# *What's New in Geothermal Heat Pumps*

## *GHP Benefits to Your Utility, Members & the Environment*

May 12, 2009

Paul Bony

Director of Residential Market Development

ClimateMaster

# What's New for Utilities

- The new energy market:
  - Climate change becoming the issue (Co2)
  - Coal generation under attack (dead?)
  - Members fuel switching from propane/natural gas to electric resistance heaters
  - Rising electric rates driven by the demand for more electricity and rising generation (fuel and alternative energy) costs

# What's New for Utilities

- A new administration focused on the low carbon, green collar economy
  - Unprecedented funding for renewable energy and energy efficiency
  - Window of opportunity

# What's New for Utilities

- ***The American Recovery and Reinvestment Act of 2009 (ARRA)***
- The conference agreement includes . . .
  - $400,000,000 for geothermal activities and projects.
- The funding level for the advancement of the ground-source heat pump industry is at the discretion of DOE
- ARRA funding opportunity announcements (FOAs) are planned to be issued over the next few months
- FOAs for the DOE Geothermal Technologies Program are issued by the DOE Golden Field Office

# What's New for Utilities

- Draft - American Clean Energy and Security Act of 2009 (ACES)
  - create millions of new clean energy jobs
  - save consumers hundreds of billions of dollars in energy costs
  - enhance America's energy independence
  - cut global warming pollution (carbon emissions)

# What's New for Utilities

- **TITLE I – CLEAN ENERGY**
  - Requires retail electricity suppliers to meet a percentage of their load with electricity generated from renewable resources (wind, biomass, solar, and geothermal)
  - The renewable electricity requirement begins at 6% in 2012 and gradually rises to 25% in 2025.
  - The governor of any state may choose **to meet one fifth of this requirement with energy efficiency** measures.

# What's New for Utilities

- **TITLE II – ENERGY EFFICIENCY**
  - Promotes new building energy efficiency.
  - Authorizes funding for retrofitting existing commercial and residential buildings to improve their energy efficiency.
  - Utilities Energy Efficiency. Establishes a new energy efficiency resource standard to enlist electricity and natural gas distribution companies in the effort to make the nation more energy efficient.

# What's New for Utilities

- **Utilities Energy Efficiency**
  - **Each distribution company must demonstrate that its customers have achieved a required level of cumulative electricity or natural gas savings** relative to business-as-usual projections.
  - The efficiency standard starts with a 1% electricity savings and 0.75% natural gas savings in 2012 and gradually increases to a 15% cumulative electricity savings and a 10% cumulative natural gas savings by 2020.

# What's New for Utilities

- **TITLE III – REDUCING GLOBAL WARMING POLLUTION**
  - reduces the number of available allowances issued each year to ensure that aggregate emissions from the covered entities are reduced by 3% below 2005 levels in 2012, 20% below 2005 levels in 2020, 42% below 2005 levels in 2030, and 83% below 2005 levels in 2050.

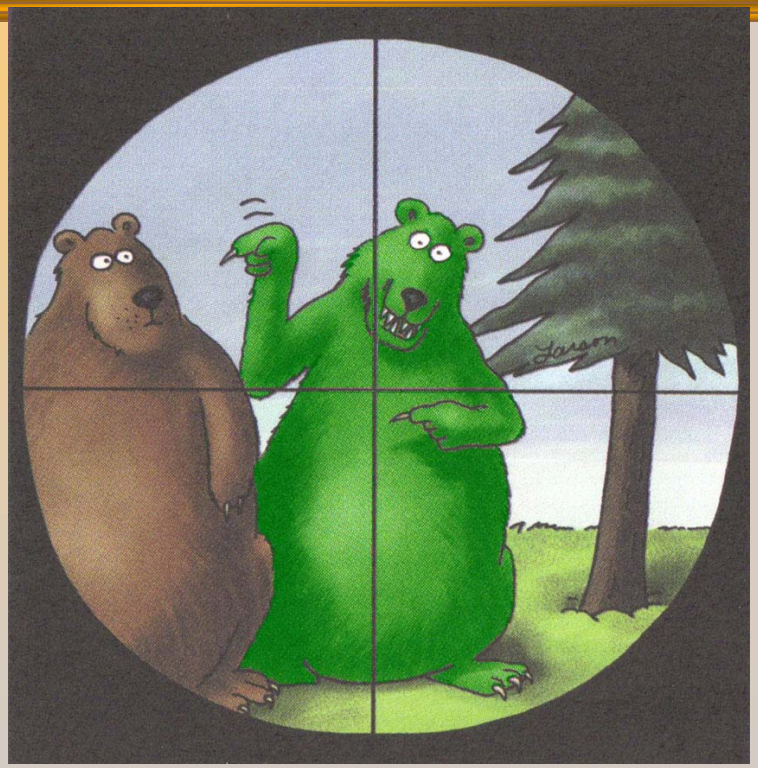
# What's New for Utilities

- Offsets.
  - The draft allows covered entities to increase their emissions above their allowances if they can obtain "offsetting" reductions at lower cost from other sources

# What's New for Utilities

- Fertile ground for new efficient electric products and services
- Cooperatives can be key players and leaders!
- Or not?

# What's New for Utilities



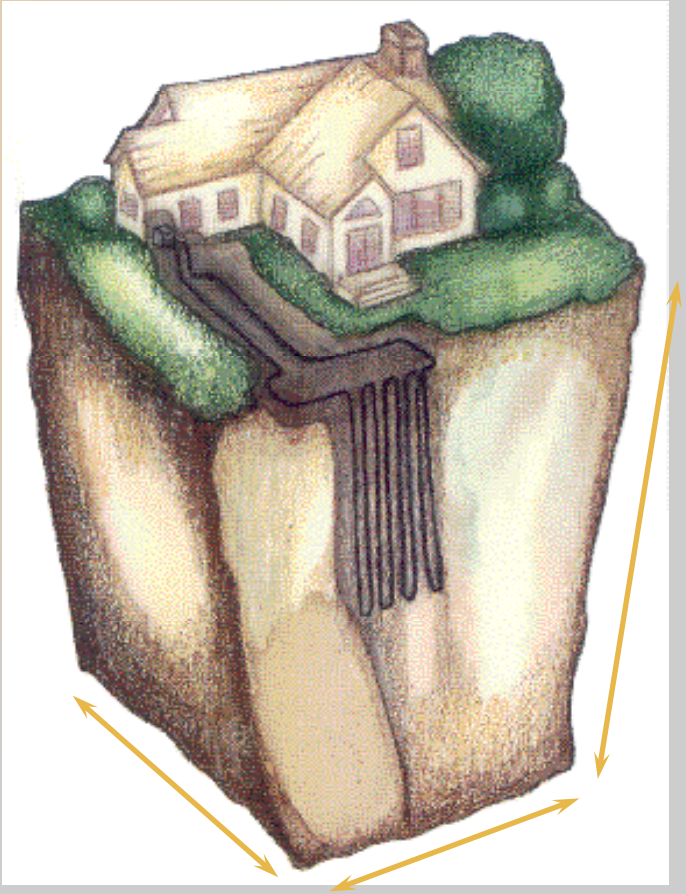
As utilities become environmental targets, do you want to be the "green" bear or the "brown" bear?

# Geo for Cooperatives

Mass market direct use geothermal technology

GreenHeat

heating & cooling a different world
with renewable energies



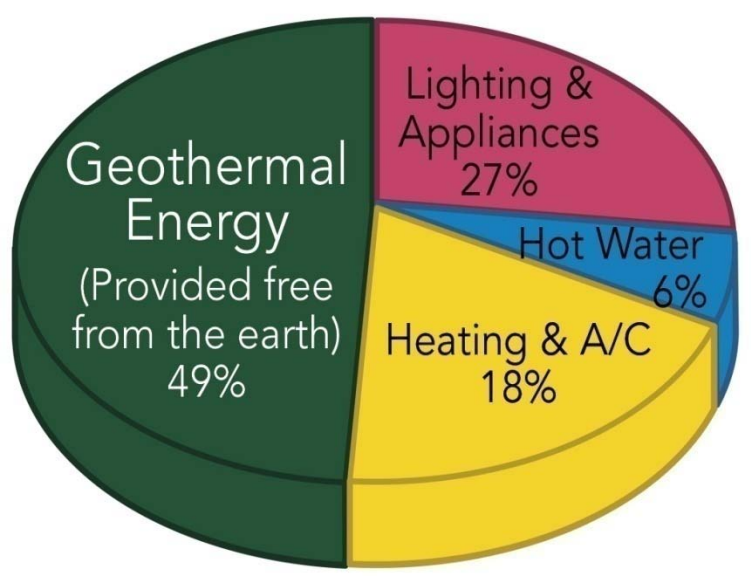
# Geo for Cooperatives

- Are you (or your boss, or your board) interested in:
  - Improving your system load factor
  - Optimizing your DSM, peak-time pricing and direct load control programs
  - Reducing pressure on your rates by increasing margins
  - Making your members happy
  - Getting the politicians off your back for not having green/ carbon reducing programs

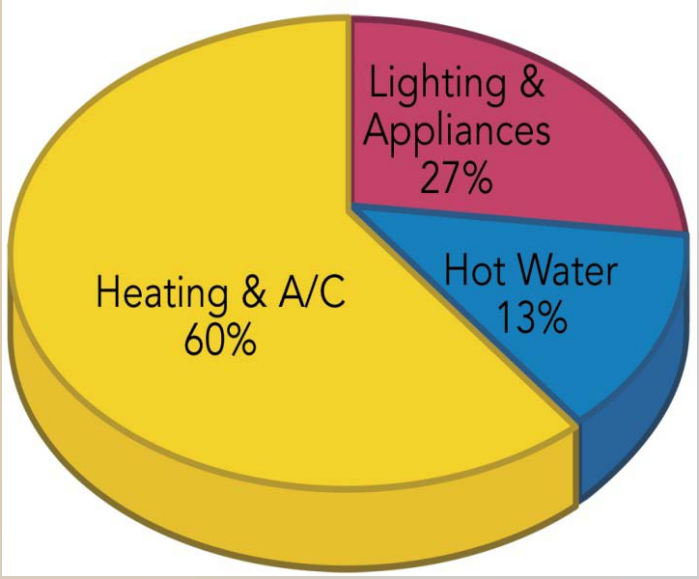
# Geo for Cooperatives

- Ground source heat pumps (GSHPs) meet all of these criteria:
  - Proven technology
  - Highest lifecycle return
    - Utility & member
  - Great load factor and electric margin
    - Replaces competing fuels
  - High environmental benefits
    - Delivers lots renewable energy (solar!)
  - Answer to new federal energy & environment goals/mandates

# Geo for Cooperatives




**Geothermal HVAC - Home**




Conventional HVAC - Home

United States General Accounting Office

GAO

Report to the Chairman, Subcommittee on Investigations and Oversight, Committee on Science, Space, and Technology, House of Representatives

152033

June 1994

# GEOTHERMAL ENERGY

## Outlook Limited for Some Uses but Promising for Geothermal Heat Pumps

*A U.S. Dept. of Energy brochure notes the aggregate benefit of installing GeoExchange Systems:*

OFFICE OF GEOTHERMAL TECHNOLOGIES

# Environmental and Energy Benefits of Geothermal Heat Pumps

Over an average 20-year lifespan, every 100,000 units of nominally sized residential GHPs will save more than 24 trillion BTUs of electrical energy, and save consumers approximately $500 million in heating and cooling costs at current prices. And over the same period, these 100,000 units reduce greenhouse gas emissions by almost 1.1 million metric tons of carbon equivalents.

# 2001 U.S. DOE Update:

The Energy Policy Report identifies geoexchange as a technology that "can significantly increase system efficiencies." In fact, if just one million homes among the more than 100 million households across the country were to use geoexchange systems for heating and cooling, we could save 8 billion kilowatt-hours of electricity and 40 trillion BTUs of fossil fuels. That would also cut electricity demand by 2.6 million kilowatts, or to put it in Energy Policy terms, 2,600 megawatts — the equivalent of building 13 new 200 MW power plants.

