



# Exploiting the Free, Renewable Energy, Above and Below your Farm

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Michigan State University  
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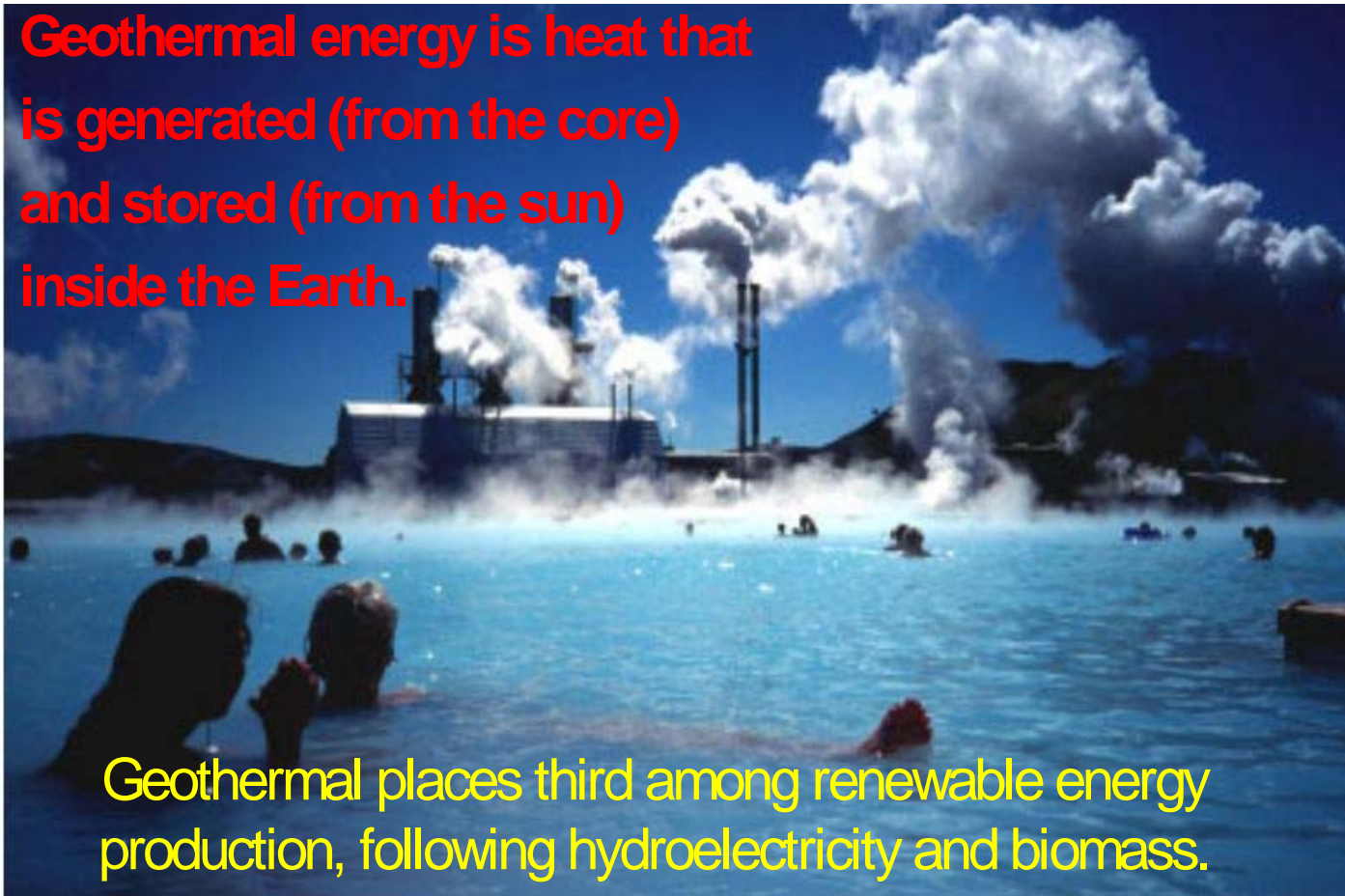
# Core Topics

