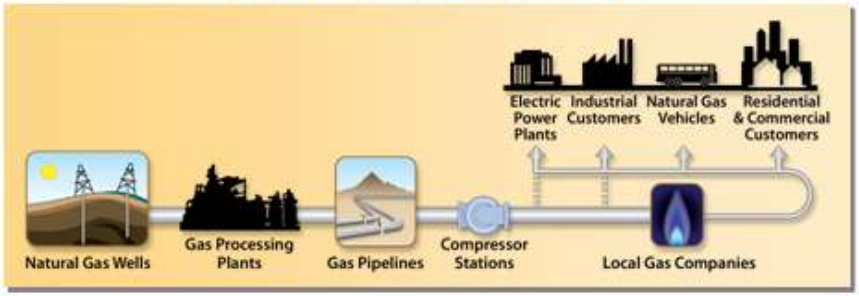
43% of U.S. Carbon Emissions



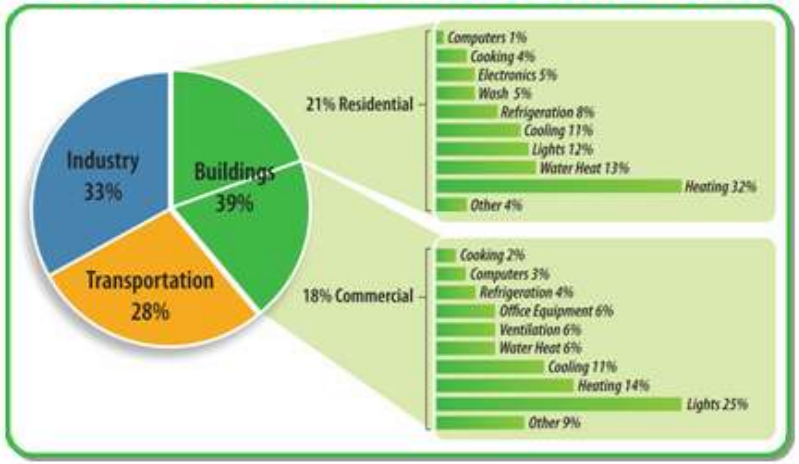
71% of U.S. Electricity



53% of U.S. Natural Gas



39% of U.S. Primary Energy Consumption

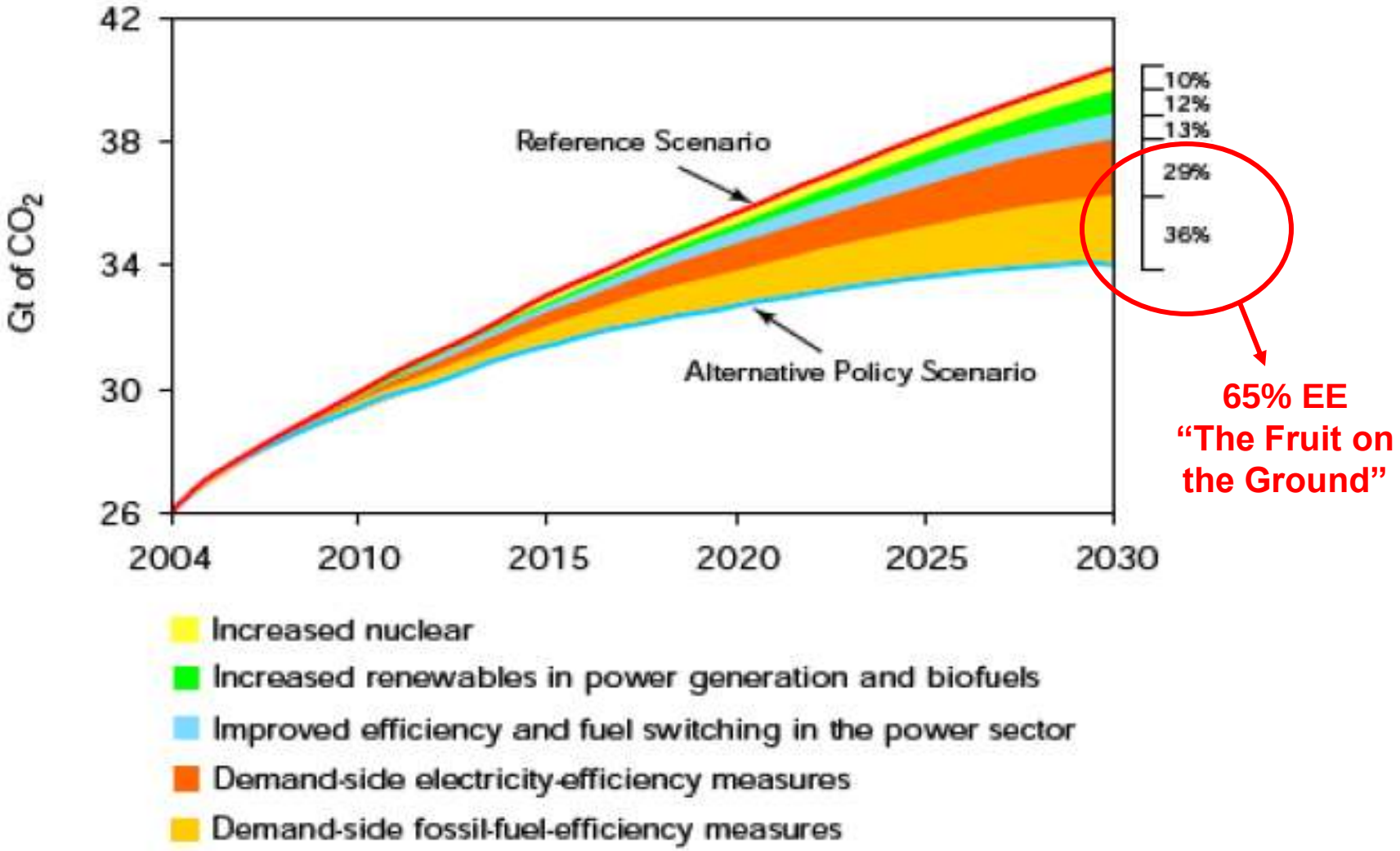


Thermal Loads

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

Potential of Demand-Side Efficiency

Global CO_2 Emissions Outlook – IEA 2006



Geothermal Heat Pump Systems

… are the most energy-efficient, environmentally clean, and cost-effective space-conditioning system