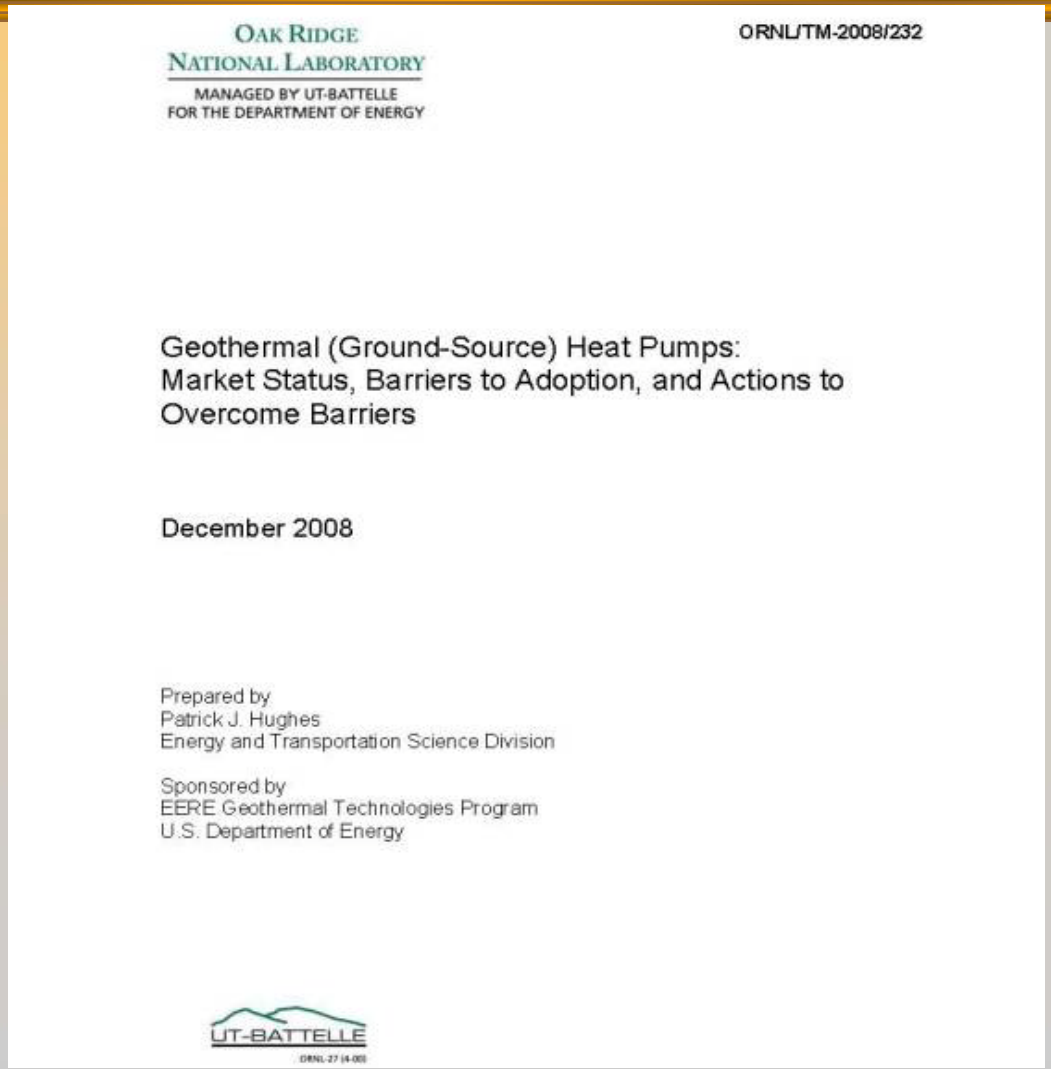
# Geo for Cooperatives

**Geothermal Heat Pumps are one of the Most Effective and Deployable technologies…**

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

*(EPA, 1993)*

# Geo for Cooperatives



OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE
FOR THE DEPARTMENT OF ENERGY

ORNL/TM-2008/232

Geothermal (Ground-Source) Heat Pumps:
Market Status, Barriers to Adoption, and Actions to Overcome Barriers

December 2008

Prepared by
Patrick J. Hughes
Energy and Transportation Science Division

Sponsored by
EERE Geothermal Technologies Program
U.S. Department of Energy

UT-BATTELLE

# Geo for Cooperatives

- U.S. was once the world leader in GHP technology and market development
  - Today domestic markets absorb ~60,000 units/yr
    - 50-60% residential (new exceeding retrofit 3 to 1)
    - 40-50% commercial
  - U.S. still has the largest installed base
    - Per capita, many European countries are ahead
- European markets are now 2-3 times the U.S.
  - ~135,000 to 190,000 units/yr
- Growth rates in Europe, parts of Asia (China, S. Korea), and Canada exceed U.S.

# Geo for Cooperatives

- Primary energy savings by 2030
  - 3.4 to 3.9 quads annually (buildings today consume about 40 quads)
    - Residential about 60%
      - Of that ~20% new, ~80% retrofit
    - Commercial about 40%
      - Of that ~33% new, 67% retrofit
  - 35 - 40% of savings needed to keep buildings in 2030 at 2008 energy use level (per EIA projections)
- Based on previous analyses by others for existing building retrofits, updated using current data, and supplemented with new construction savings estimate

# Geo for Cooperatives

- Deferred electric generation capacity — 2030
  - 91 to 105 GW
  - 42 - 48% of net new capacity additions by 2030 (per EIA projections)
- Utility bill reductions in 2030
  - $33 to 38 billion/yr (assuming rates in 2030 = rates in 2006)

# Geo for Cooperatives

- Tier 1 –
  - High first-cost of GHP systems to consumers
- Tier 2 –
  - Lack of consumer knowledge and/or trust in benefits
  - Lack of policymaker/regulator knowledge and/or trust in benefits
  - GHP design and business model infrastructure limitations
  - GHP installation infrastructure limitations
- Tier 3 –
  - Lack of new technologies and techniques to improve GHP system cost/performance

†Based on the sense of a group of GHP industry experts.

# Geo for Cooperatives

## Actions To Accelerate Market Adoption of GHPs

- Tier 2 –
  - Streamline/deploy *Rural Electric Co-Op programs* to provide GHP infrastructure
  - Universal access to GHP infrastructure via loop-leasing
  - Develop data, models, tools enabling lowest Life Cycle Cost GHP infrastructure

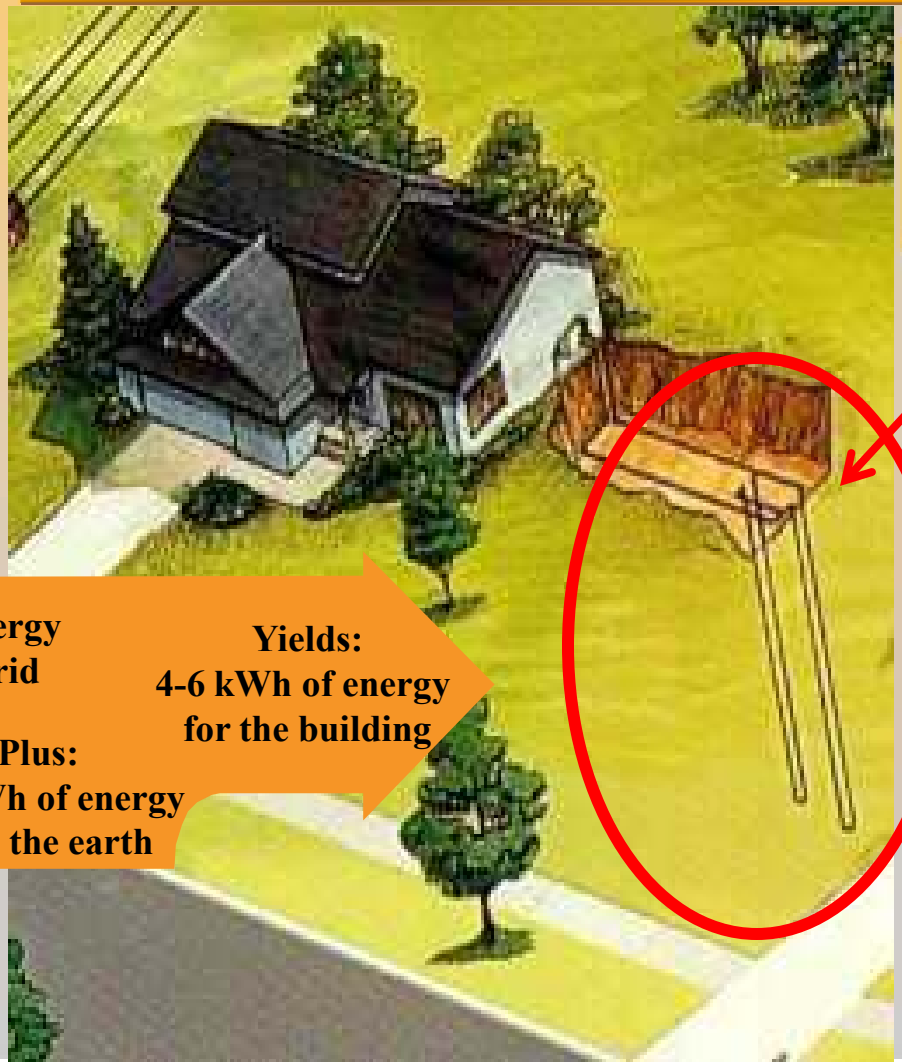
# Geo for Cooperatives

- ‘GHP infrastructure’ is the outside-the-building part of the GHP system
  - Can be half or more of the overall GHP system cost
  - Rest of system about the same cost as conventional
    - Could be less in volume production
- ‘GHP infrastructure’ is like utility plant
  - It moves energy
  - It outlives the building and many generations of heat pumps

# Geo for Cooperatives

- Why do we expect building owners to finance 'GHP infrastructure' on their own credit?
  - When we bring central station renewable energy to market the transmission lines will not be financed on building owner credit
  - Instead, as consumers of 72% of the nation's electricity, building owners will pay for these transmission lines in their utility bills

# Geo for Cooperatives

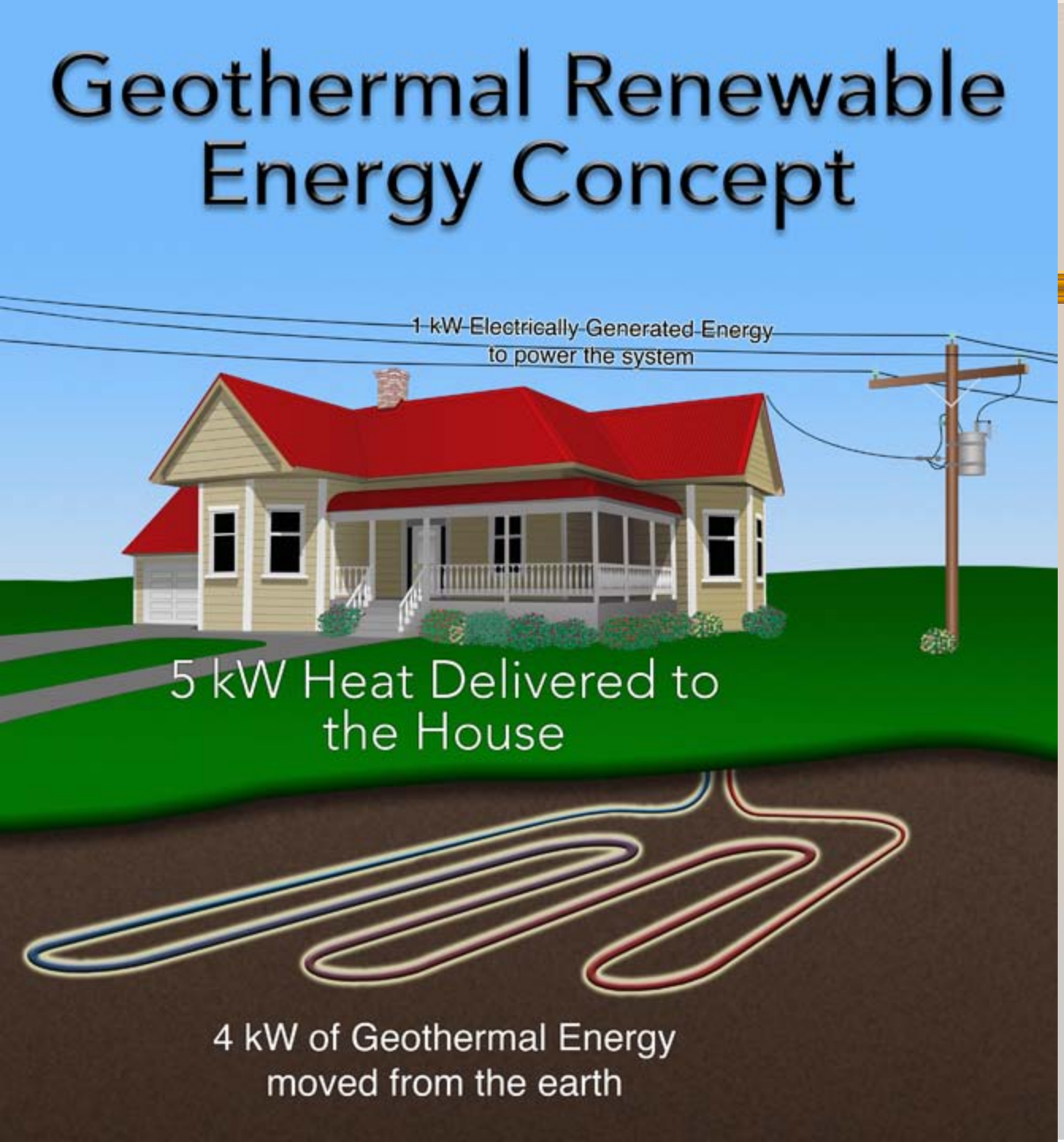


**Another form of utility plant for delivering renewable energy supplies to the load**

**1 kWh of energy from the grid**

**Yields: 4-6 kWh of energy for the building**

**Plus: 3-5 kWh of energy from the earth**


Geothermal Renewable Energy Concept
1 kW Electrically Generated Energy to power the system
5 kW Heat Delivered to the House
4 kW of Geothermal Energy moved from the earth

