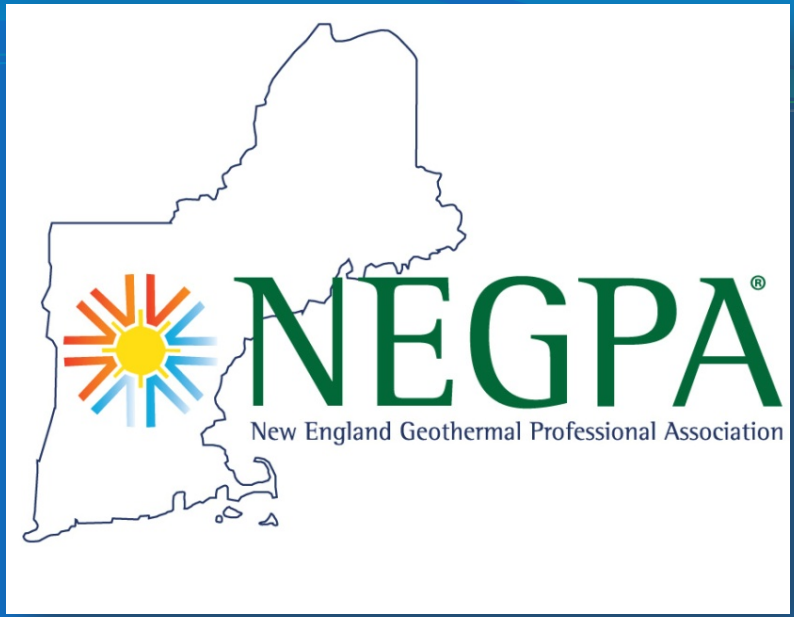



# Better Building by Design

Thursday January 6th, 2014

## *Geothermal Heat Pump Systems*
## *Most efficient, least understood*

***Martin Orio, AI – President - NEGPA***

# Why Geothermal?

***FACT:***

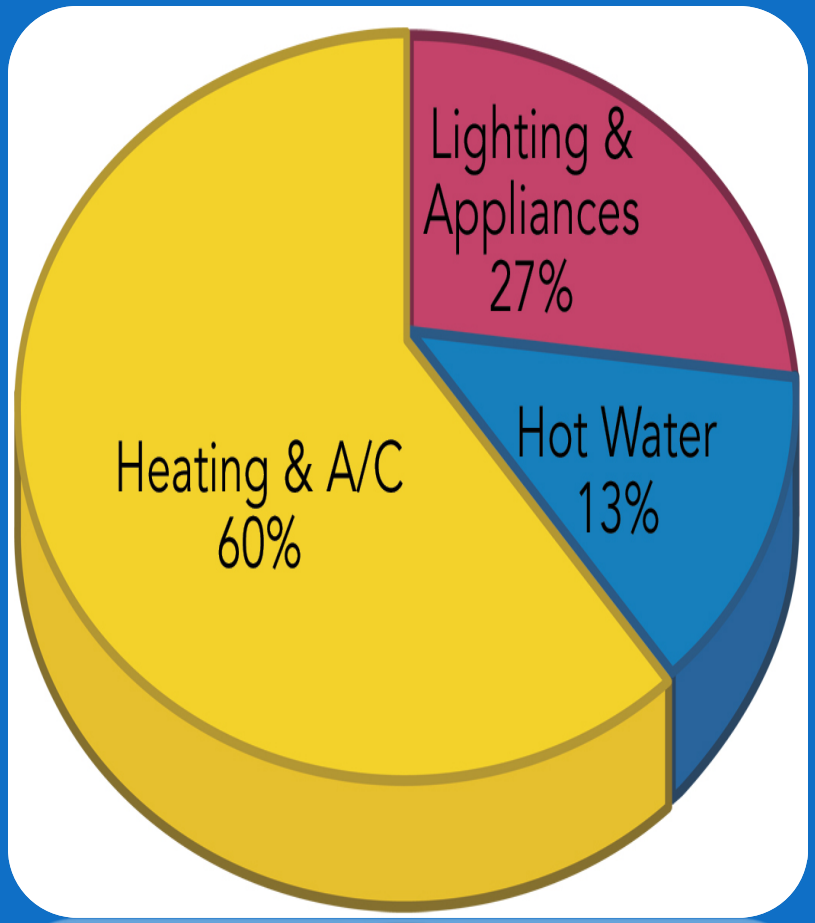
**Most efficient AND earth-friendly HEATING AND COOLING MECHANISM ON THE PLANET!**

# What Does the US EPA have to Say About Geothermal Heat Pumps?

- Lowest Cost Heating & Cooling
- Best for the Air Environment
- Best for Electric Utilities