- Geothermal Explained
- Advantages of Geothermal
- Agricultural Applications of Geothermal
- Environmental Impact
- Impact on Electric Utilities
- Economics
- Combination with Solar

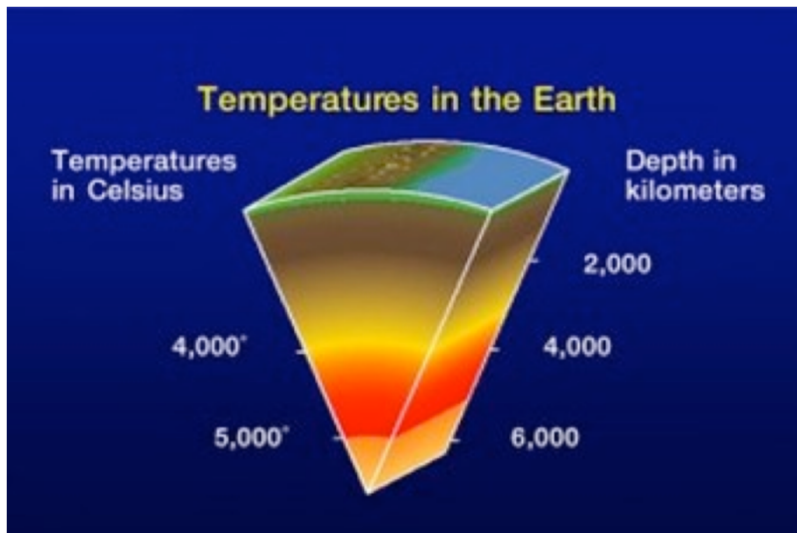
# Introduction to Geothermal

Geothermal energy is heat that is generated (from the core) and stored (from the sun) inside the Earth.

Geothermal places third among renewable energy production, following hydroelectricity and biomass.



# Our Free Solar Energy Storage System

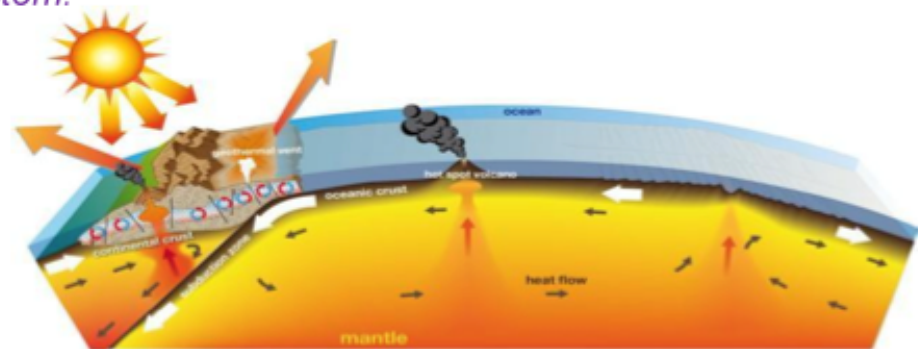


The core of the Earth is kept hot by radioactive decay while the surface is kept warm by solar radiation.

**Geothermal "energy"** is extracted from the depths of the Earth.

Geothermal heating and cooling (**Geoexchange**) is extracted from just below the Earth's surface.

This is why we refer to the Earth as *our free solarenergy storage system*.

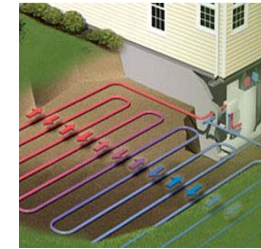


# Types Of Geothermal Energy

## 1. Geoexchange

Used to heat and cool air and water through a simple temperature exchange with the constant temperature of the Earth just a few feet below the surface.

*Efficient, practical & available everywhere.*



Ground-source heat pump

## 2. Geothermal Direct-Use

Hot water is pumped out of deep geothermal reservoirs and through heat exchangers and control units to warm air and water for various uses.