# Geo for Cooperatives

- **Ground source heat pumps will enable cooperatives to meet their mandated energy efficiency, renewable energy and carbon reducing requirements.**

- **While improving load factor, and with out net metering and other program approaches that put pressure on rates.**

# Geo for Cooperatives

Because you:

- Recover the cost of the loop, interest expense, program costs and earn more than your cost of funds.
- Increase your margins with incremental electric sales.
- Improve your load factor w/o load control and even more with it!.
- Earn loyalty from your members for:
  - Helping them lower their total energy bill.
  - Supporting the environment by reducing carbon emissions.

# Geo for Cooperatives

## Value to Members

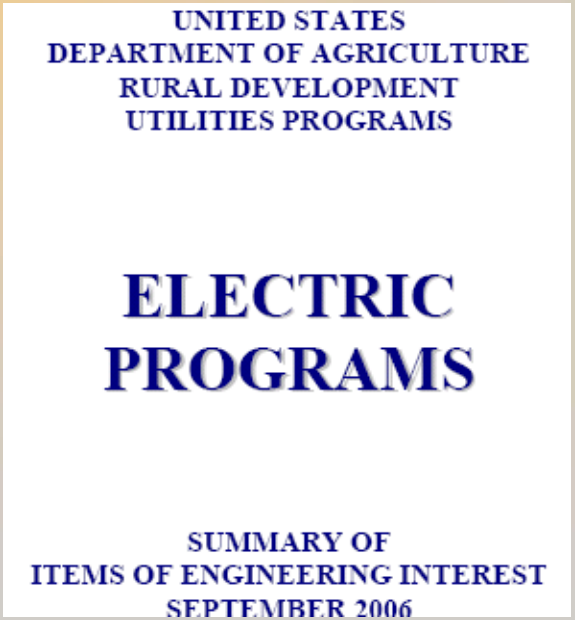
- Piece of mind
  - Less volatile heating & cooling costs
  - Utility grade customer service
- Annual energy savings of $250+ to $2,000 +
  - No up-front investment (using DMEA programs)
  - Immediate positive cash flow
- They are doing their part for the environment

# Geo for Cooperatives

- The equipment keeps getting better
  - "COP's" (% efficiency) are reaching 5 (500%)
  - Hybrid units can greatly reduce installation costs
- Fits load control and peak time pricing
  - Can be tied to a gas furnace for load control
  - Water to water units can support thermal storage for expanded peak clipping

# Geo for Cooperatives

- http://www.usda.gov/rus/electric/engineering/2006/en-in-06.pdf



UNITED STATES
DEPARTMENT OF AGRICULTURE
RURAL DEVELOPMENT
UTILITIES PROGRAMS

**ELECTRIC PROGRAMS**

SUMMARY OF
ITEMS OF ENGINEERING INTEREST
SEPTEMBER 2006

# Geo for Cooperatives

- The USDA/RUS can now provide 35 year loan funds for GSHP loops (new in the Farm Bill)
  - The GSHP loops become utility plant
  - Instant first cost savings for co-op members
    - Drives positive cash flow cash flow
    - New margin opportunity
    - Long term utility relationship and member satisfaction
  - Levels the electric utility playing field with natural gas
- Establishes a model for Investor Owned and Municipal utilities

# Geo for Cooperatives

## Title I - Rural Electrification

**SEC. 2. GENERAL AUTHORITY OF THE SECRETARY OF AGRICULTURE.**

(a) LOANS. – The Secretary of Agriculture (referred to in this Act as the 'Secretary") is authorized and empowered to make loans in the several States and Territories of the United States for rural electrification and the purpose of furnishing and improving electric and telephone service in rural areas, as provided in this Act, and for the purpose of assisting borrowers to implement demand side management, energy conservation programs, and on-grid and off-grid renewable energy systems.

# Geo for Cooperatives

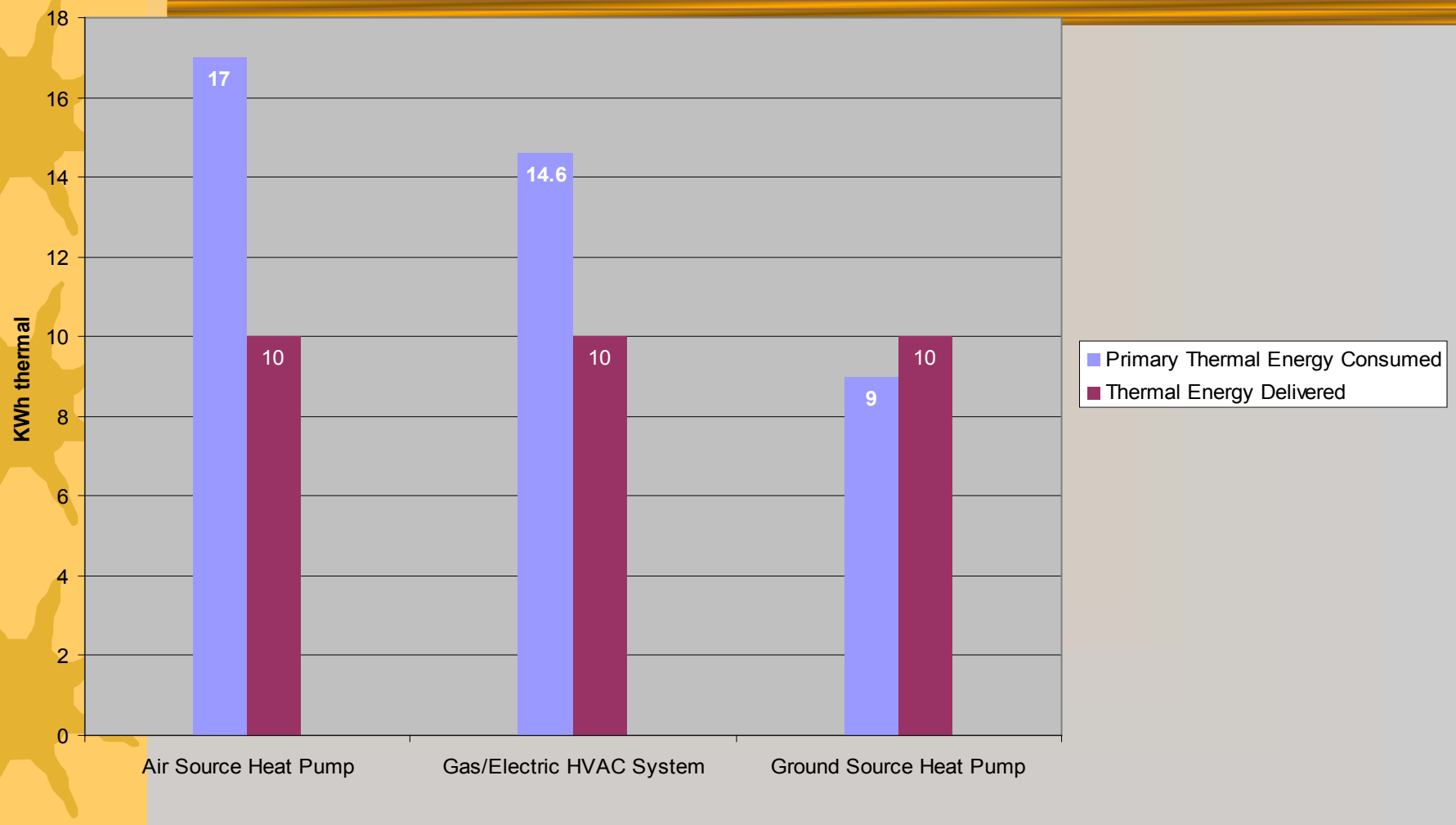
JOINT EXPLANATORY STATEMENT OF THE COMMITTEE OF CONFERENCE

TITLE VI—RURAL DEVELOPMENT

(51) Energy Efficiency Programs

The Senate amendment amends sections 2(a) and 4 in the REA by authorizing the Secretary to extend loans to energy efficiency programs. (Section 6101) The House bill contains no comparable provision. The Conference substitute adopts the Senate provision. (Section 6101) The Managers note that **assistance is authorized under this section for renewable energy, including geo-thermal ground loops, under sections 2 and 4 of the REA as amended**. The Managers expect that applications for such assistance will be properly considered and when meritorious, that they should be funded.

## Comparison of Primary Energy Input versus Energy Output as delivered by Various HVAC Technologies



# Geo for Cooperatives

- Each residential heat pump linked to geothermal system can reduce peak loads in
  - Summer by 1–2 KW
  - Winter by 4–8 KW
- Residential (Electric Program)
  - Over 10 million residential consumers
  - Assume just 1 KW reduction per installation
  - 10,000 MW demand reduction

# Geo for Cooperatives

- Coop ownership and long term financing can reduce consumer resistance to high up front costs.
- Pioneers among the electric cooperatives are already implementing.
- Electric cooperatives have the business acumen to develop the widespread commercialization of the technology.
- Displaces the need for Rural Development financing of new generating plants (ban on funding coal plants).
- Job creation using existing or readily developed local skills and tools.

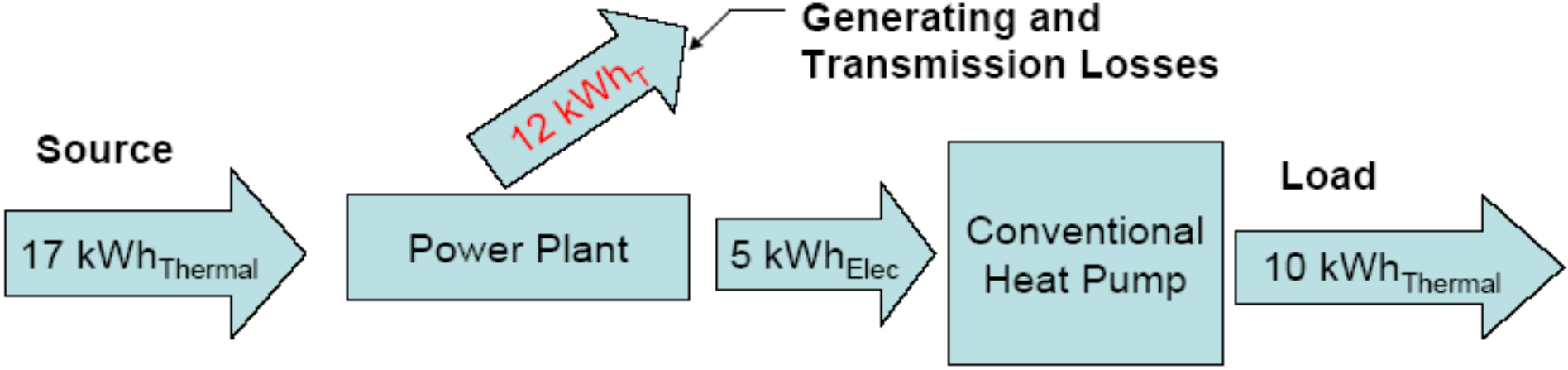
# Geo for Cooperatives

- Free up peak transmission and generation capacity for other purposes.
- Better use of existing capacity.
- Leverages electricity produced from renewable sources.
- Leverages clean coal technologies.
- Reduce the use of **natural gas** as a heating fuel, freeing its use for electric generation with renewable fuels.
- Reduced water consumption by power plants.