EPA Report 430-R-93-004 - *Space Conditioning the Next Frontier*

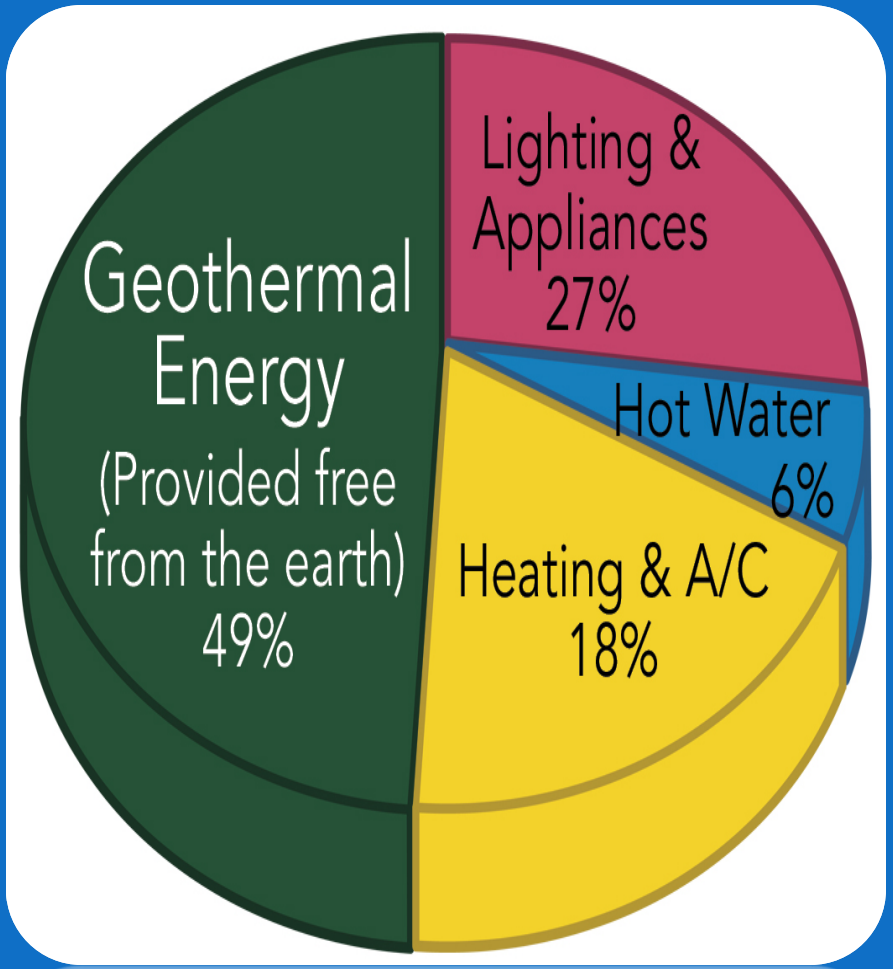
# Residential Site Energy
## Conventional System




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

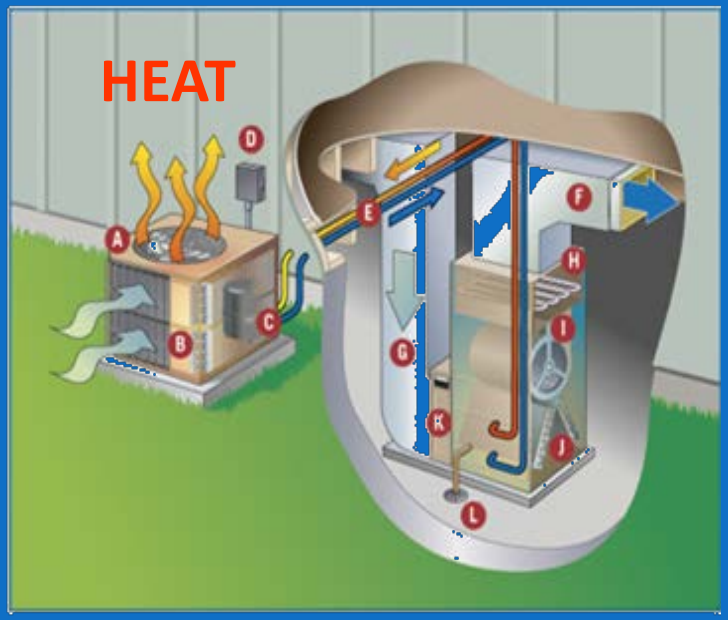
# Residential Site Energy
## Geothermal Heat Pump System

**Total site energy consumption is cut in half**



# Heat Pumps Are All Around Us…

Air conditioners and air-source heat pumps transfer heat from inside houses to the air outside