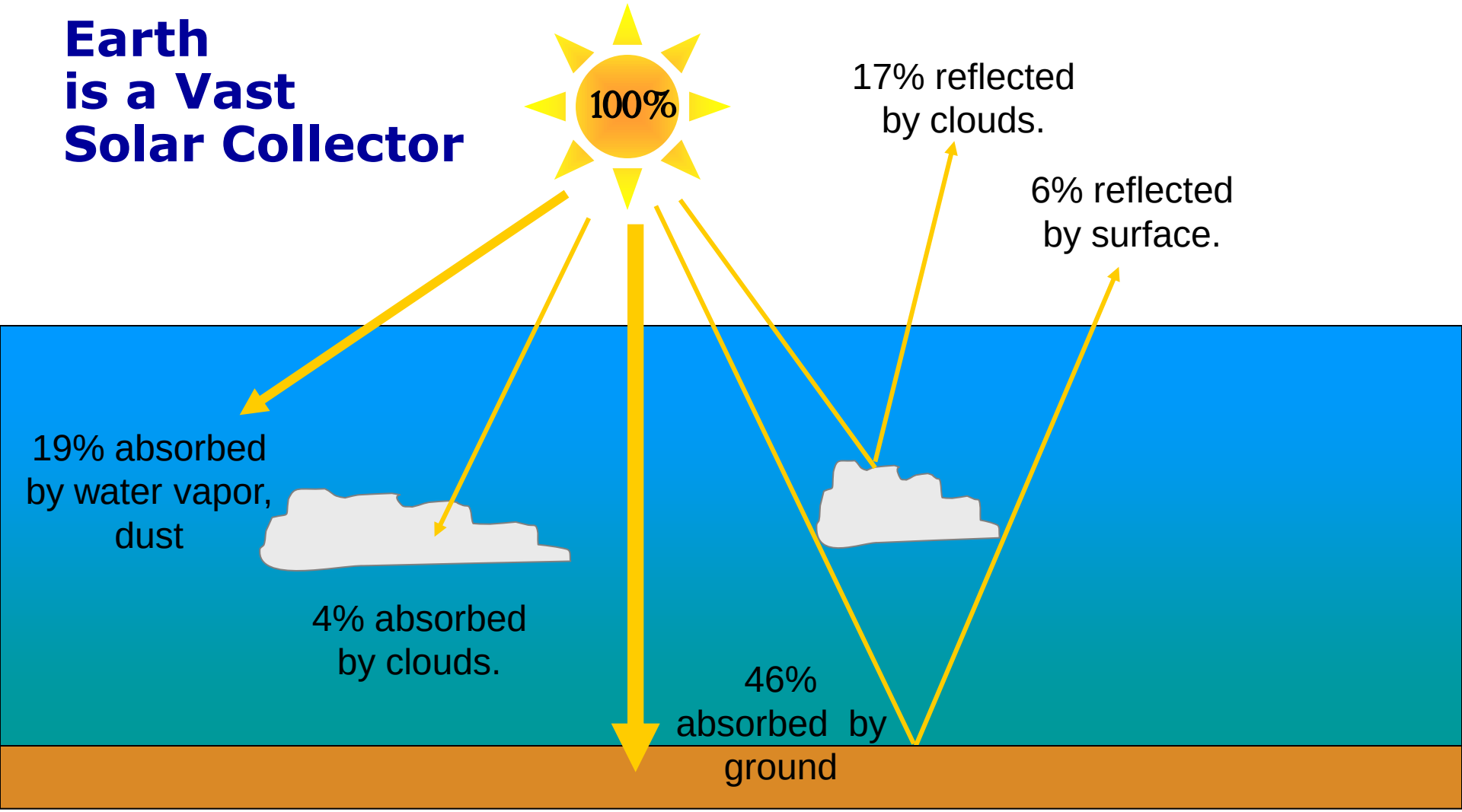
… produce the lowest carbon dioxide emissions, including all source effects, of all available space-conditioning technologies

(U.S. EPA)

Geothermal Heat Pumps are one of the Most Effective Ways to the Reduce Energy Consumption and Environmental Footprint of our Building Stock