Direct-use geothermal well

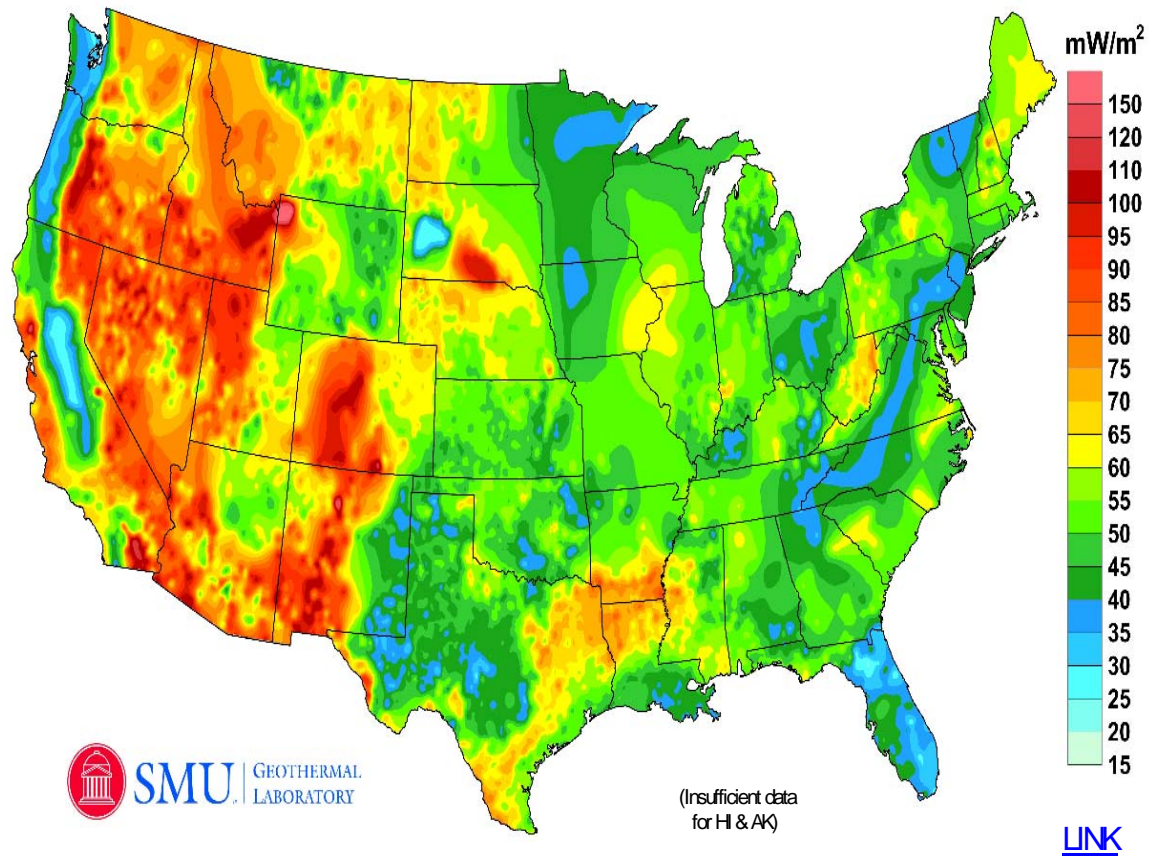
## 3. Geothermal Electricity Production

Electricity generated by steam-powered turbines from deep sources of heat over 300°-700°F.



Steam Turbine

# Direct Geothermal Potential In US





# Direct Geothermal Ag Applications



- Space Heating & Cooling
- Hot Water
- Season Extension for Greenhouses & Fields
- Crop Drying
- Refrigeration
- Aquaculture
- Soil Sterilization for pest & fungus control
- Food Processing & Dehydration
- Pasteurization
- Small-scale power generation



# Geoexchange\* AG Applications

\*AKA Geothermal Heat Pumps, Ground Source Heat Pumps, Water Source Heat Pumps

- Heating and cooling for farm buildings of all types
- Water heating & cooling for dairies, cleaning, etc.