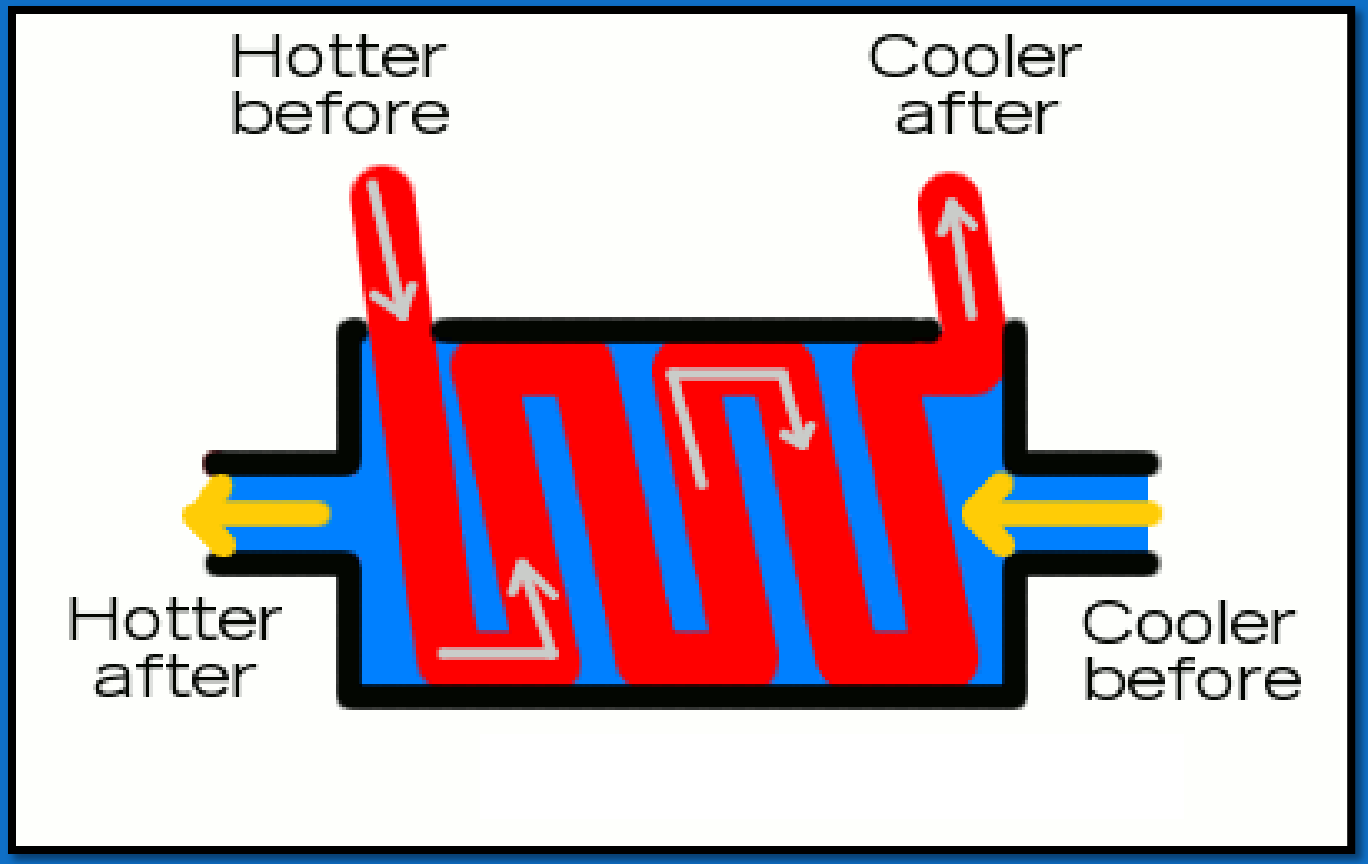




Refrigerators transfer heat from food into the kitchen

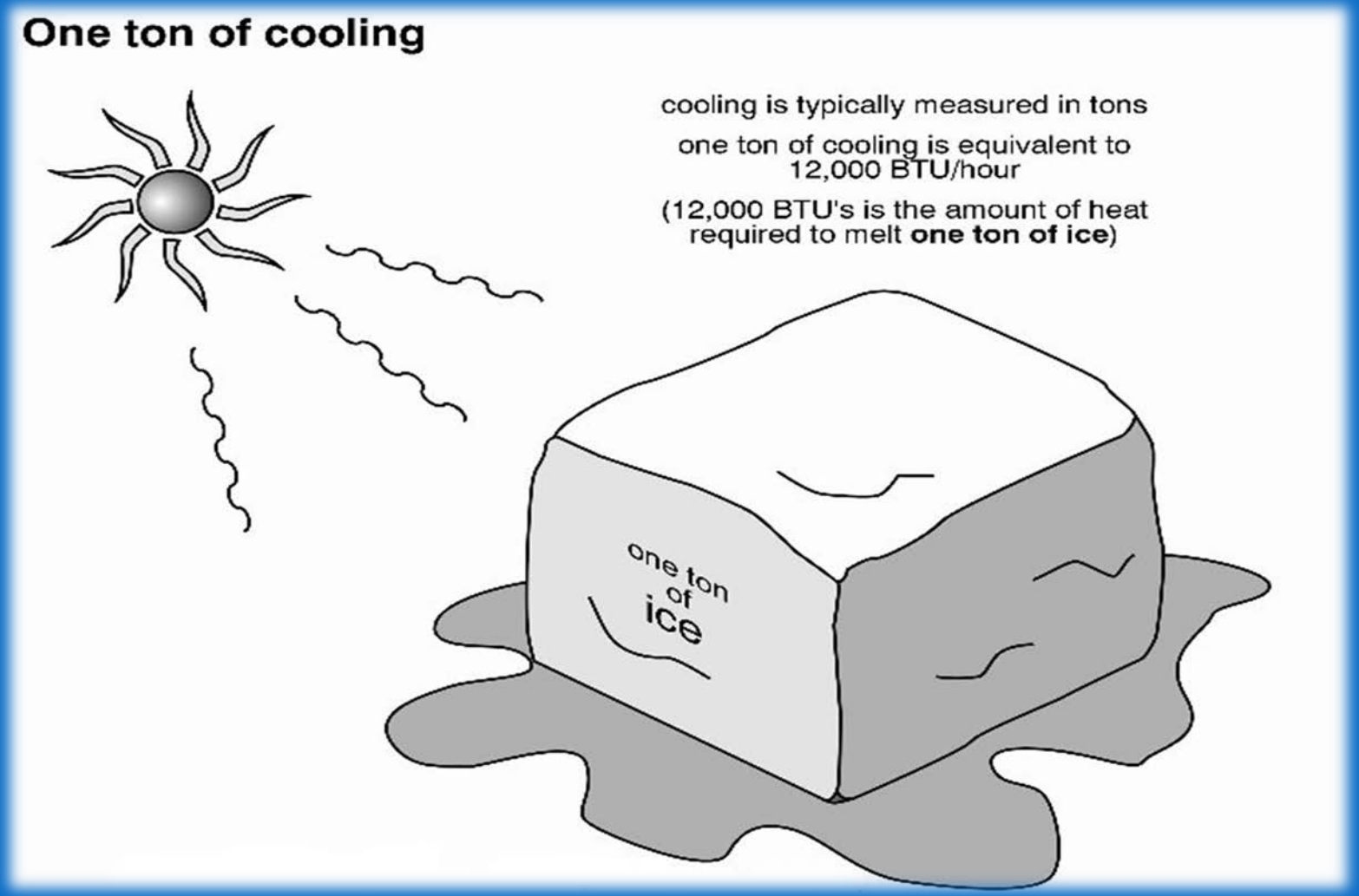
# Efficiency in Heat Exchange

Compressor uses electrical energy and refrigerant to move energy from the ground into the building




Like all things in nature, the further the distance between source and destination, the more energy expended.