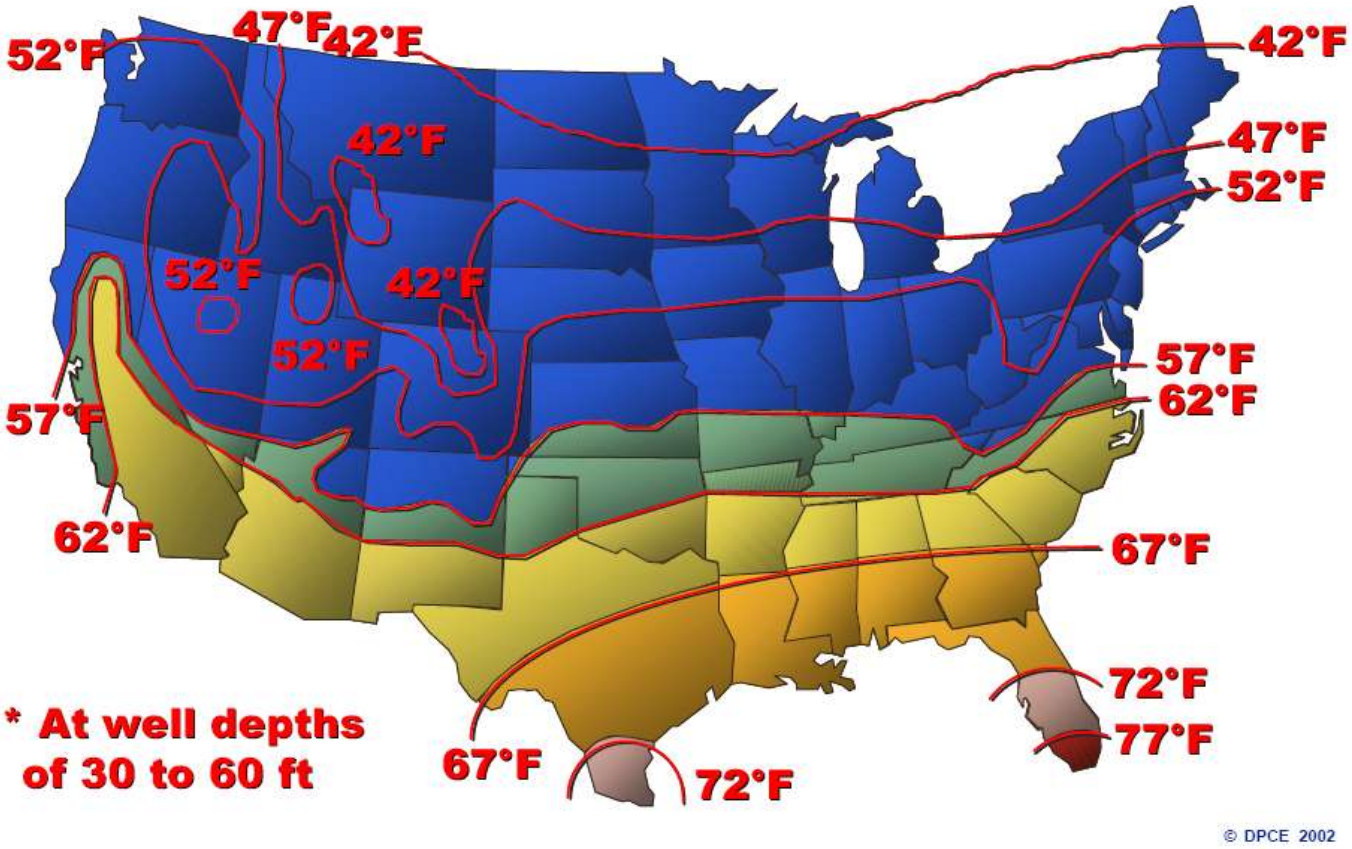
Geothermal Heat Pump
Basic Principles

Earth is a Vast Solar Collector

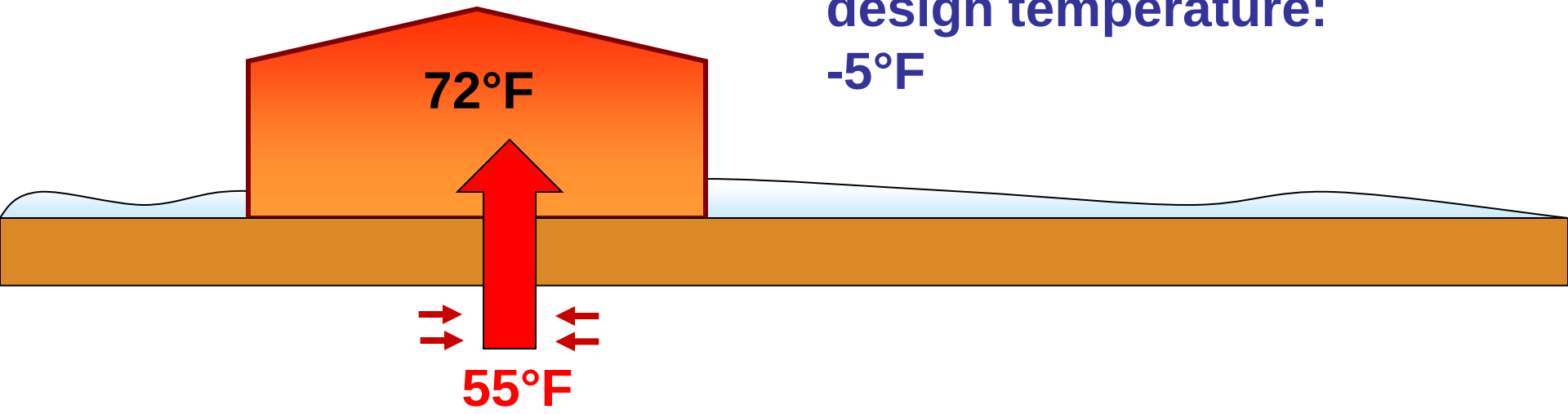


Solar energy maintains a nearly constant temperature throughout the year just below ground

U.S. Underground Temperatures

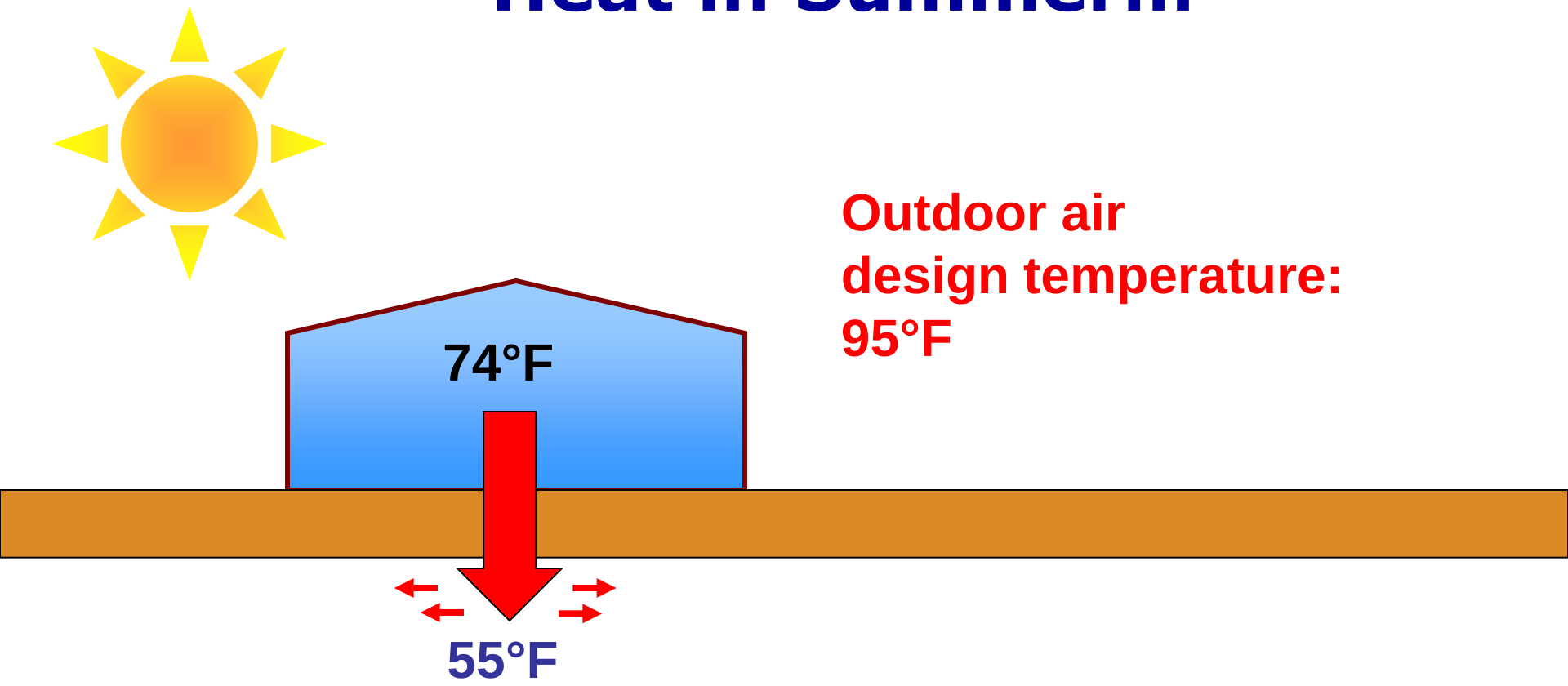


The Earth is a Source of Heat in Winter…



Geothermal heat pumps transfer underground heat into buildings to provide heating

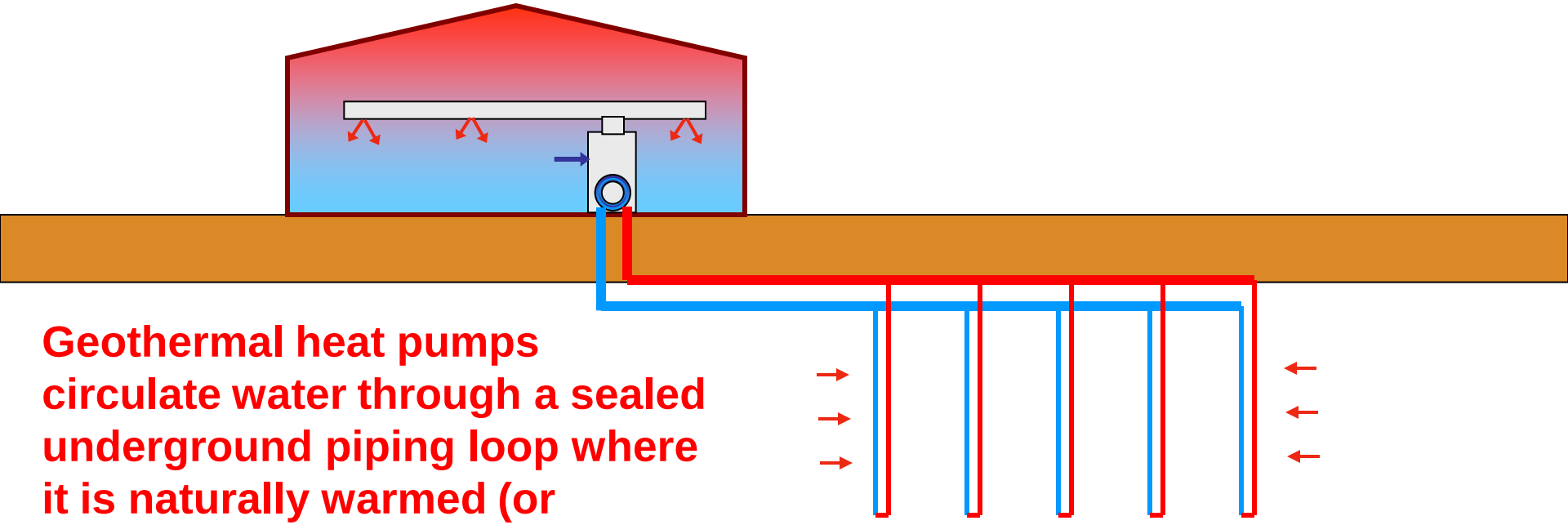
…and an Efficient Place to Reject Heat in Summer…