# Geo for Cooperatives

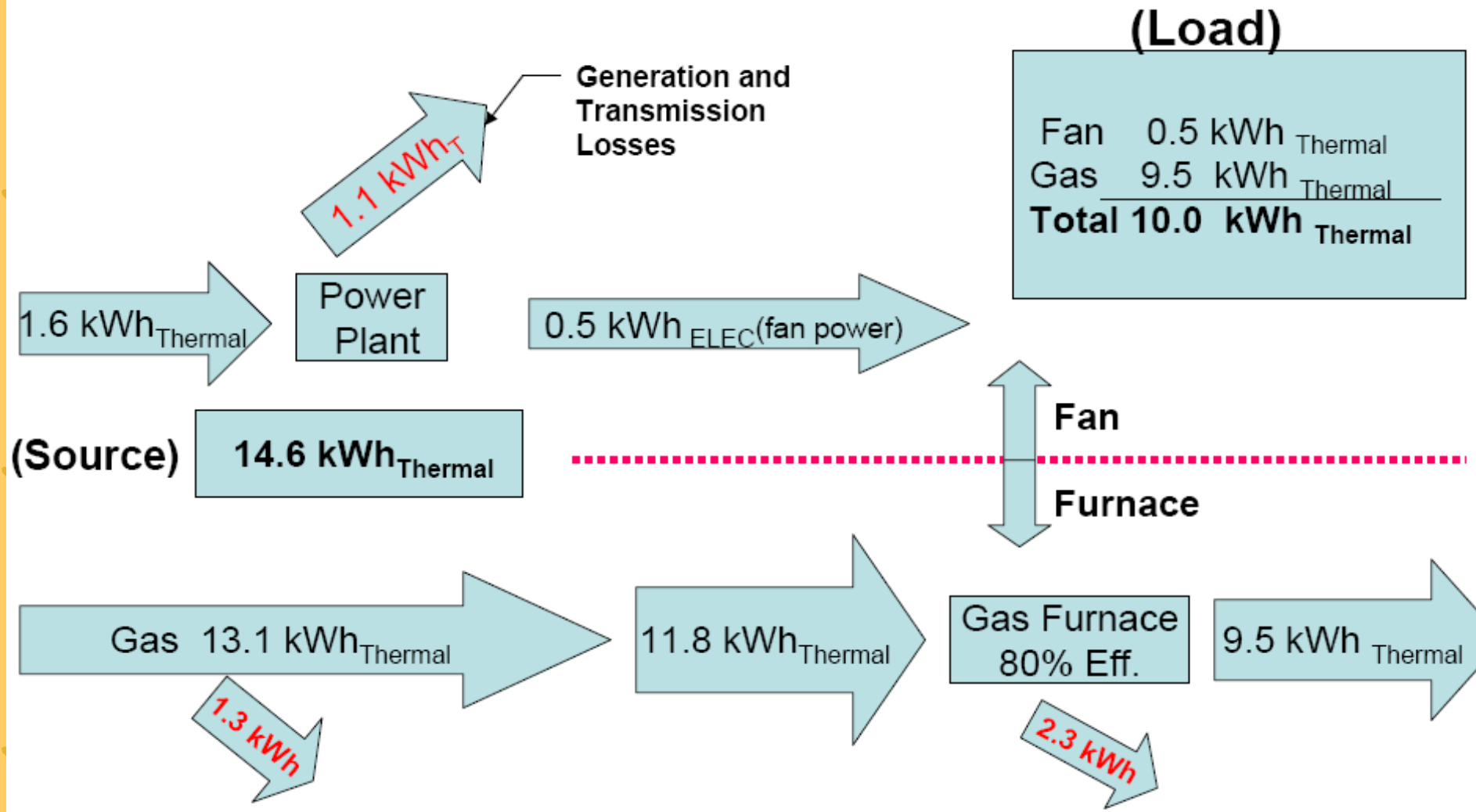
- The Agency will consider loans for cooperative owned geothermal loops supported by a comprehensive business plan, **industry support** and monitoring of results.
- The Agency plans to have construction work plan guidelines developed based on experience gained from initial applications.
- Business models may include individual distribution borrowers or G & Ts who are current borrowers.

# Air Source Heat Pump



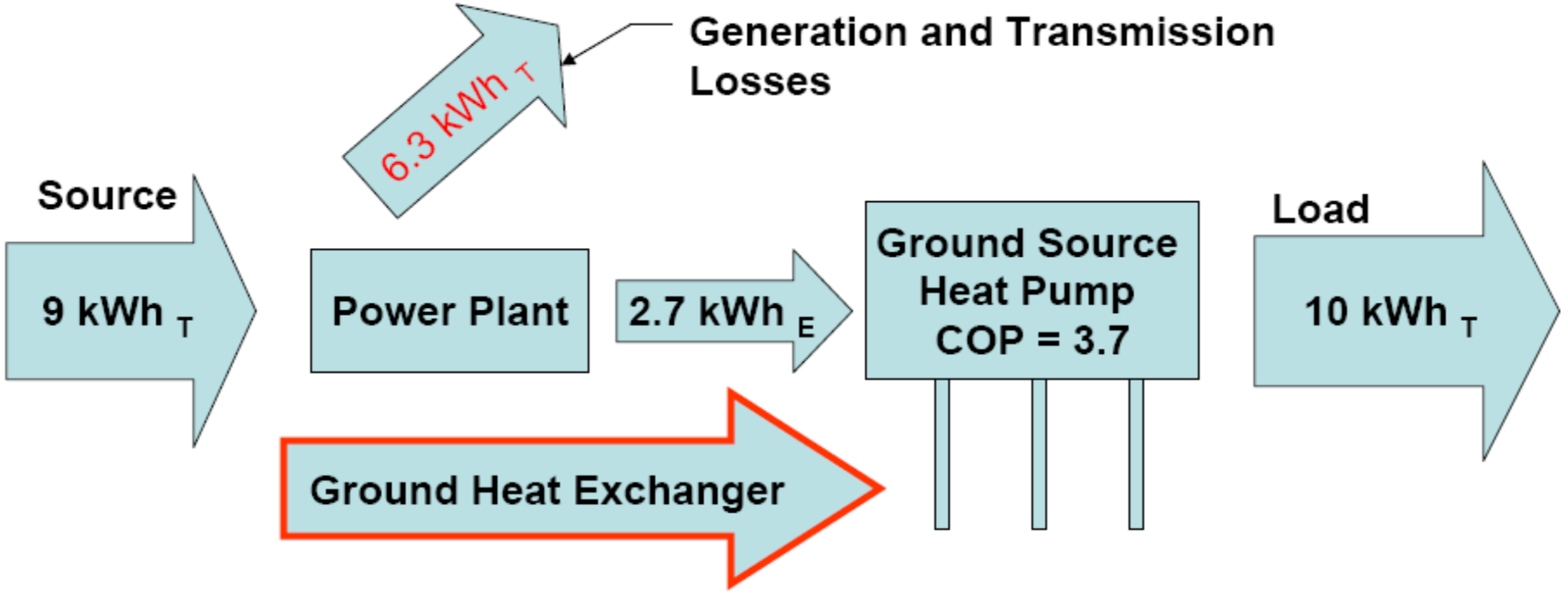

The required input energy to deliver 10 kWh of heat to a home using an air-source heat pump would be 17 kWh. About 70% of the input energy is lost during the generation and transmission process of a typical fossil-fuel power plant. The air-source heat pump will deliver a COP of 2 when defrost and auxiliary heat penalties are properly applied.

# Gas/Electric HVAC System




The natural gas system loses about 10% in the transmission process and another 10 to 20% at the furnace. Electricity is also needed for the furnace fans. The total required to deliver 10 kWh to the building is 14.6 from the source. This is an overall efficiency of 68% source to delivered.

# Ground Source Heat Pump



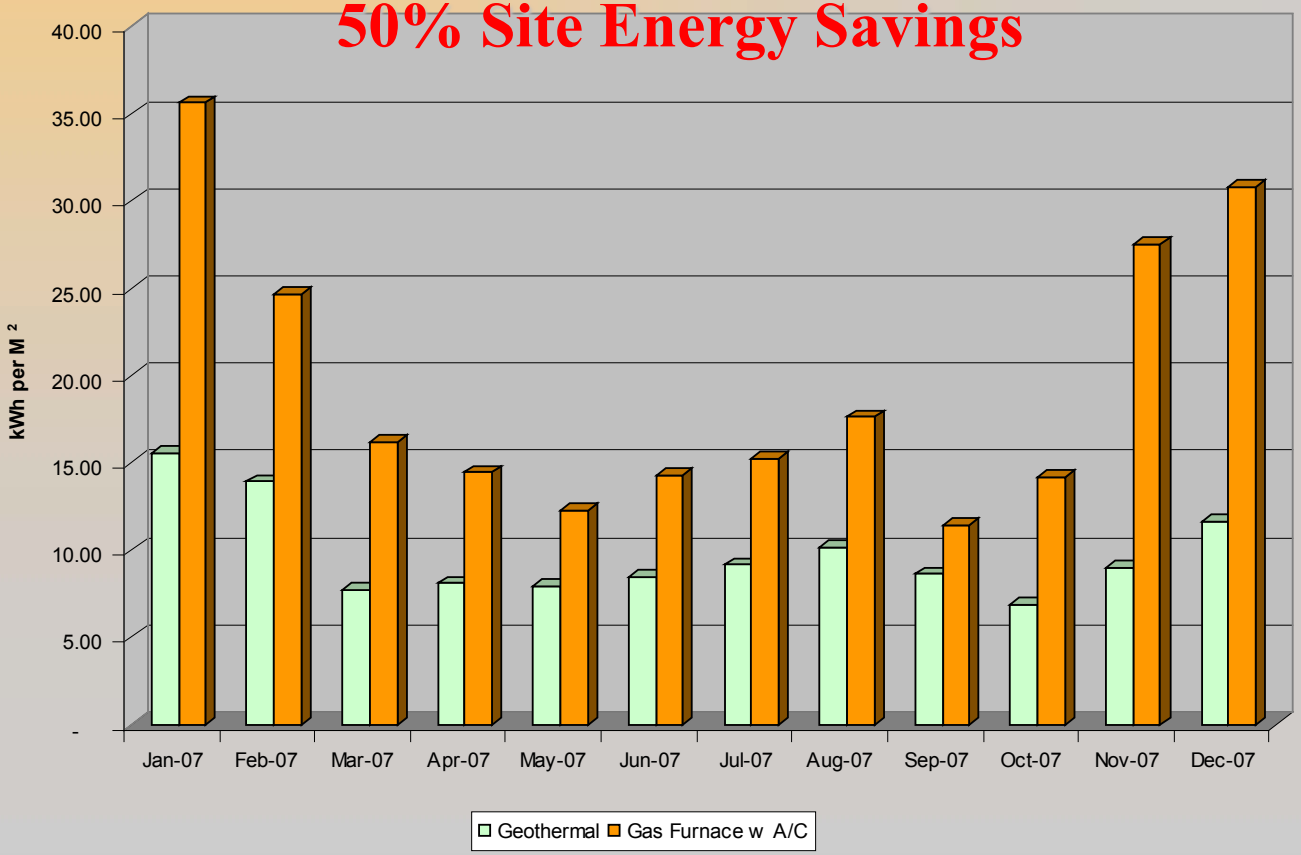

GSHP require only 9 $kWh_T$ from the source to provide 10 $kWh_T$ to the building since they can provide a COP of 3.7