# What is a “ton”?



# Geothermal Heat Pumps are Solar Energy Management devices...

- ☼ ***EXTRACT*** stored **Solar Energy** in the **WINTER**
- ☼ ***STORE*** **Solar Building "Gain" Energy** in the **SUMMER**

Everybody knows heat pumps don't work north of the Mason-Dixon Line!

Not So!

Geothermal Uses Constant Earth Temp.

Not Declining Air Temp.

# Our Average Earth Temperature…

Remains at

**48 ~ 54°**

**The Year Around**

# FREE STORED SOLAR ENERGY
# With NO BATTERIES or INVERTERS!

**Stanford University's**

**Global Climate & Energy Project**

The amount of solar energy reaching the surface of the planet is so vast that in one year it is about twice

as much as will ever

be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined!

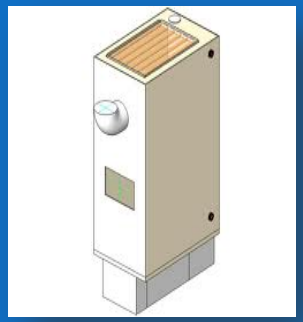
# What is COP ?

***Real* #'s at...**

AHRI CERTIFIED™ www.ahridirectory.org

**Efficiency measurement for…** **HEATING**

**(Coefficient of Performance)**



Top quality Oil or Gas Furnace 80% efficient

Pellet or Wood Stove 80% efficient

Electric resistance heaters 100% efficient

Air-Source Heat Pump Annually about 230% efficient in New England

Geothermal Heat Pump 450 to 600% efficient all winter long

***Real* #'s at...**

AHRI CERTIFIED™ www.ahridirectory.org

# What is SEER & EER?

**System efficiency measurement for COOLING**

## SEER = Seasonal Electrical Efficiency Ratio
(fluctuating temp exchange)

## EER = Electrical Efficiency Ratio
(constant temp exchange)

***Top efficiency "Air-to-Air" heat pump has a SEER of up to 21 (or annualized EER of about 15)***

Efficiency declines as outdoor air temp increases above 75 F!!!

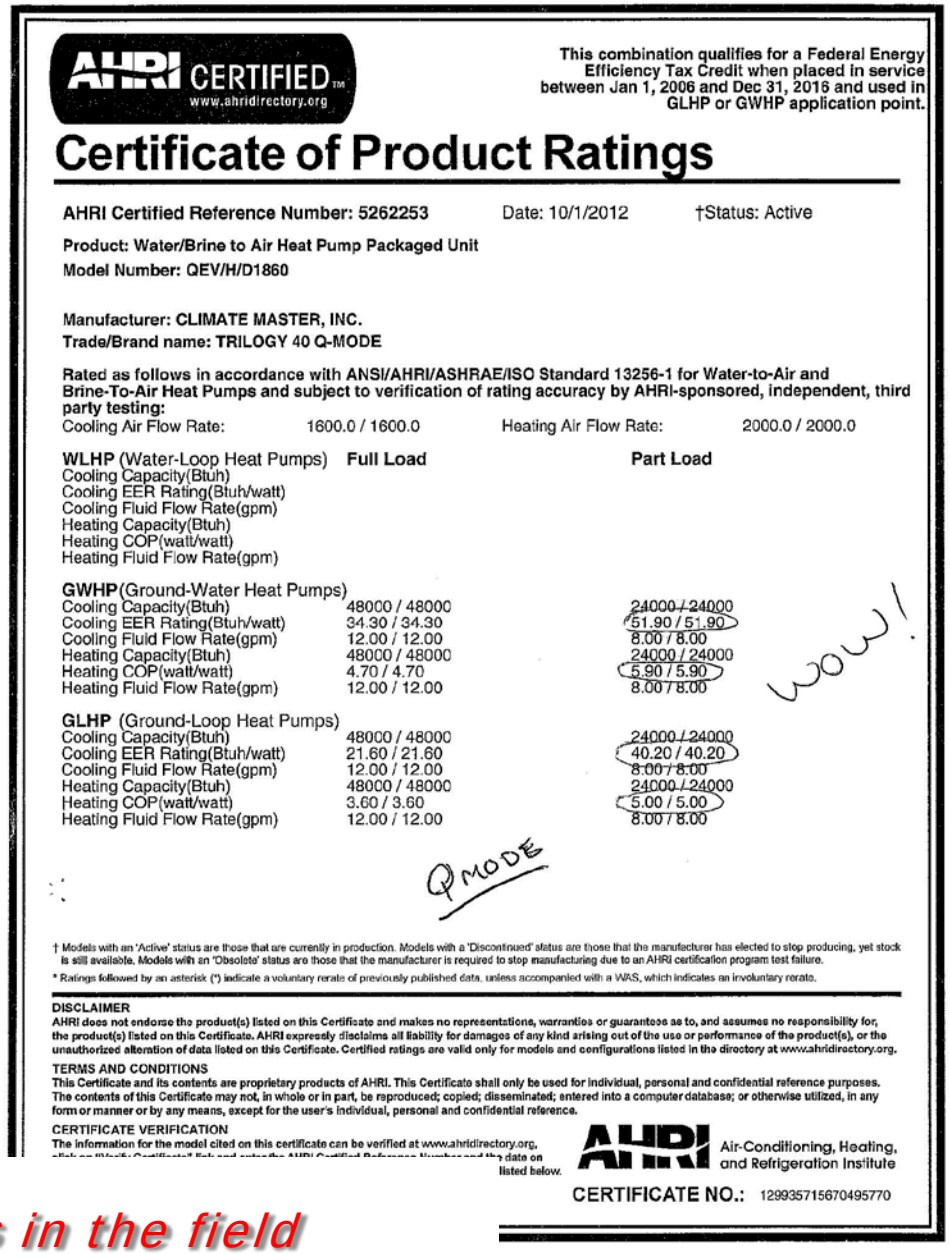
***Today's geothermal - EER's up to 51***