Outdoor air design temperature: 95°F

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

…using Heat Pump Technology

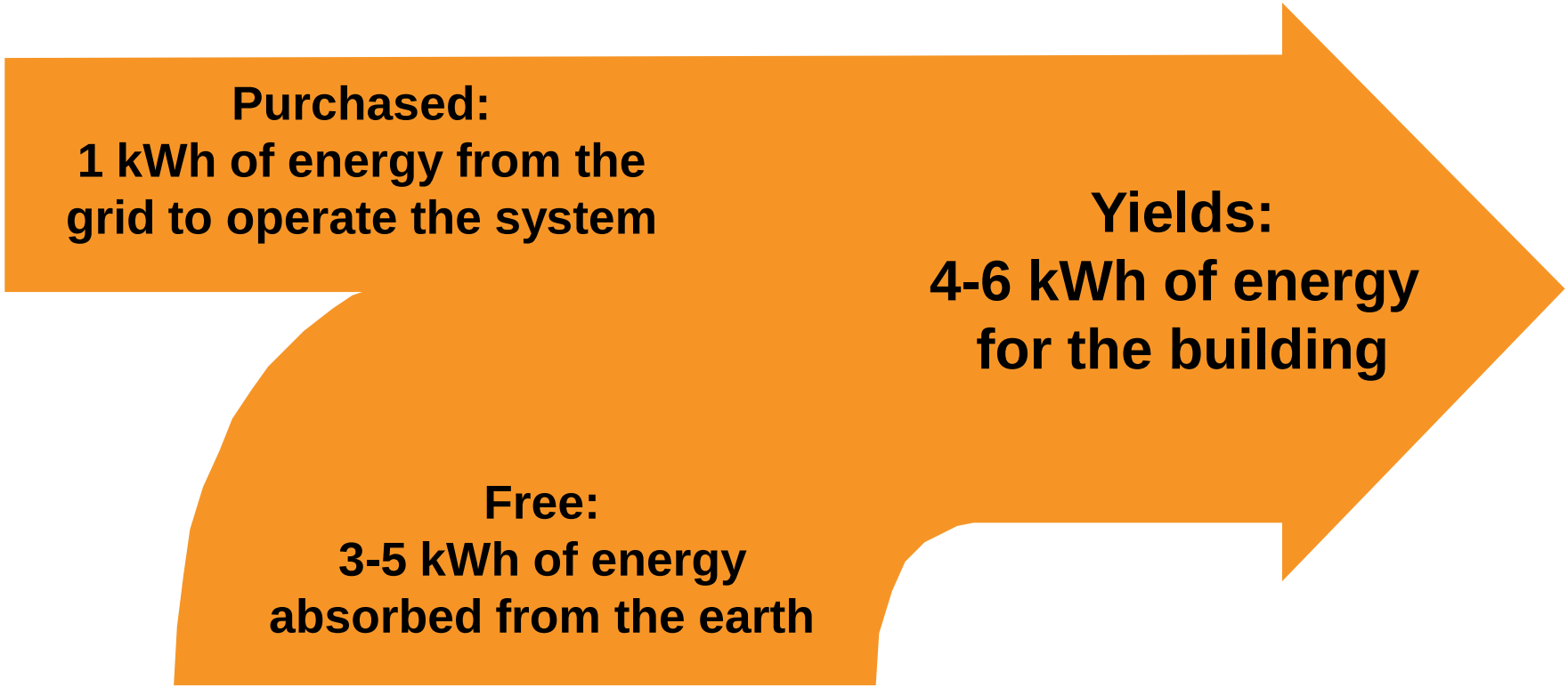


Geothermal heat pumps circulate water through a sealed underground piping loop where it is naturally warmed (or cooled) by the Earth