# Geo for Cooperatives

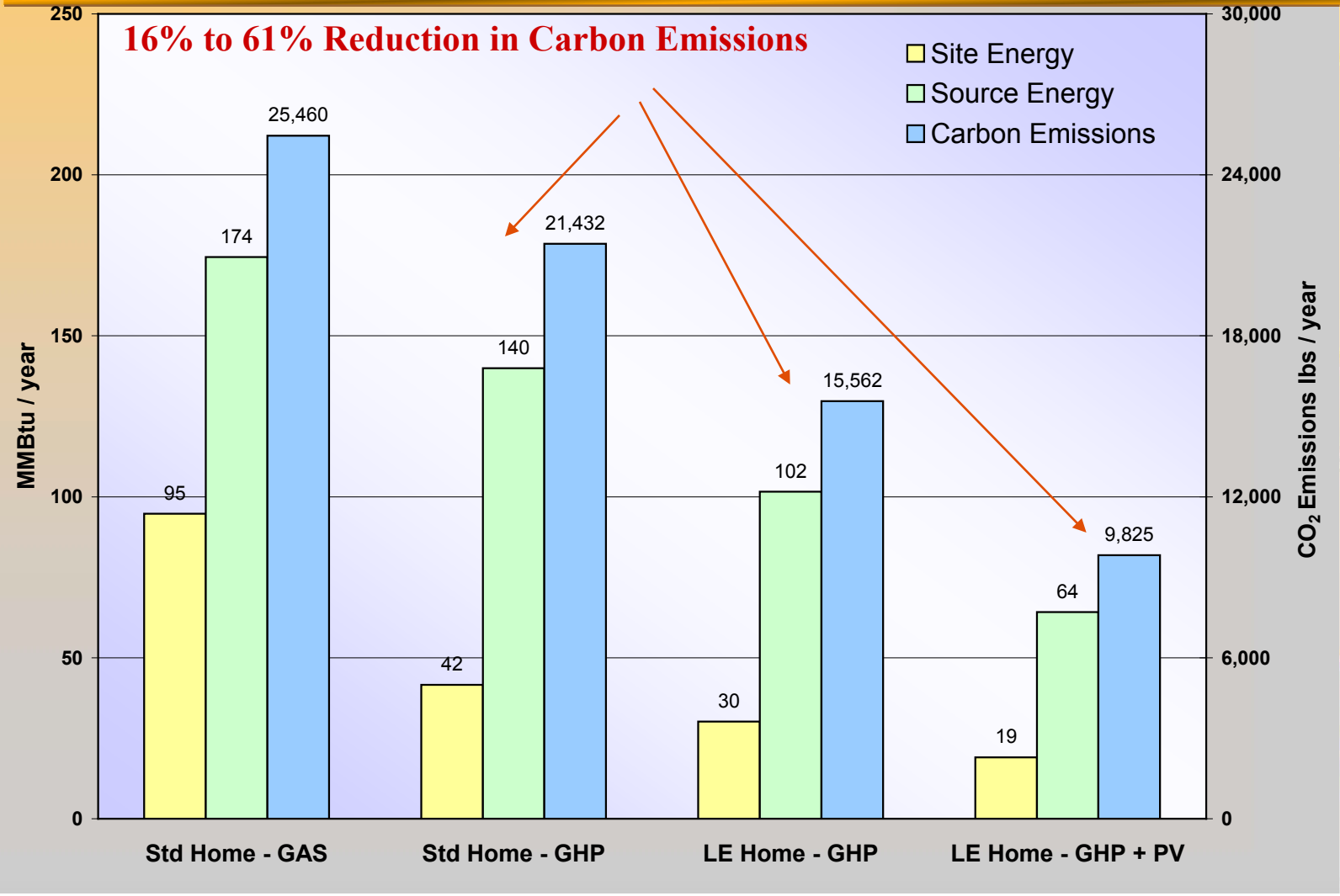
- DOE is working to officially designate GSHPs as a renewable energy resource
- Cooperatives will be able to obtain credit for CO2 savings from GSHP programs
- A GeoExchange systems saves more CO2 than an equivalent investment in solar PV.
  - Based on Colorado electric energy carbon load and weather data.
  - Your results will vary.

# Geo for Cooperatives

## Habitat for Humanity
## Average of 16 Homes - Total Site Energy Use in 2007
## 50% Site Energy Savings



# Habitat for Humanity
# Total Energy Consumption and Carbon Emissions (Oklahoma)



# Geo for Cooperatives

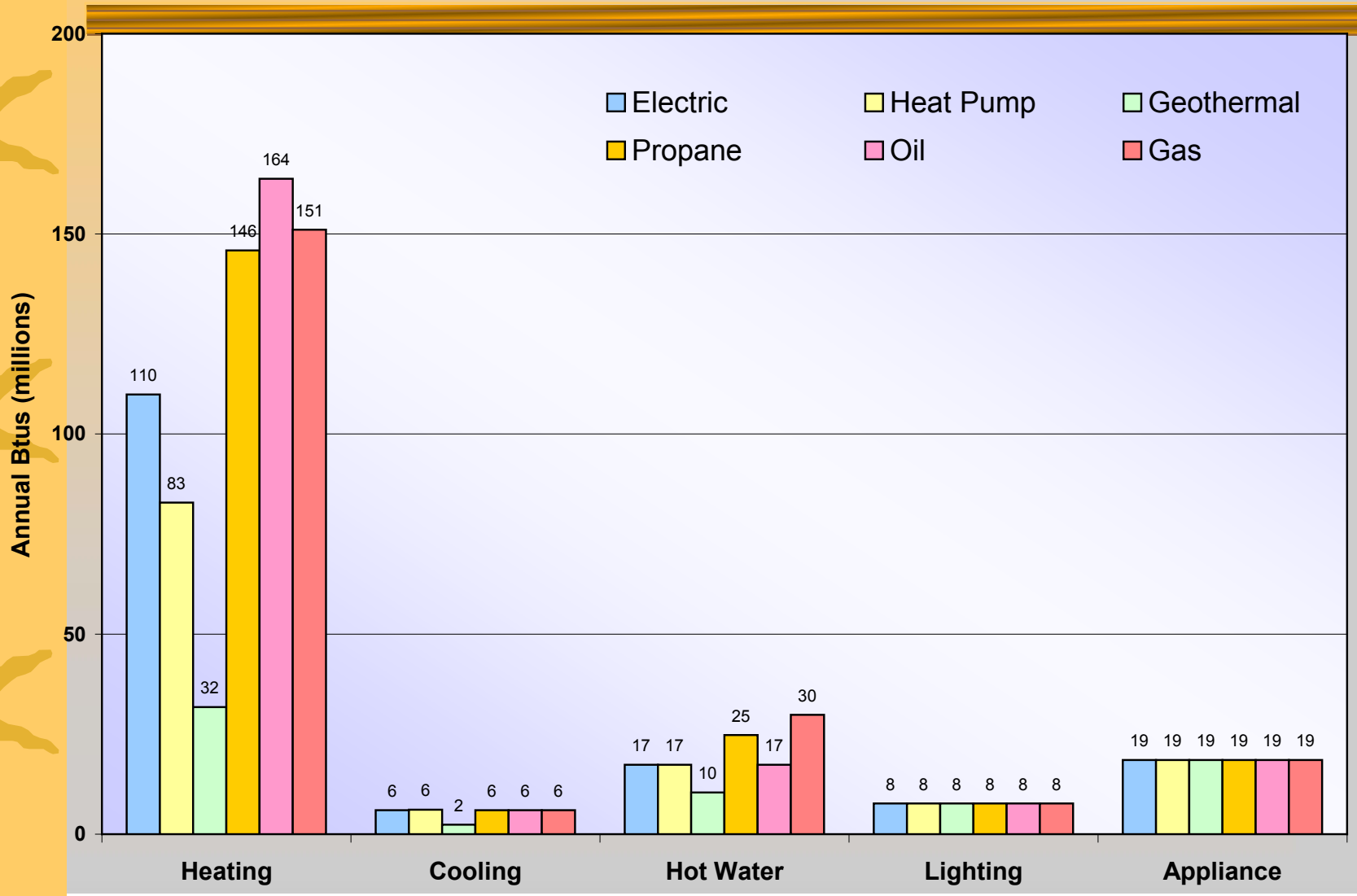
Oklahoma kW/ton at 85 F Outside Air Temperature

| EER | GHP #1 | GHP #2 | GHP #3 | Average | *Difference vs. 13 SEER AC |
|---|---|---|---|---|---|
| 15.1 | 0.89 | 0.84 | 0.83 | 0.85 | 0.45 |
| 16 | 0.85 | 0.81 | 0.81 | 0.82 | 0.48 |
| 17 | 0.80 | 0.77 | 0.78 | 0.78 | 0.52 |