Geoexchange can save 30-80% on energy costs!



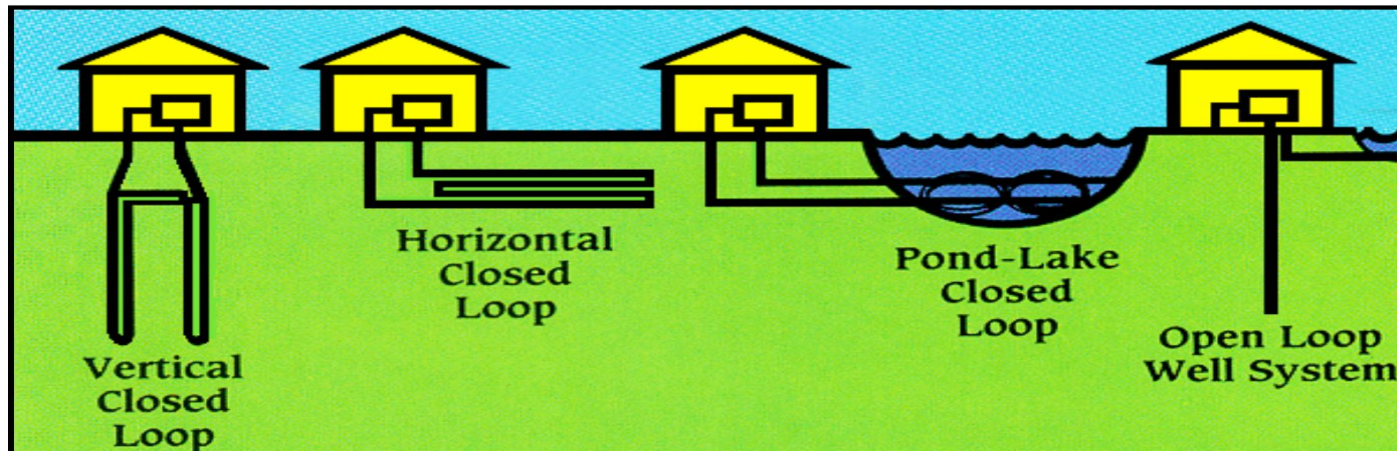


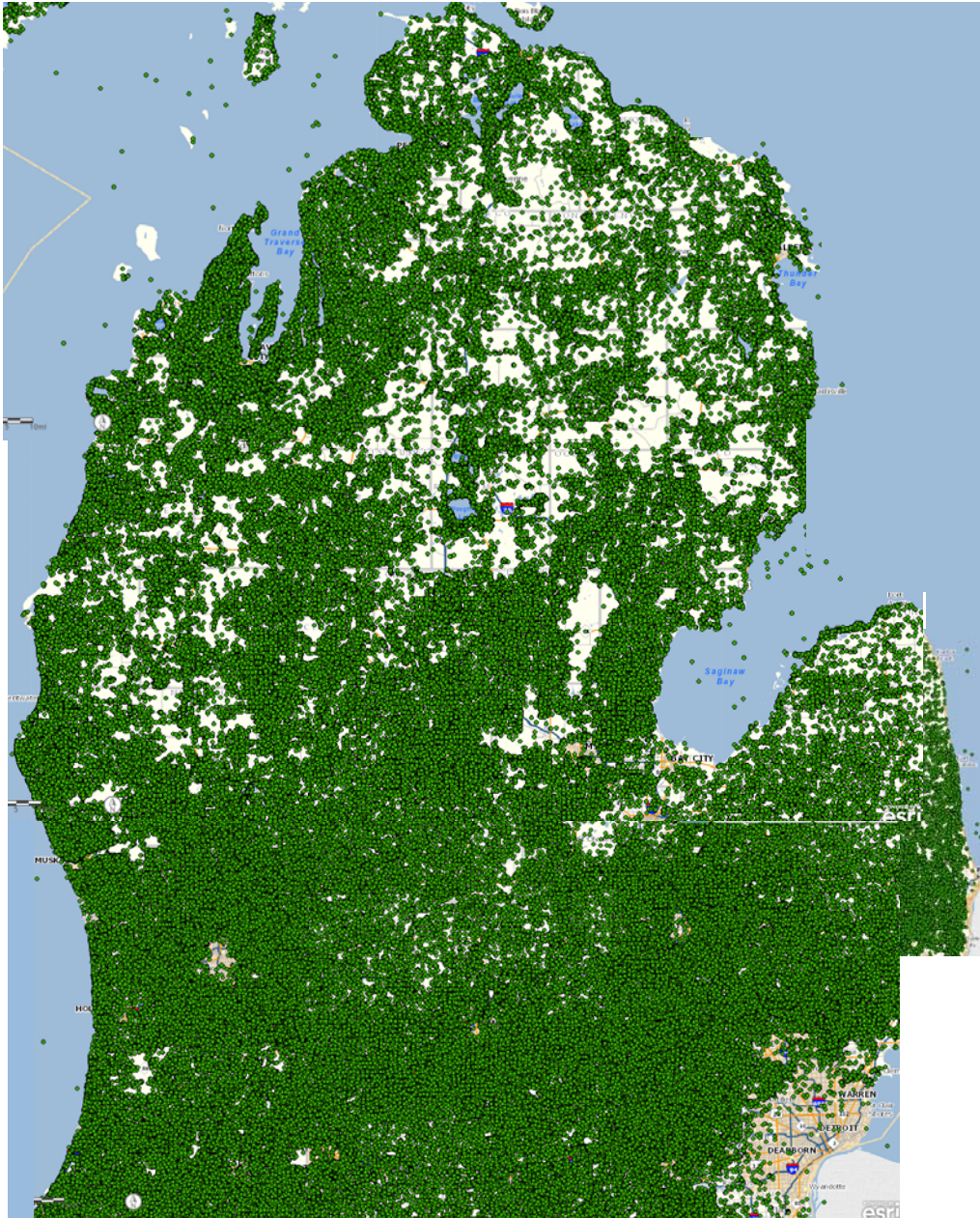
# Advantages Of Geothermal Heat Pumps

- **Efficient & Cost Effective** – Provides 3 to 4 units of energy for every one unit used to power the system. Operational cost savings up to 80% over conventional electric or fossil fuel systems.
- **Can be Utilized Everywhere** – subterranean temperatures remain relatively constant throughout the U.S.
- **Clean Renewable Energy** – Works with nature, not against it. Minimizes threats of pollution and global climate change.
- **Safe** – No flames or carbon monoxide
- **Low Maintenance & Long Life** – requires only periodic checks and filter changes
- **Scalable** – systems can range in size from small residential to large commercial applications

# Geothermal Heat Pump Designs

- 1) Vertical loop
- 2) Horizontal loop
- 3) Pond loop
- 4) Open loop





1 Million  
Michigan  
Wells

1 Million  
Free  
Clean  
Renewable  
Energy Sources



# Distribution Options



- Forced Air Ductwork
- Radiant In-Floor Heating
- Fan Coil Units (for large open areas such as barns)