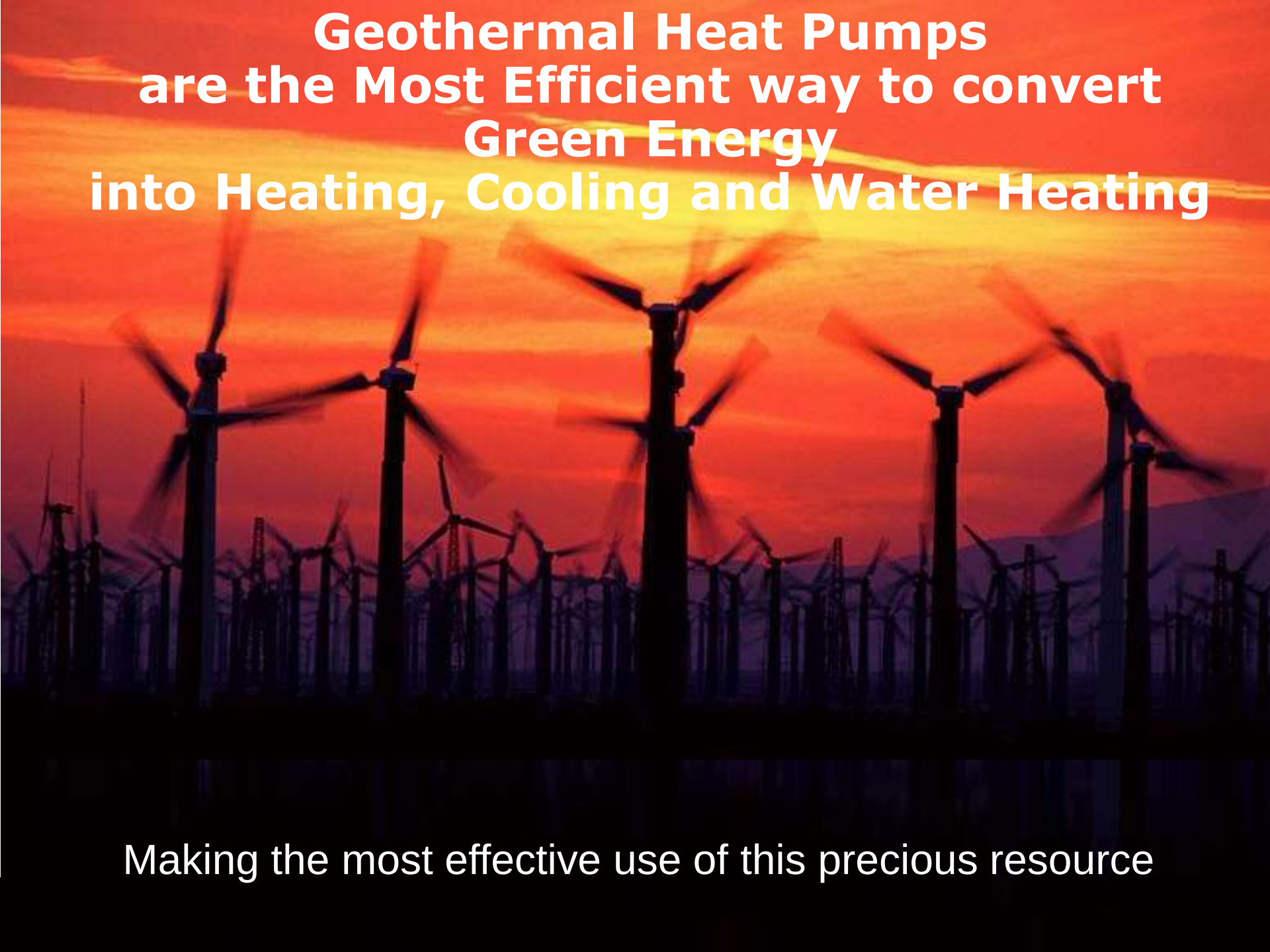
Geothermal Heat Pumps

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

Geothermal Heat Pumps Transfer Heat Efficiently



400-600% Efficient



Geothermal Heat Pumps are the Most Efficient way to convert Green Energy into Heating, Cooling and Water Heating

Making the most effective use of this precious resource

Geothermal Heat Pumps Are a Scalable Technology

Geothermal Heat Pumps

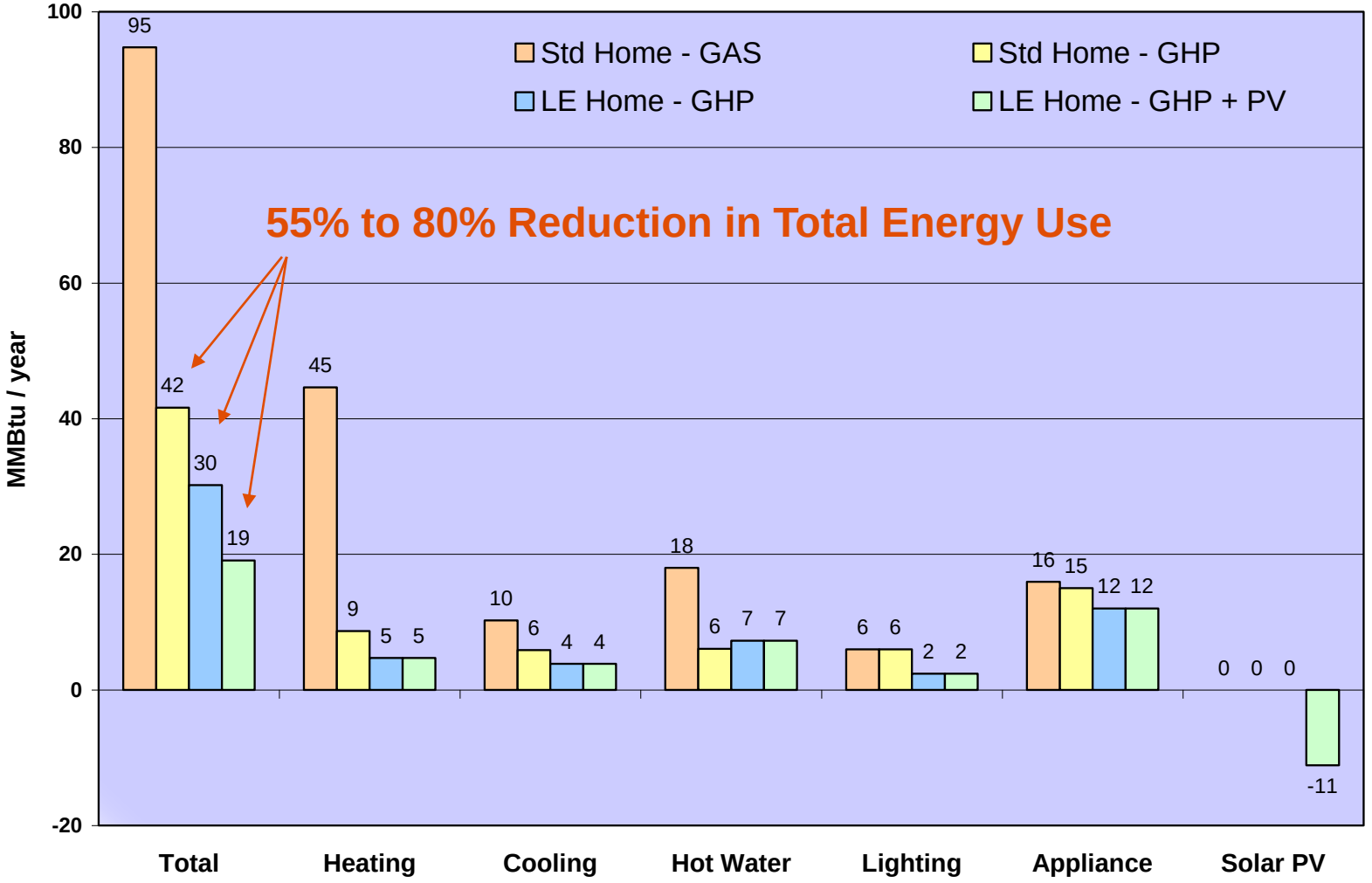
1300 Sq. Ft. Low Energy Habitat for Humanity Homes