*Assumes 13 SEER AC at 105° F outside air temperature is about 1.3 kW/ton

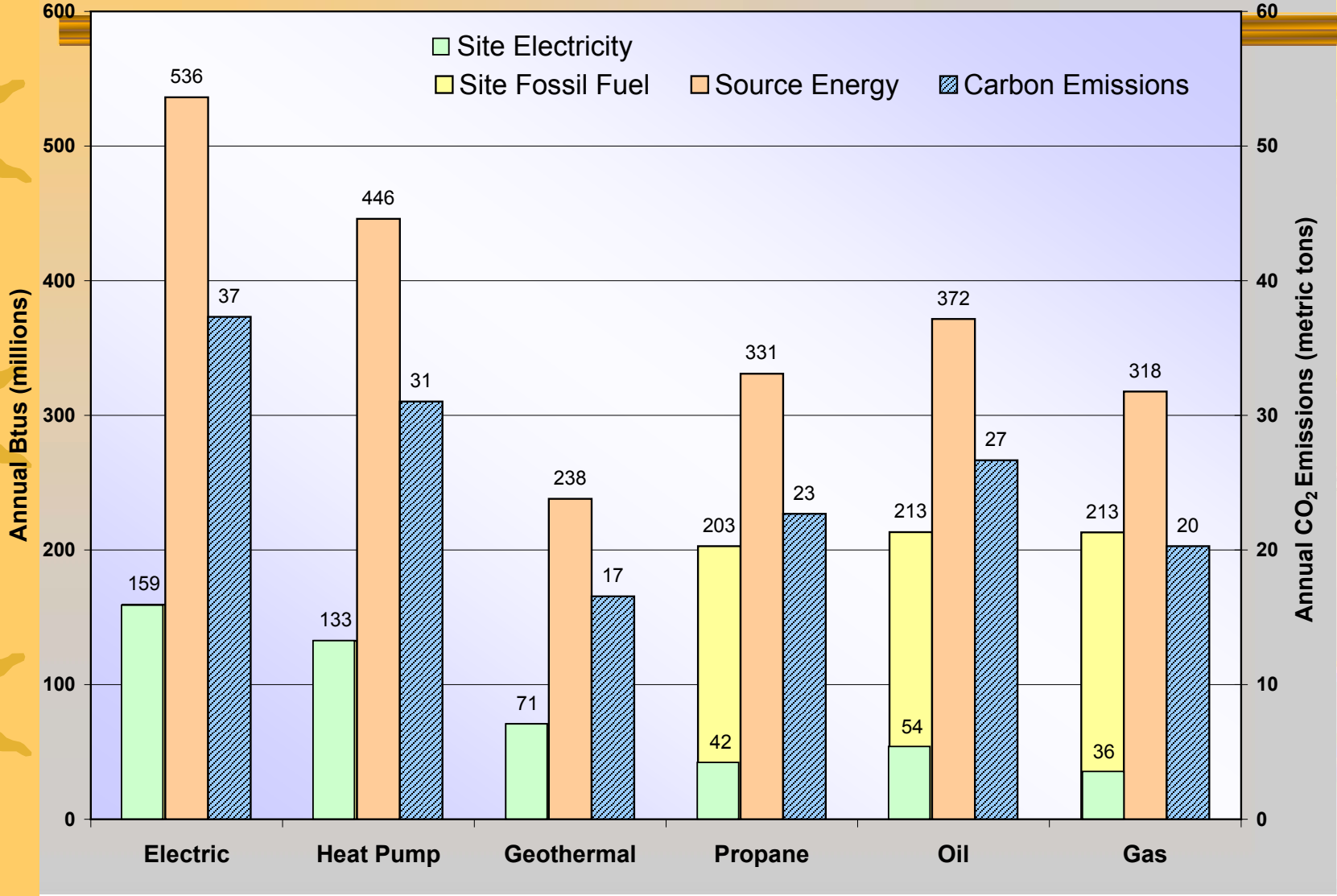
# Site Energy Consumption by End Use

## 1800 Sq. Ft. S.F. Home - Minneapolis



# Total Energy Consumption and Emissions

## 1800 Sq. Ft. S.F. Home - Minneapolis



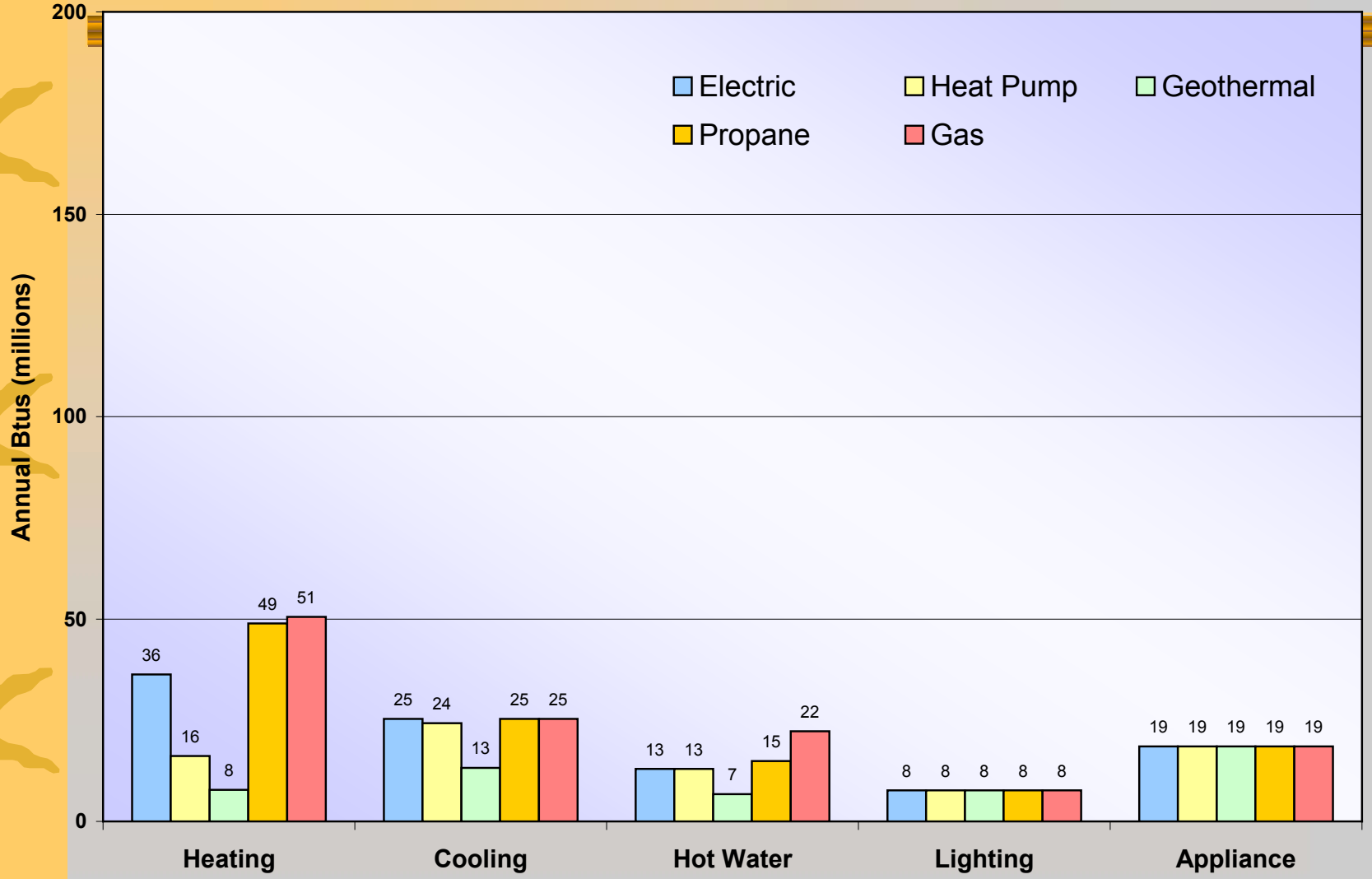
# *Geothermal Economics & DSM Impact*
# *1800 Sq. Ft. S.F. Home - Minneapolis*

Based on EIA Short Term Energy Outlook (June 08) energy cost projections for 2008-2009

| House Type: | Geothermal | Heat Pump | Gas | Electric | Propane | Oil |
|---|---|---|---|---|---|---|
| Retrofit Investment: | $ 14,000 | $ - | $ - | | $ - | $ - |
| Replacement Investment: | $ 10,000 | | | | | |
| **Annual Energy Cost:** | | | | | | |
| Heating | $ 734 | $ 1,917 | $ 2,398 | $ 2,542 | $ 3,881 | $ 4,892 |
| Cooling | $ 64 | $ 167 | $ 163 | $ 163 | $ 163 | $ 163 |
| Hot Water | $ 257 | $ 419 | $ 480 | $ 419 | $ 635 | $ 419 |
| Lighting | $ 191 | $ 191 | $ 191 | $ 191 | $ 191 | $ 191 |
| Appliance | $ 461 | $ 461 | $ 461 | $ 461 | $ 461 | $ 461 |
| Total | $ 1,707 | $ 3,155 | $ 3,693 | $ 3,776 | $ 5,331 | $ 6,126 |
| Annual Energy Cost Saving | | $ 1,448 | $ 1,986 | $ 2,069 | $ 3,624 | $ 4,419 |
| Retrofit Simple Payback (Yrs) | | 9.7 | 7.0 | 6.8 | 3.9 | 3.2 |
| Replace Simple Payback (Yrs) | | 6.9 | 5.0 | 4.8 | 2.8 | 2.3 |
| **DSM Benefits:** | | | | | | |
| Summer Peak kW | | -2.2 | -1.6 | -2.2 | -1.8 | -2.2 |
| Winter Peak kWh | | -7.5 | 7.8 | -7.5 | 7.4 | 7.2 |
| Annual kWh | | -18,103 | 10,287 | -25,947 | 8,508 | 4,940 |

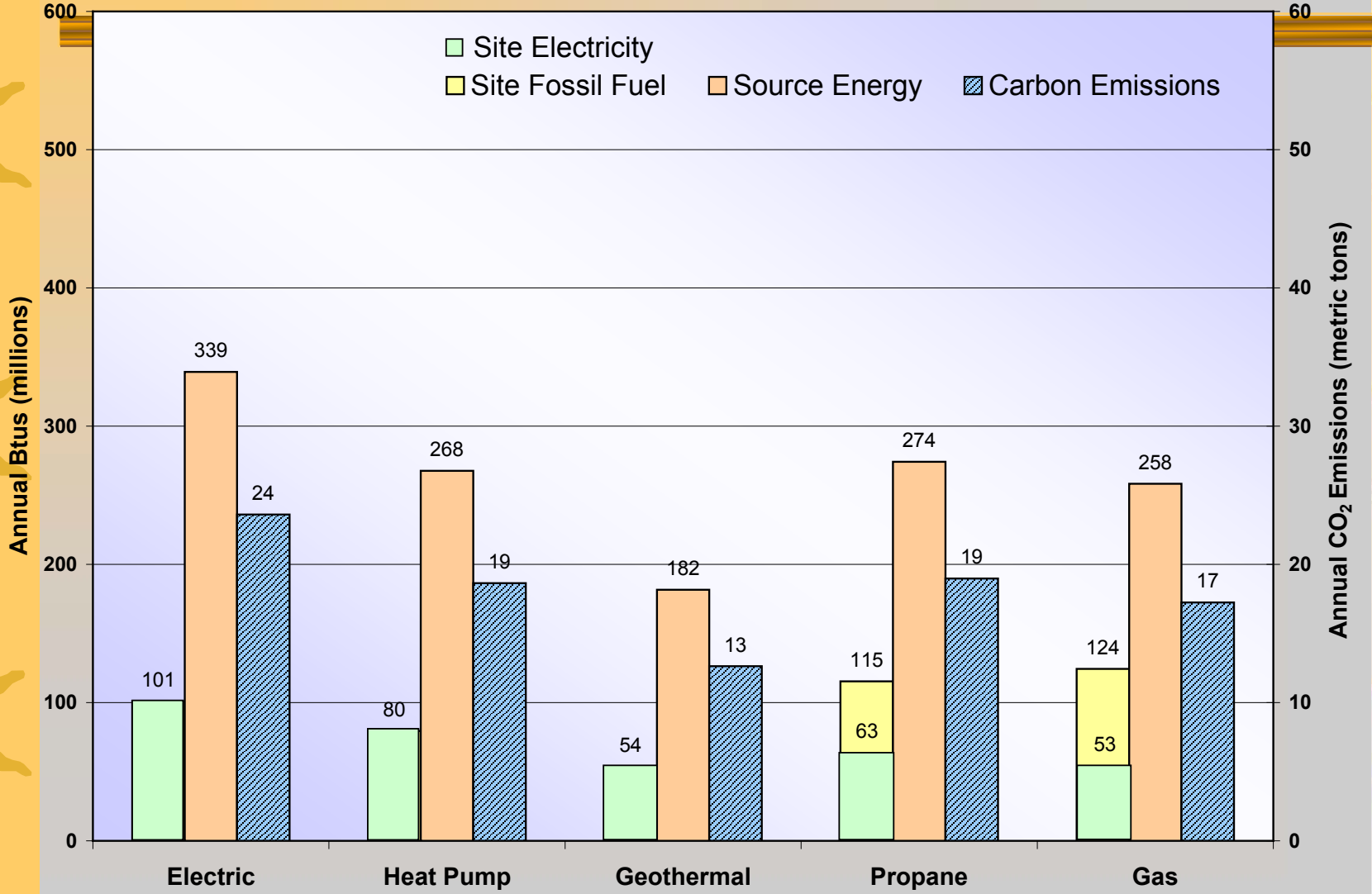
# Site Energy Consumption by End Use

## 1800 Sq. Ft. S.F. Home - Dallas



# Total Energy Consumption and Emissions

## 1800 Sq. Ft. S.F. Home - Dallas

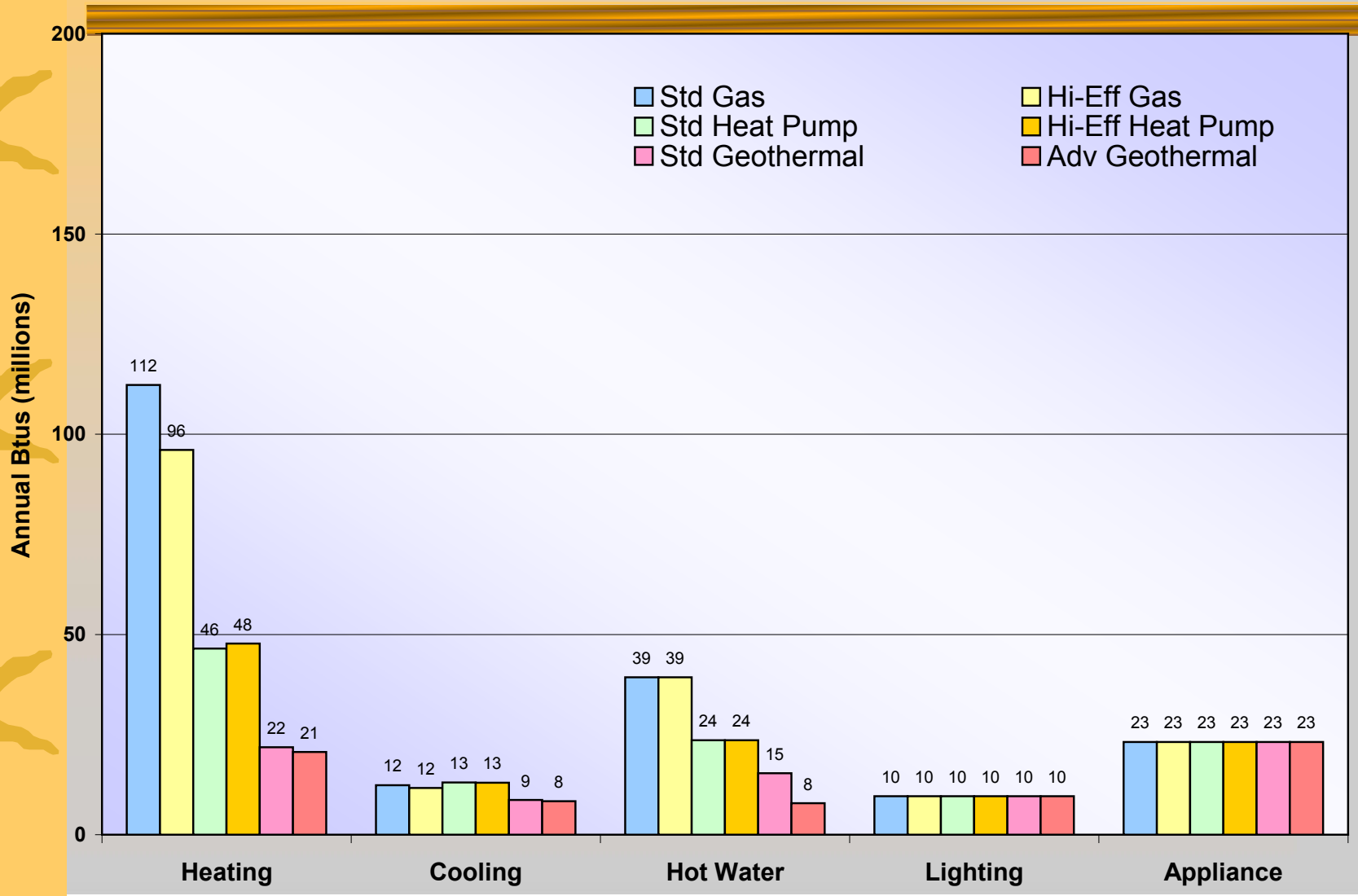


# *Geothermal Economics & DSM Impact*
# *1800 Sq. Ft. S.F. Home - Dallas*

Based on EIA Short Term Energy Outlook (June 08) energy cost projections for 2008-2009