# ENVIRONMENTAL IMPACT

INSTALLING AN AVERAGE RESIDENTIAL GEOTHERMAL SYSTEM

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PLANTING

# 750 TREES





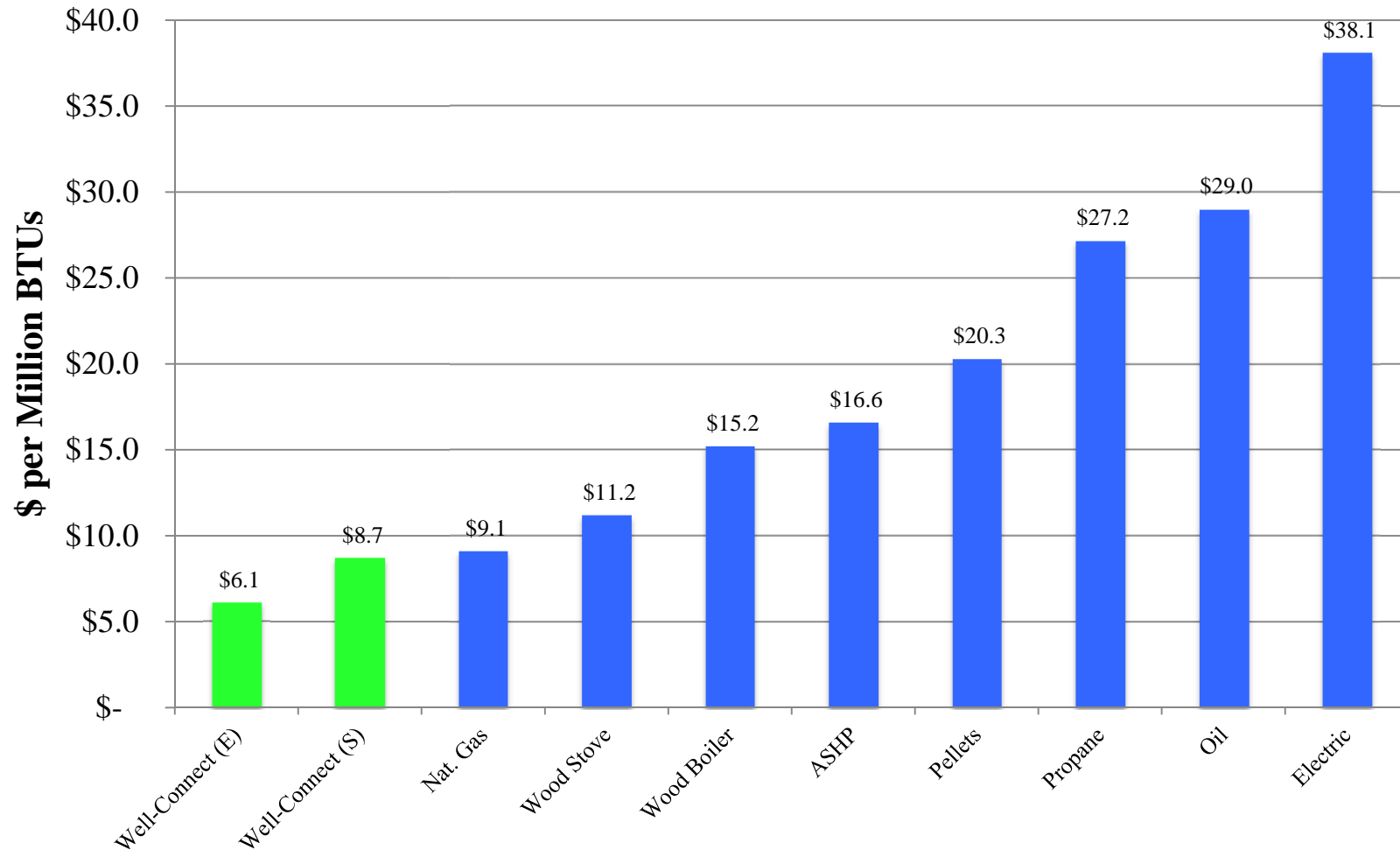
# Electric Utility Challenges

- Stagnant or even Declining Load Growth (Revenue)
  - Solar/Wind
- Rising Peak Demand and associated Costs
- Michigan Coal Plants going Off-Line
- Increasing Drain on Capital to support investments in Renewable Energy to Reduce Carbon Emissions
- Pressure to Control/Reduce Rates to Customers