Habitat for Humanity
Low Energy Home Construction Details

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

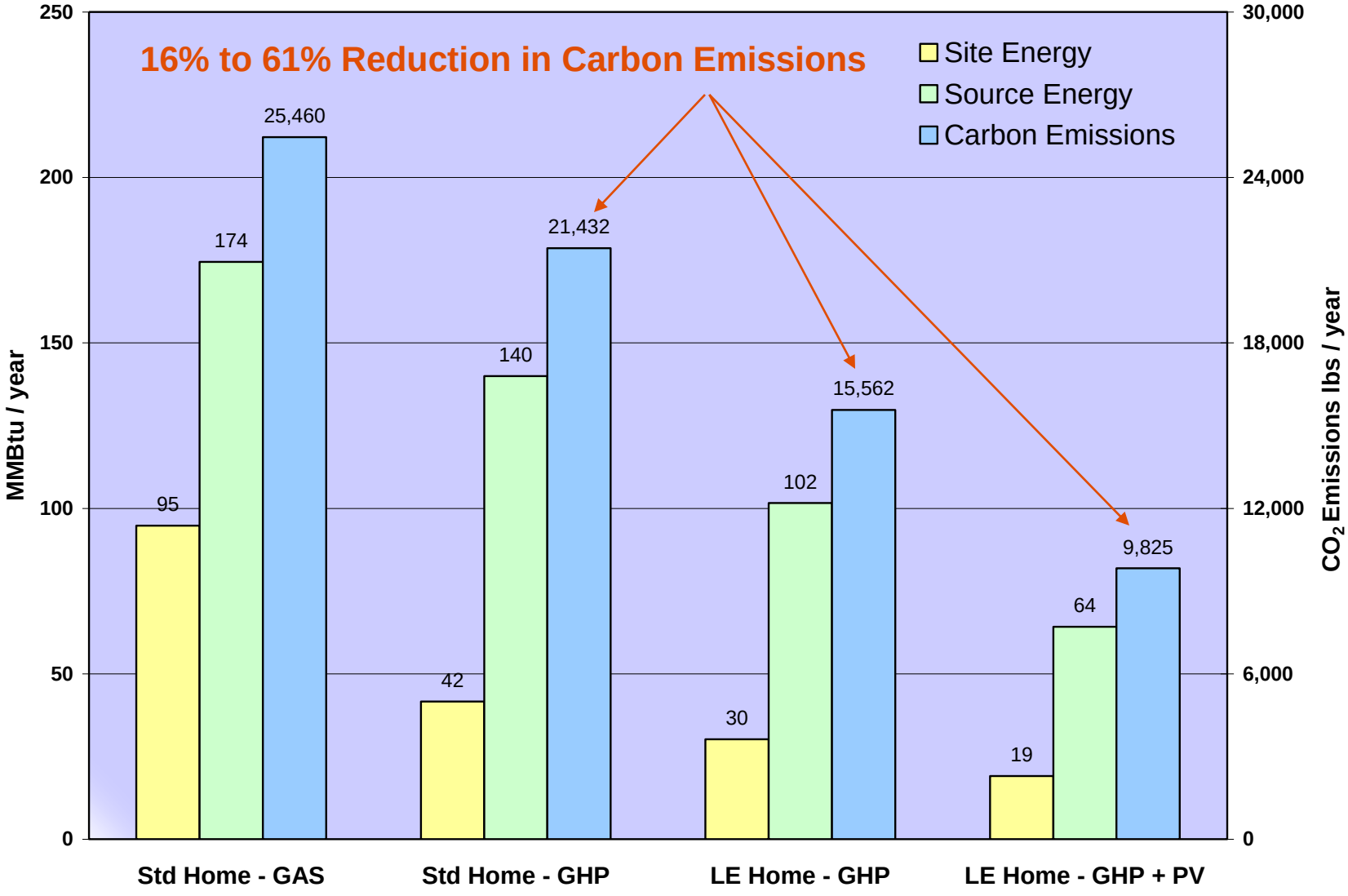
Habitat for Humanity

Site Energy Consumption by End Use – Std and Low Energy Homes



Habitat for Humanity

Total Energy Consumption and Carbon Emissions



Geothermal Heat Pumps in Commercial Buildings

Statue of Liberty Gift Shop

ASHRAE Headquarters - Atlanta, GA

Galt House Hotel - Louisville, KY

Black Point Inn - Prouts Neck, ME

Alta Condos, 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

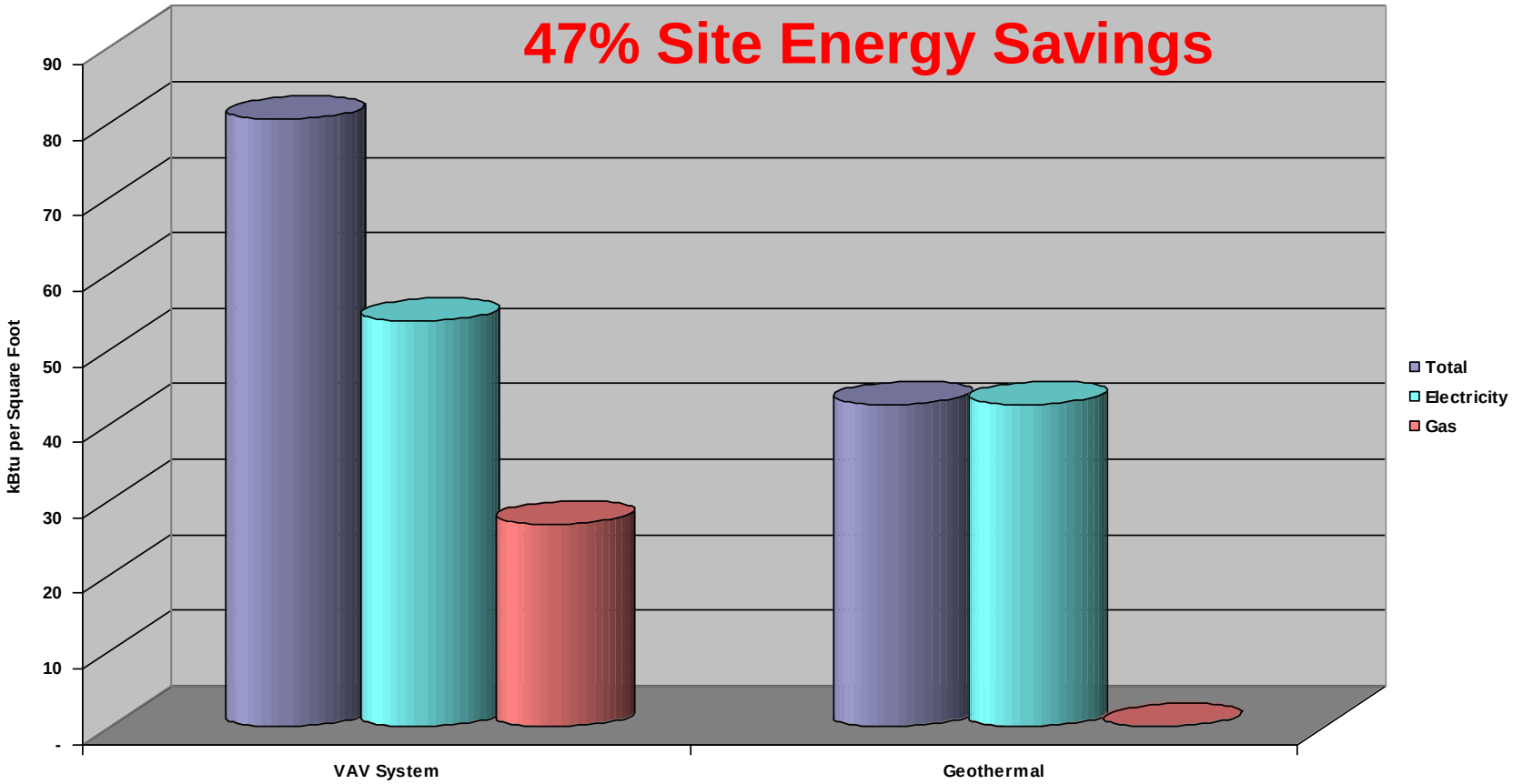
Hirschfeld Towers – Denver, CO