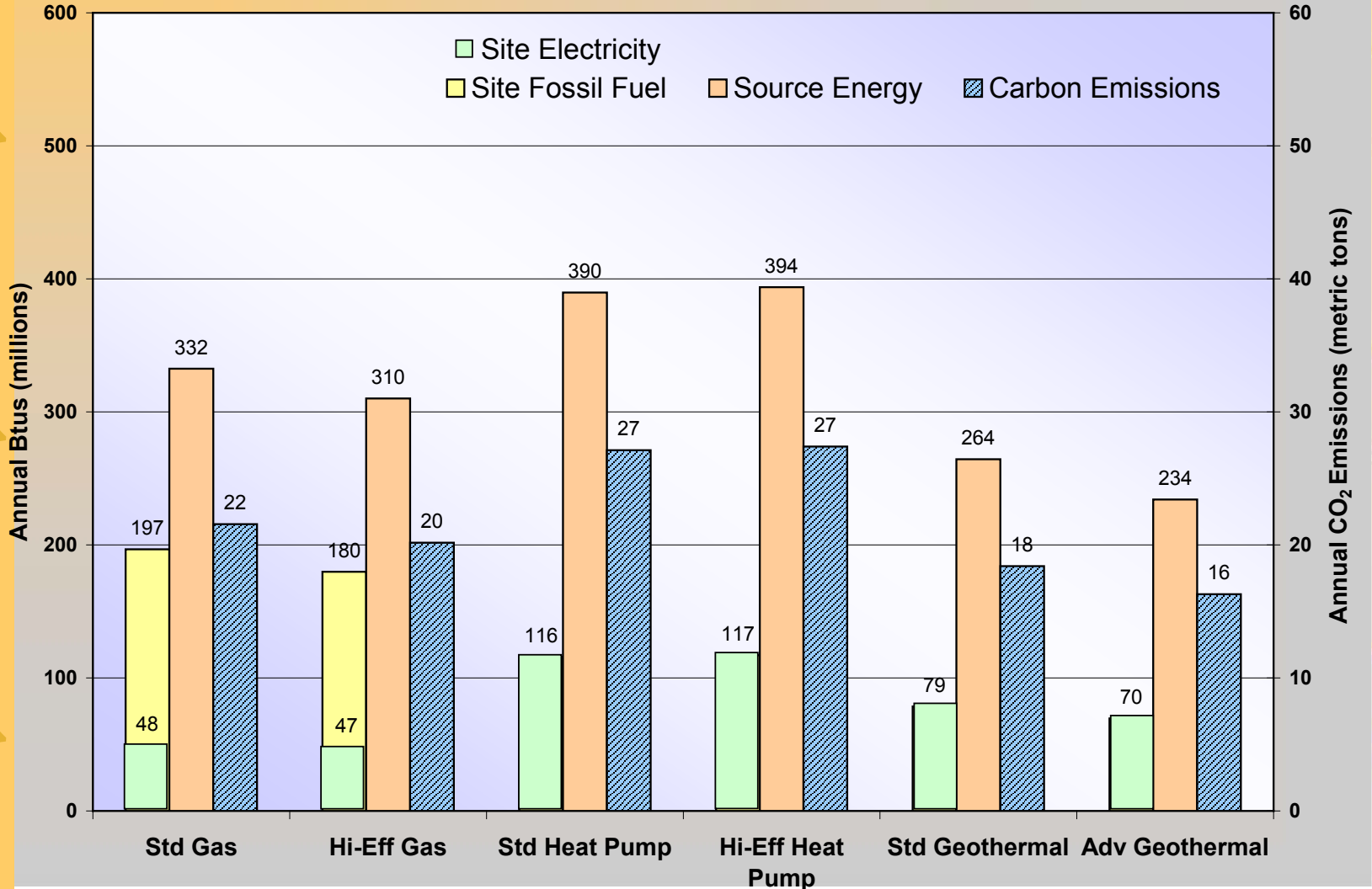
| House Type: | Geothermal | Heat Pump | Gas | Electric | Propane |
|---|---|---|---|---|---|
| Retrofit Investment: | $ 12,000 | $ - | $ - | $ - | $ - |
| Replacement Investment: | $ 8,000 | | | | |
| **Annual Energy Cost:** | | | | | |
| Heating | $ 263 | $ 544 | $ 871 | $ 1,223 | $ 1,524 |
| Cooling | $ 493 | $ 903 | $ 943 | $ 943 | $ 943 |
| Hot Water | $ 236 | $ 460 | $ 390 | $ 460 | $ 640 |
| Lighting | $ 269 | $ 269 | $ 269 | $ 269 | $ 269 |
| Appliance | $ 651 | $ 651 | $ 651 | $ 651 | $ 651 |
| Total | $ 1,912 | $ 2,827 | $ 3,124 | $ 3,546 | $ 4,027 |
| Annual Energy Cost Saving | | $ 915 | $ 1,212 | $ 1,634 | $ 2,115 |
| Retrofit Simple Payback (Yrs) | | 13.1 | 9.9 | 7.3 | 5.7 |
| Replace Simple Payback (Yrs) | | 8.7 | 6.6 | 4.9 | 3.8 |
| **DSM Benefits:** | | | | | |
| Summer Peak kW | | -2.1 | -1.7 | -2.1 | -2.0 |
| Winter Peak kWh | | -7.7 | 1.7 | -7.7 | 1.4 |
| Annual kWh | | -7,501 | 245 | -13,723 | -2,679 |

# Site Energy Consumption by End Use
## 2500 Sq. Ft. New S.F. Home – St. Louis



# Total Energy Consumption and Emissions

## 2500 Sq. Ft. New Home – St. Louis



# *Geothermal Economics & DSM Impact*

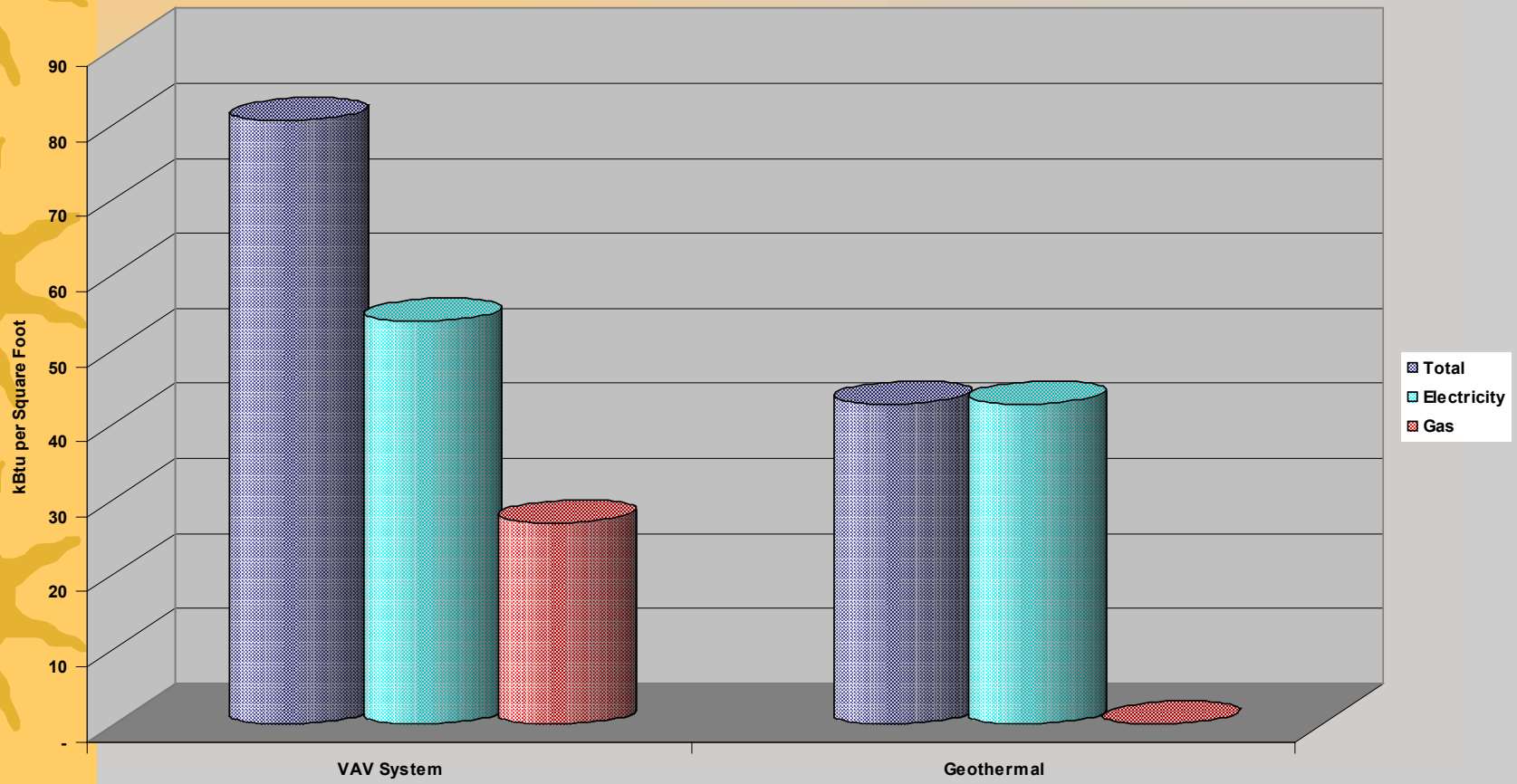
## *2500 Sq. Ft. New Home – St. Louis*

Based on EIA Short Term Energy Outlook (June 08) energy cost projections for 2008-2009

| House Type: | Std Gas | Hi-Eff Gas | Std Heat Pump | Hi-Eff Heat Pump | Std Geothermal |
|---|---|---|---|---|---|
| Installation Cost: | $ 6,500 | $ 8,500 | $ 6,500 | $ 8,000 | $ 18,000 |
| Annual Energy Cost: | | | | | |
| Heating | $ 1,840 | $ 1,572 | $ 1,075 | $ 1,104 | $ 505 |
| Cooling | $ 336 | $ 318 | $ 355 | $ 353 | $ 236 |
| Hot Water | $ 662 | $ 662 | $ 584 | $ 584 | $ 384 |
| Lighting | $ 238 | $ 238 | $ 238 | $ 238 | $ 238 |
| Appliance | $ 577 | $ 577 | $ 577 | $ 577 | $ 577 |
| Total | $ 3,653 | $ 3,367 | $ 2,829 | $ 2,856 | $ 1,940 |
| Additional Cost | $ 11,500 | $ 9,500 | $ 11,500 | $ 10,000 | |
| Annual Energy Cost Saving | $ 1,713 | $ 1,427 | $ 889 | $ 916 | |
| Retrofit Simple Payback (Yrs) | 6.7 | 6.7 | 12.9 | 10.9 | |
| DSM Benefits: | | | | | |
| Summer Peak kW | -0.6 | -0.6 | -1.6 | -1.6 | |
| Winter Peak kWh | 7.7 | 7.9 | -8.3 | -8.3 | |
| Annual kWh | 8,960 | 9,348 | -10,922 | -11,258 | |