*With no efficiency decline due to outdoor air temp increase because it is not exchanging with air!*

# Today's Geothermal Heat Pump

AHRI data sheet…

-Accurate 3rd party confirmation
-Includes pumping penalty & pressure drop factors
-Measures all devices under equal conditions
-Informs Estar Tier 3 efficiency requirements
-If your chosen HVAC system does not have an AHRI rating ask why!



AHRI CERTIFIED™ www.ahridirectory.org

This combination qualifies for a Federal Energy Efficiency Tax Credit when placed in service between Jan 1, 2006 and Dec 31, 2016 and used in GLHP or GWHP application point.

## Certificate of Product Ratings

**AHRI Certified Reference Number: 5262253** Date: 10/1/2012 †Status: Active

**Product: Water/Brine to Air Heat Pump Packaged Unit**
**Model Number: QEV/H/D1860**

**Manufacturer: CLIMATE MASTER, INC.**
**Trade/Brand name: TRILOGY 40 Q-MODE**

**Rated as follows in accordance with ANSI/AHRI/ASHRAE/ISO Standard 13256-1 for Water-to-Air and Brine-To-Air Heat Pumps and subject to verification of rating accuracy by AHRI-sponsored, independent, third party testing:**

Cooling Air Flow Rate: 1600.0 / 1600.0 Heating Air Flow Rate: 2000.0 / 2000.0

| **WLHP** (Water-Loop Heat Pumps) | **Full Load** | **Part Load** |
|---|---|---|
| Cooling Capacity(Btuh) | | |
| Cooling EER Rating(Btuh/watt) | | |
| Cooling Fluid Flow Rate(gpm) | | |
| Heating Capacity(Btuh) | | |
| Heating COP(watt/watt) | | |
| Heating Fluid Flow Rate(gpm) | | |
| **GWHP**(Ground-Water Heat Pumps) | | |
| Cooling Capacity(Btuh) | 48000 / 48000 | ~~24000 / 24000~~ |
| Cooling EER Rating(Btuh/watt) | 34.30 / 34.30 | ~~51.90 / 51.90~~ |
| Cooling Fluid Flow Rate(gpm) | 12.00 / 12.00 | ~~8.00 / 8.00~~ |
| Heating Capacity(Btuh) | 48000 / 48000 | ~~24000 / 24000~~ |
| Heating COP(watt/watt) | 4.70 / 4.70 | ~~5.90 / 5.90~~ |
| Heating Fluid Flow Rate(gpm) | 12.00 / 12.00 | ~~8.00 / 8.00~~ |
| **GLHP** (Ground-Loop Heat Pumps) | | |
| Cooling Capacity(Btuh) | 48000 / 48000 | ~~24000 / 24000~~ |
| Cooling EER Rating(Btuh/watt) | 21.60 / 21.60 | ~~40.20 / 40.20~~ |
| Cooling Fluid Flow Rate(gpm) | 12.00 / 12.00 | ~~8.00 / 8.00~~ |
| Heating Capacity(Btuh) | 48000 / 48000 | ~~24000 / 24000~~ |
| Heating COP(watt/watt) | 3.60 / 3.60 | ~~5.00 / 5.00~~ |
| Heating Fluid Flow Rate(gpm) | 12.00 / 12.00 | ~~8.00 / 8.00~~ |

WOW!

QMODE

† Models with an 'Active' status are those that are currently in production. Models with a 'Discontinued' status are those that the manufacturer has elected to stop producing, yet stock is still available. Models with an 'Obsolete' status are those that the manufacturer is required to stop manufacturing due to an AHRI certification program test failure.

* Ratings followed by an asterisk (*) indicate a voluntary rerate of previously published data, unless accompanied with a WAS, which indicates an involuntary rerate.