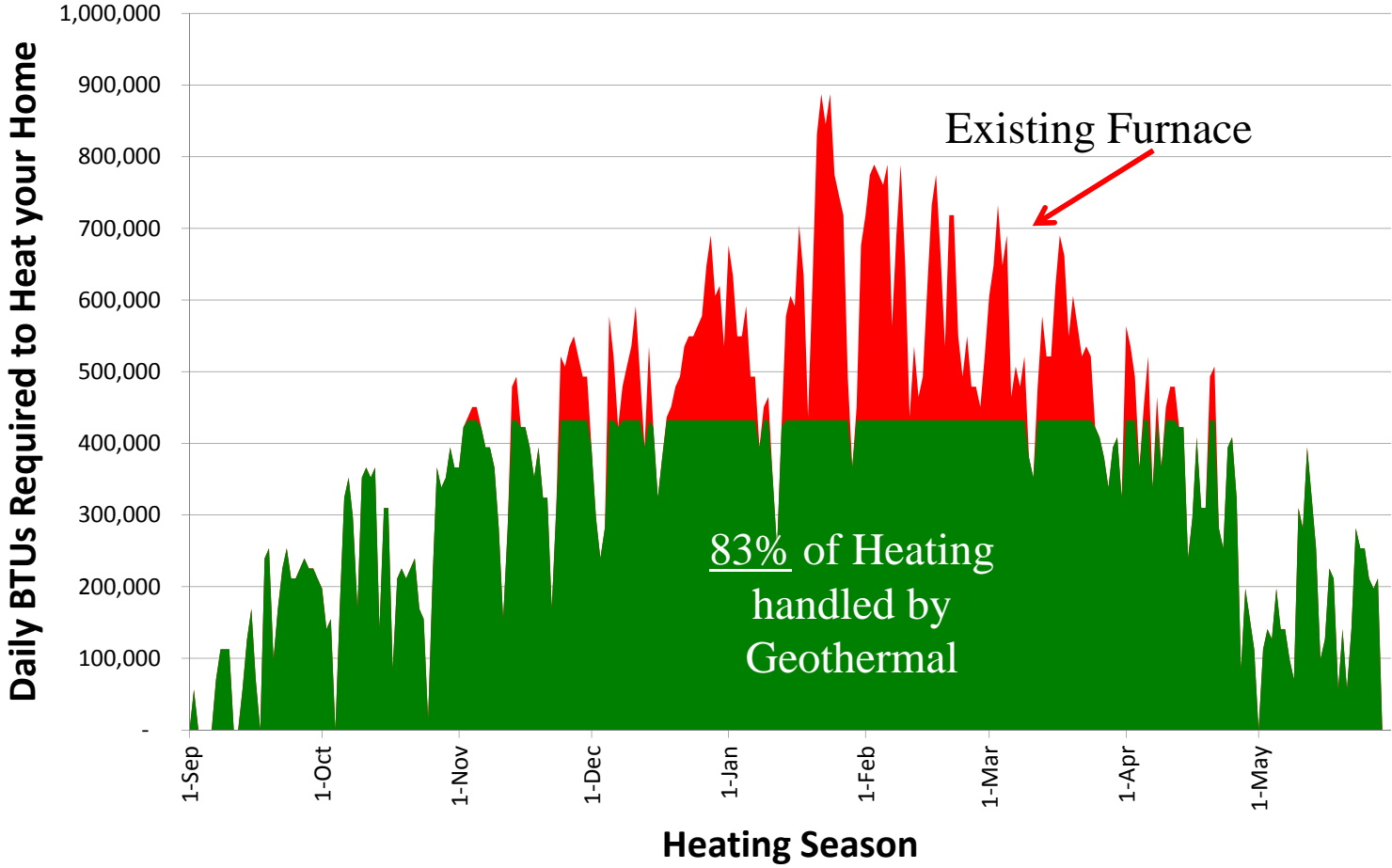
**Geothermal can  
Uniquely &  
Dramatically Address  
all of these Challenges**



# Heating Source Cost Comparison



# Hybrid System



# Geothermal Heat Pumps Are A Highly Efficient Way To Utilize Solar Generated Electricity!





# FREE, RENEWABLE ENERGY

**FREE HEATING & COOLING**

Use the **FREE** energy from above and below to heat and cool your home.

Use free unlimited renewable energy from your well water.

Return clean water back to the environment

# Thank You!



*Affordable Geothermal For Rural America*





# Geothermal Projects