The Oklahoma State Capitol uses over 600 geothermal heat pumps

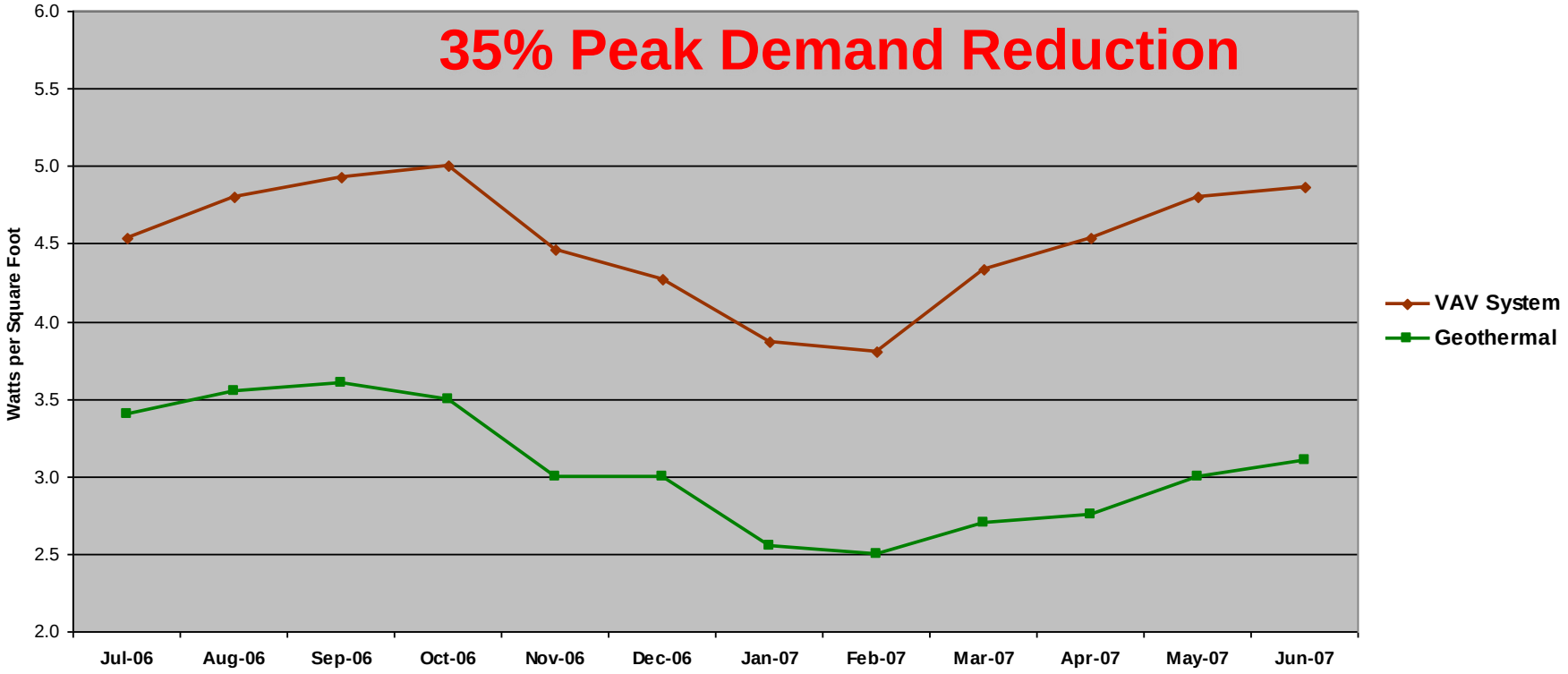
Garrett Office Buildings
Edmond, Oklahoma

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



The Potential of Geothermal Heat Pumps in Existing Housing

An Example

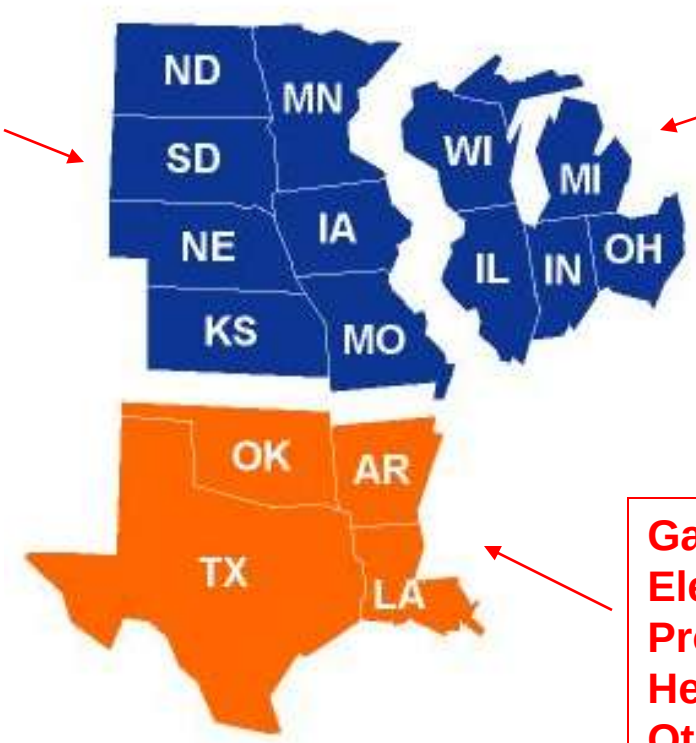
Existing Housing Stock (# Homes) - 2005

West North Central

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

East North Central

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



West South Central

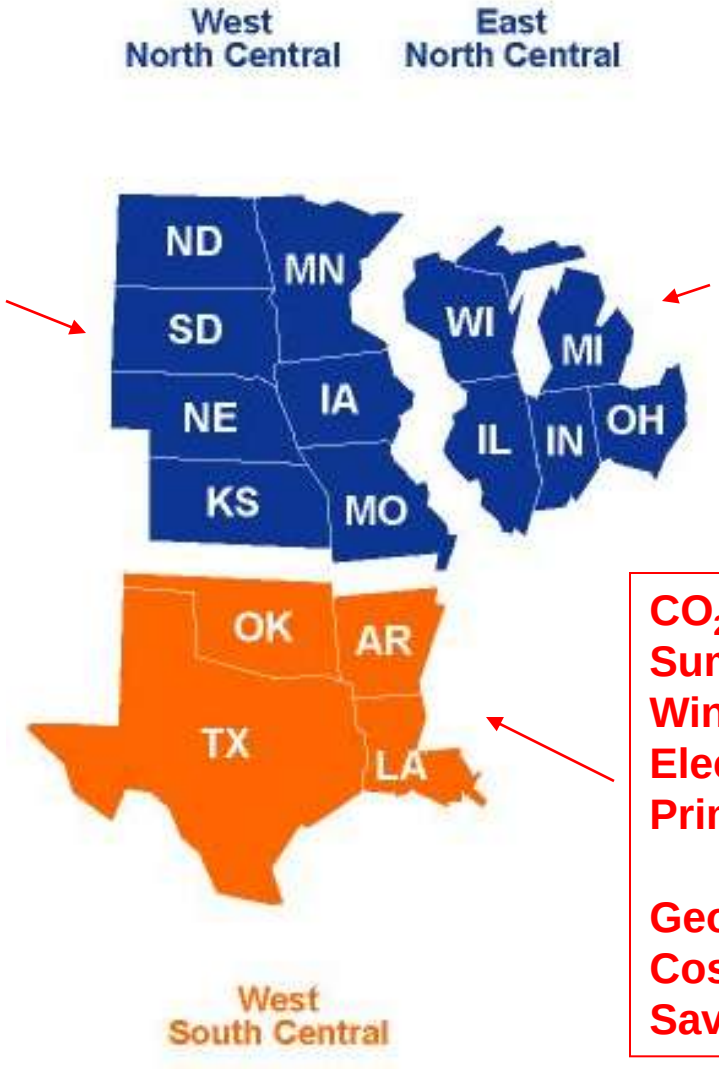
Gas – 5.7 million
Electric – 4.3 million
Propane – 800k
Heat Pump – 900k
Other – 400k