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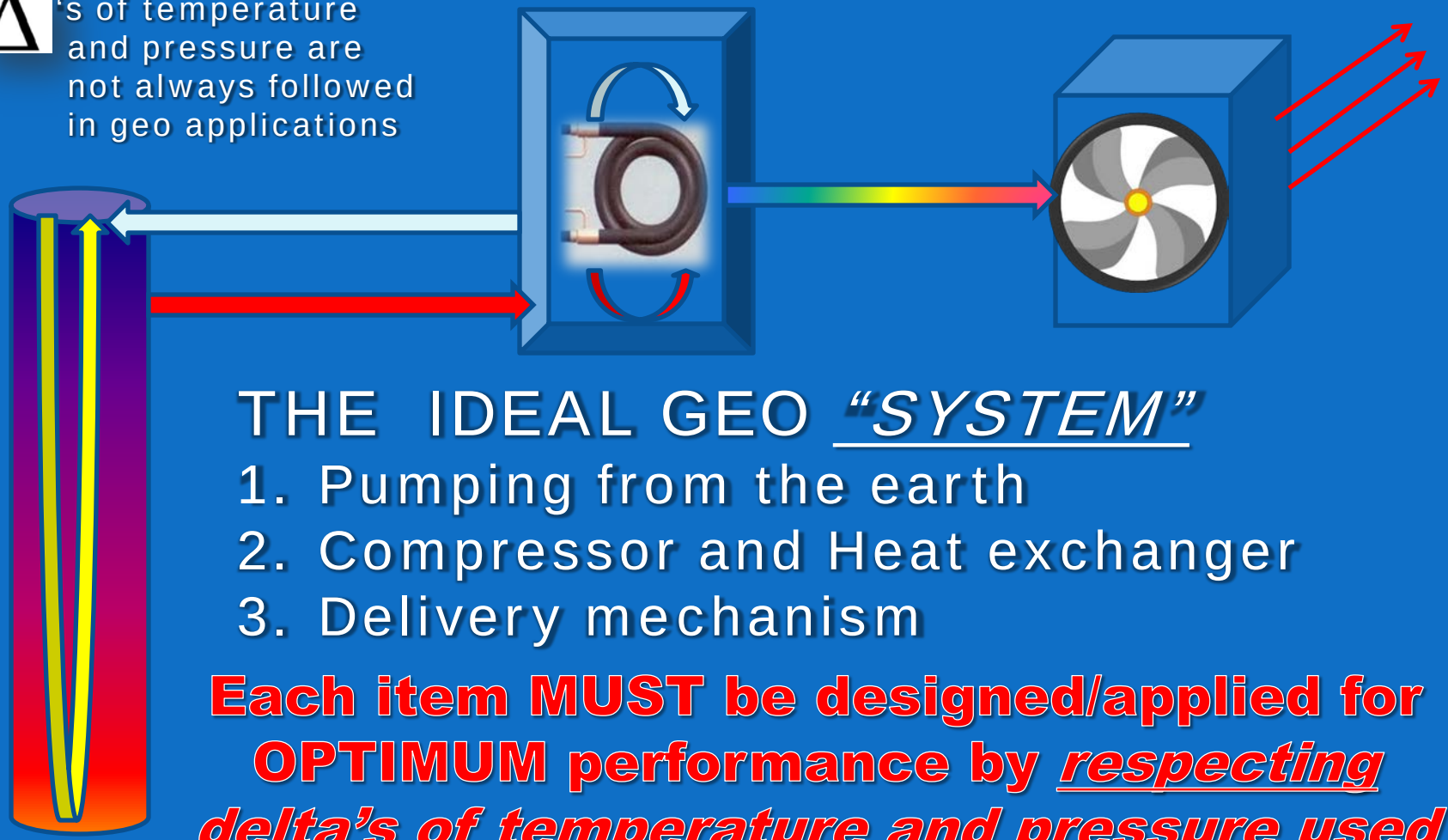
AHRI Air-Conditioning, Heating, and Refrigeration Institute

CERTIFICATE NO.: 12993571567049577O

***Reproducing lab conditions in the field Is critical to the success of your geo project!***

# Respecting/applying ISO-13256 installation parameters

Δ's of temperature and pressure are not always followed in geo applications

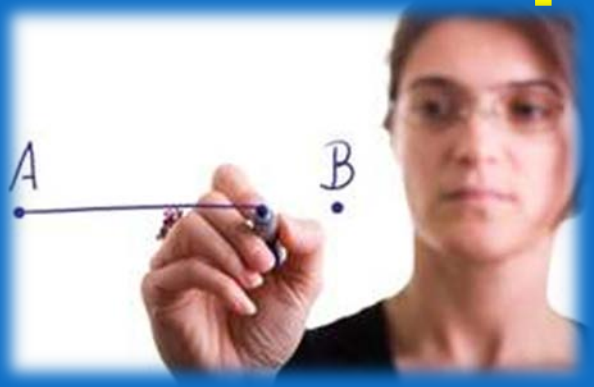


## THE IDEAL GEO *"SYSTEM"*

1. Pumping from the earth
2. Compressor and Heat exchanger
3. Delivery mechanism

**Each item MUST be designed/applied for OPTIMUM performance by *respecting delta's of temperature and pressure used in the AHRI/ISO test lab!***

# Delta “T” and “P” = temperature and pressure




Re: Heat Exchange/Pressure

The further your travel between point “A”, and point “B”, the more energy you use!

Geothermal in…

…Winter – Extracts heat from the earth

…Summer – Dispels heat to the earth…

…using a refrigerant circuit

# How to achieve ISO - 13256 system operational efficiency on your geothermal install

- ✓ Minimize draw of secondary or *"parasitic"* energy using elements (well pumps or loop pumps, circulators, blowers, etc.)
- ✓ Minimizes deltas of TEMPERATURE and PRESSURE
- ✓ Low duct static, Proper pipe sizing (minimize pressure drop), Low "turbulence" (minimize flex duct runs)
- ✓ Minimize loss on the way to the zone (mastic and insulate ductwork)
- ✓ Deploy 100% geothermal heating and cooling
- ✓ Don't use duct heaters as a second – stage
- ✓ *FOLLOW ISO-13256 DESIGN POINTS!!!*

**Translation: CAREFUL DESIGN IS CRITICAL TO MAINTAINING AHRI/ISO PROVEN EFFICIENCIES**

# Respecting/applying ISO-13256 installation parameters

Δ's of temperature and pressure are not always followed in geo applications

## THE IDEAL GEO *"SYSTEM"*

1. Pumping from the earth
2. Compressor and Heat exchanger
3. Delivery to zone

**Each item MUST be designed/applied for OPTIMUM performance by *respecting delta's of temperature and pressure used in the AHRI/ISO test lab!***