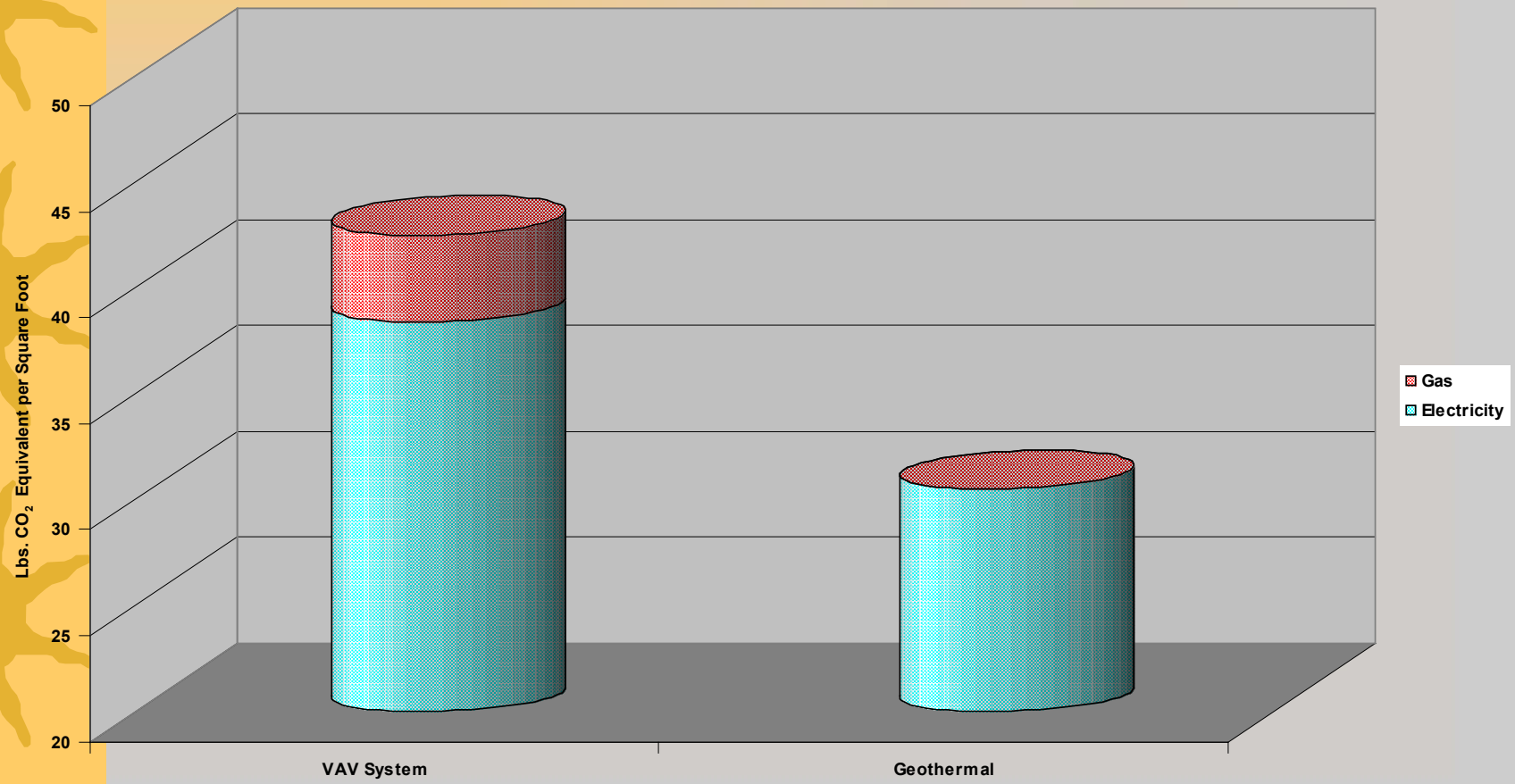
# Garrett Office Buildings
# Actual Metered Annual Energy Use
# 2006-2007

## 47% Site Energy Savings



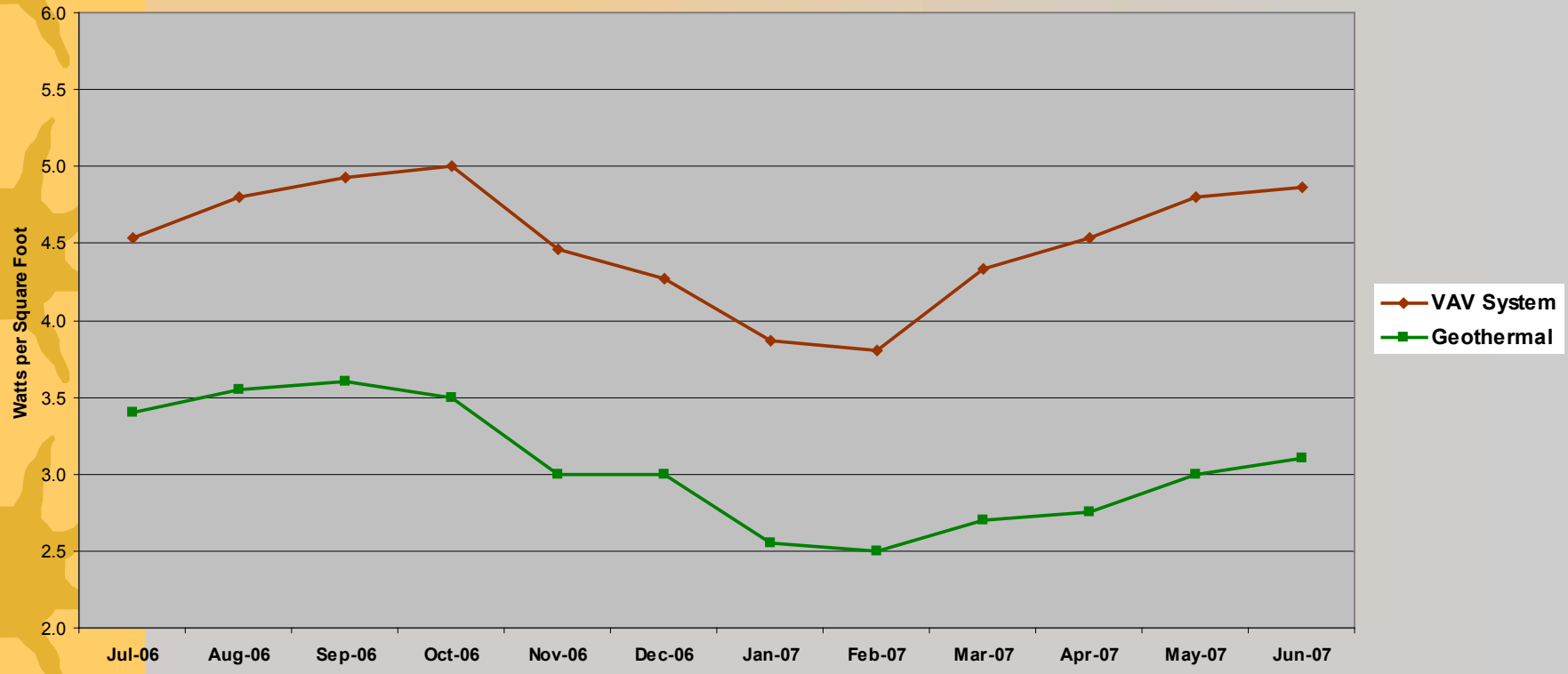
# Garrett Office Buildings
# Annual $CO_2$ Emissions 2006-2007

## 28% Carbon Emissions Reduction



# Garrett Office Buildings
# Monthly Peak Demand 2006-2007

## 35% Peak Demand Reduction

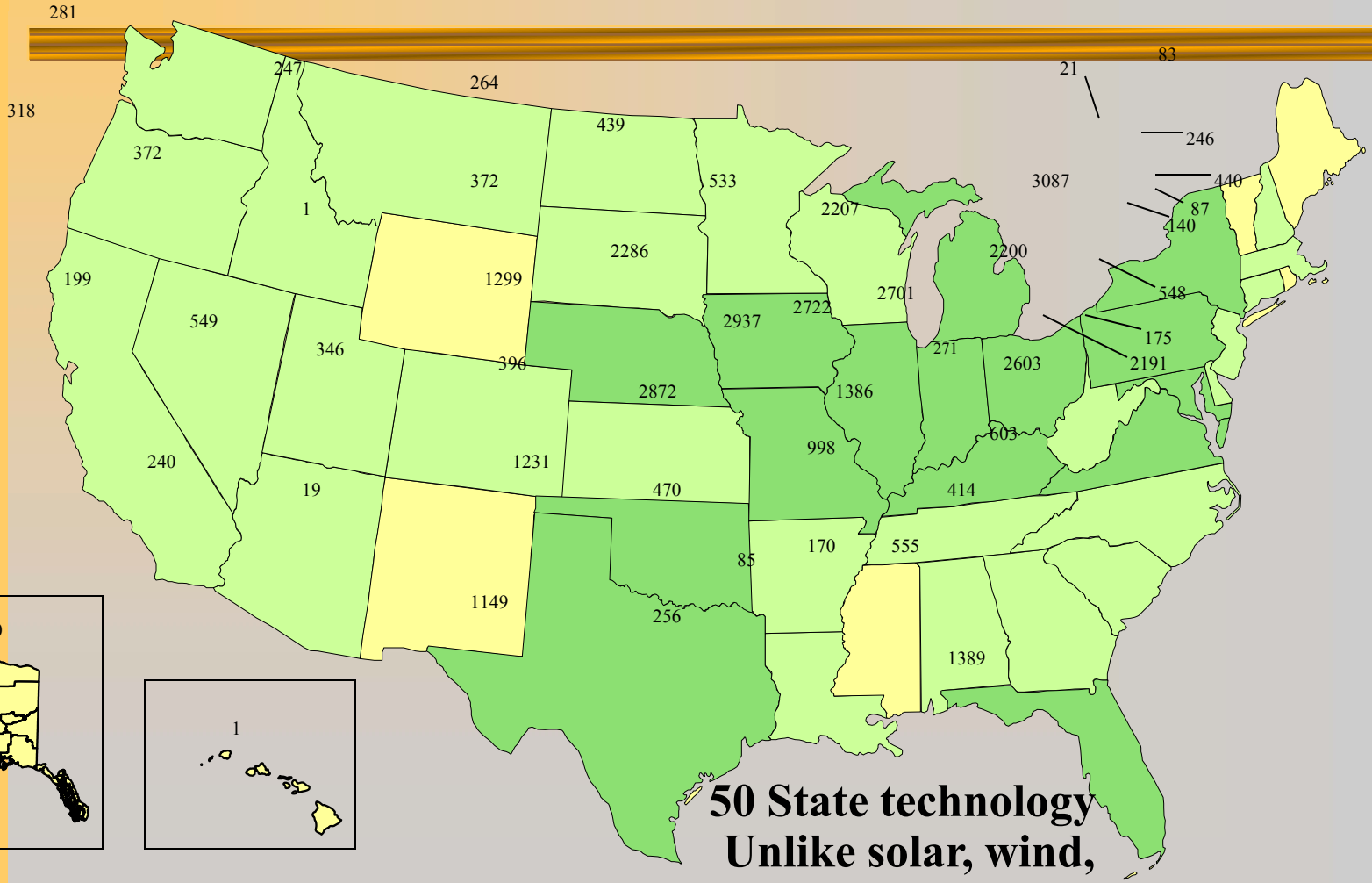


# Geo for Cooperatives

- Since their introduction in the 1980's, over 1 million geothermal heat pumps have been installed in the united states

# *Geothermal Heat Pump*

## *Geographic Shipment Distribution - 2006*




**50 State technology**
**Unlike solar, wind, and "hot rocks" geothermal**

# Thank You For Your Attention!


**If you ever need a hand you can reach me at:**

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