EIA 2005 Residential Energy Consumption Survey

Geothermal Heat Pump Retrofits
DSM Annual Benefits

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 Market Penetration:

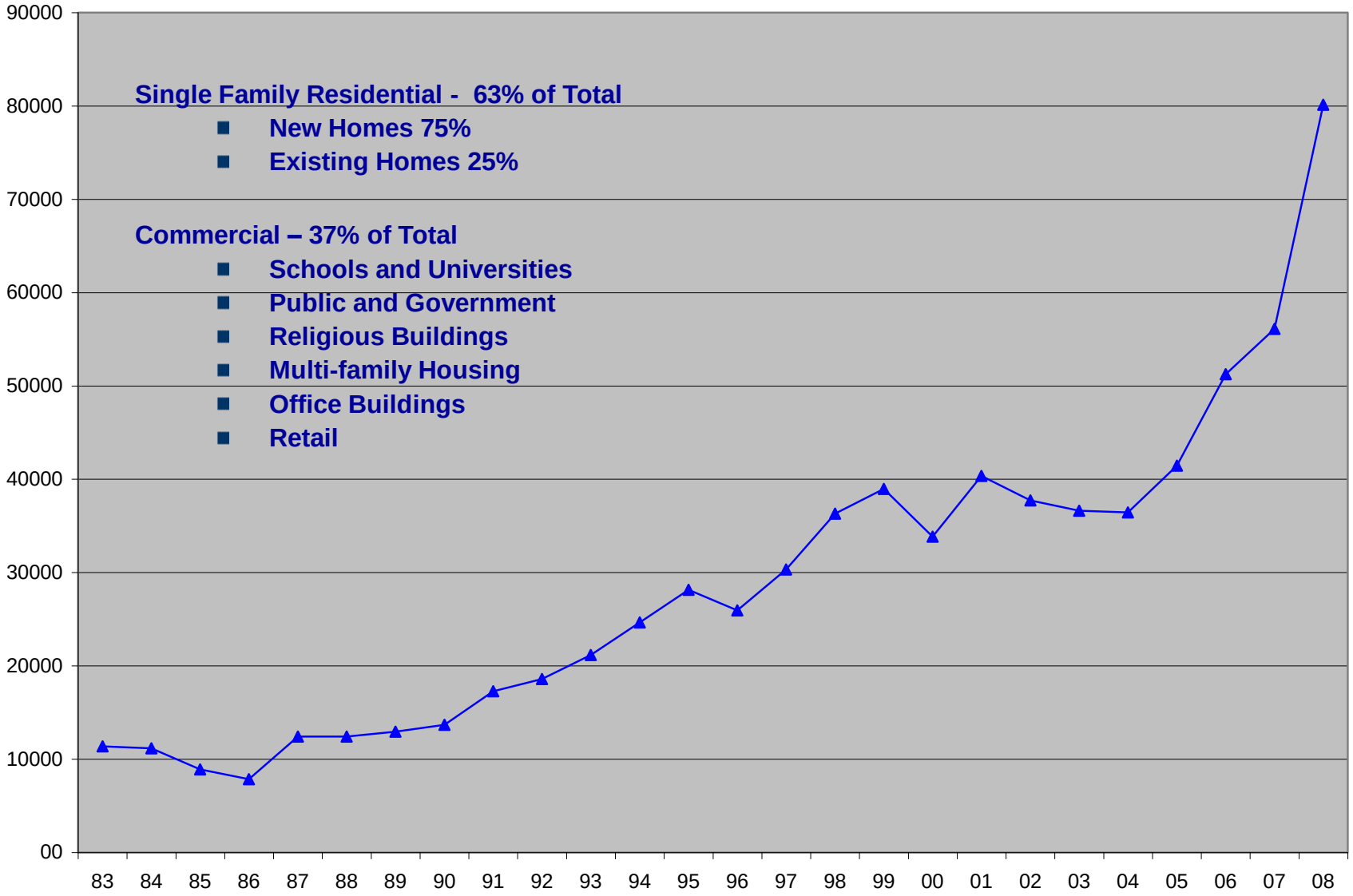
25% of homes without access to natural gas

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

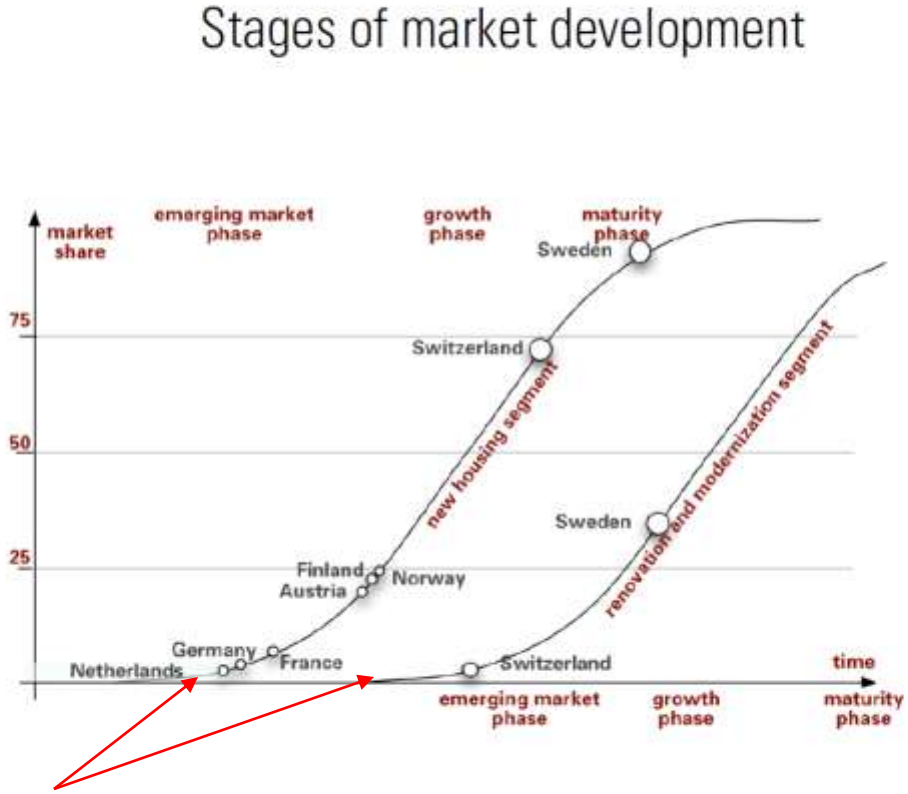
Geo Units – 1.5 million
Cost - $15 to $21 billion
Savings - $3.3 billion / yr

Geothermal Heat Pump Market Perspective

Historical N.A. Geothermal Industry Shipments



Geothermal Heat Pump



USA **GHPs were installed in 1 out of 38 new US homes in 2008 (2.6% share)**

Thank You!