# Today's Primary Message...
# DESIGN is CRITICAL

**Quality design & install *REALLY* matters!**

*What happens on the earth-side and on the distribution side re: design and install parameters are far more important than the heat pump itself to operating efficiency and system longevity!*

# Got LEED points?

**Choosing top-quality geothermal equipment can help satisfy up to half (or more) of the requirements for LEED certification…**

- Optimize Energy Efficiency – 8 points
- Additional Commissioning – 1 point
- Ozone Depletion – 1 point
- Measurement and Verification – 1 point
- IEQ (Indoor Environmental Quality) – 3 point
- Thermal Comfort – 2 points
- Innovation in Design – 4 points
- LEED accredited professional – 1 point

**Up to 19 points for new construction**
**Up to 21 points for retrofit applications!**

# Geothermal Heat Pumps Amplify Electric Renewable

**Both Generate Electric Power**

Wind Generators & Photo Voltaic

# AMPLIFY Alternative Energy w/ Geothermal Heat Pumps

## Building **HEATING**

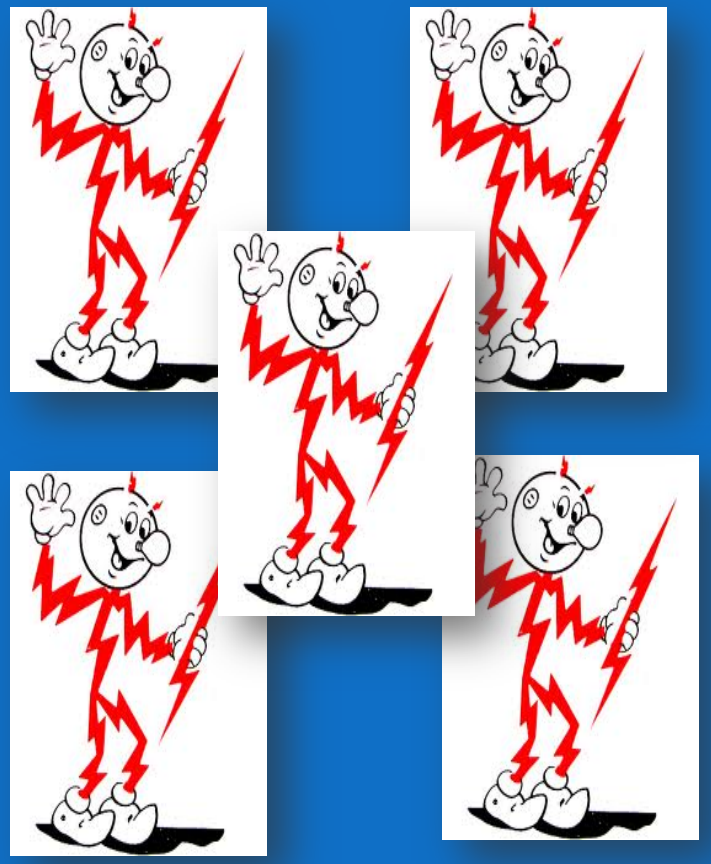
PV – Wind, etc.

1 unit of purchased Electric Energy

+

4 free units extracted FROM the Earth

=



5 Units Heat Energy TO the BUILDING

# Overview of Geothermal Heat Pump Systems

**elements include equipment and installation of…**

- ✓**EARTH COUPLING**
- ✓**HEAT PUMPS**
- ✓**DISTRIBUTION**

…each element has to be thoughtfully consider to ***minimize first cost*** and ***maximize*** *operating performance and system longevity*

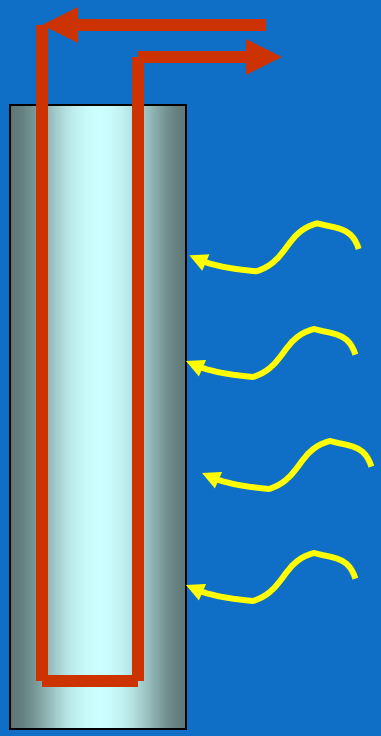

# …*recognized options for *Earth Coupling*

- Open to Diffusion
- Standing Column Well
- Closed Loop (various types)

☞*"DX" loop (This method not recognized by IGSHPA)

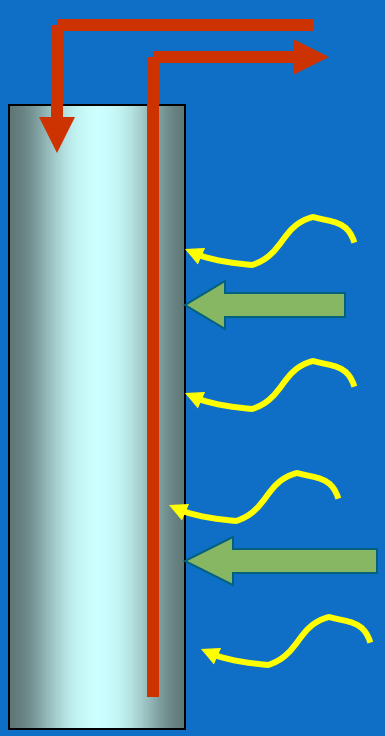
# Types of Earth Coupling

Closed Loop



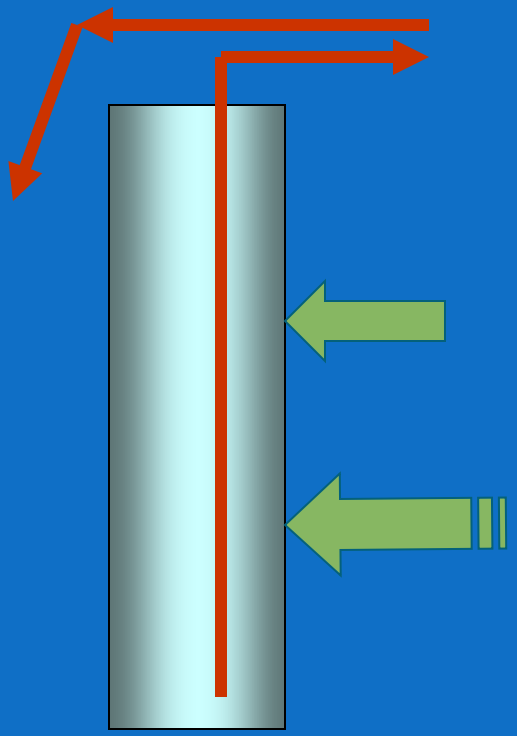
Conductive

Standing Column



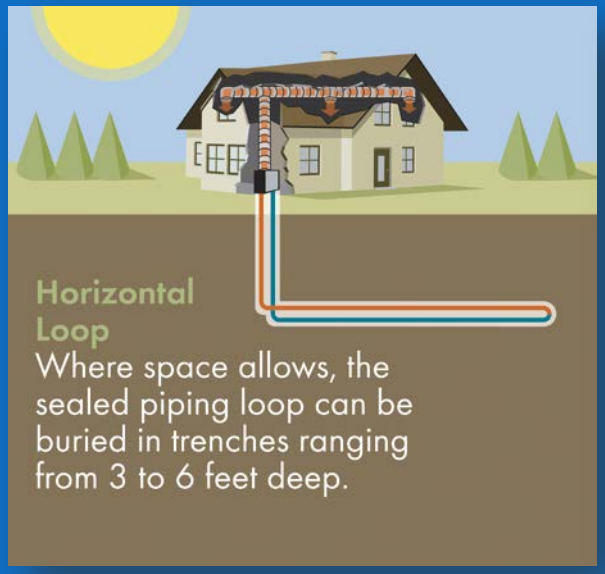
Conductive & Advective

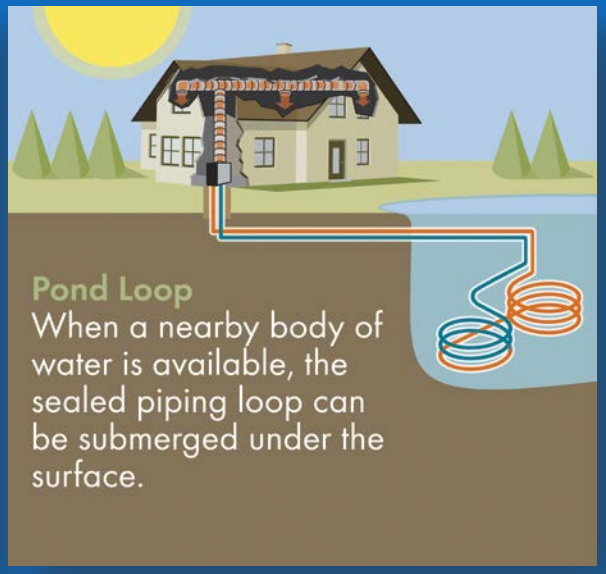
Open to Recycle

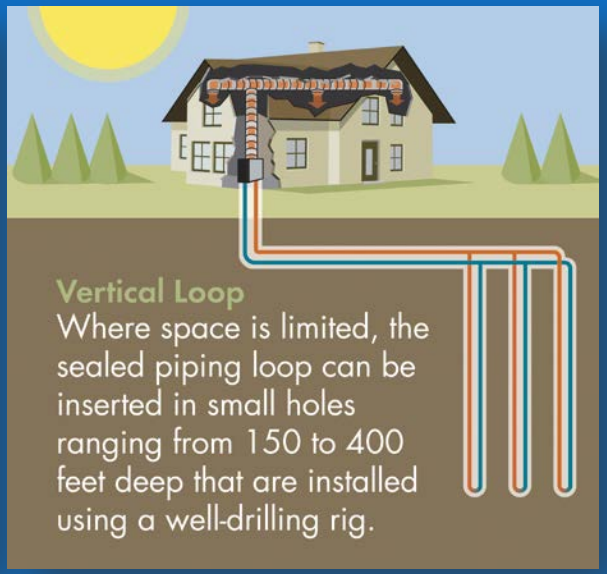


Advective

# CLOSED LOOP


Horizontal Loop
Where space allows, the sealed piping loop can be buried in trenches ranging from 3 to 6 feet deep.


Pond Loop
When a nearby body of water is available, the sealed piping loop can be submerged under the surface.


Vertical Loop
Where space is limited, the sealed piping loop can be inserted in small holes ranging from 150 to 400 feet deep that are installed using a well-drilling rig.

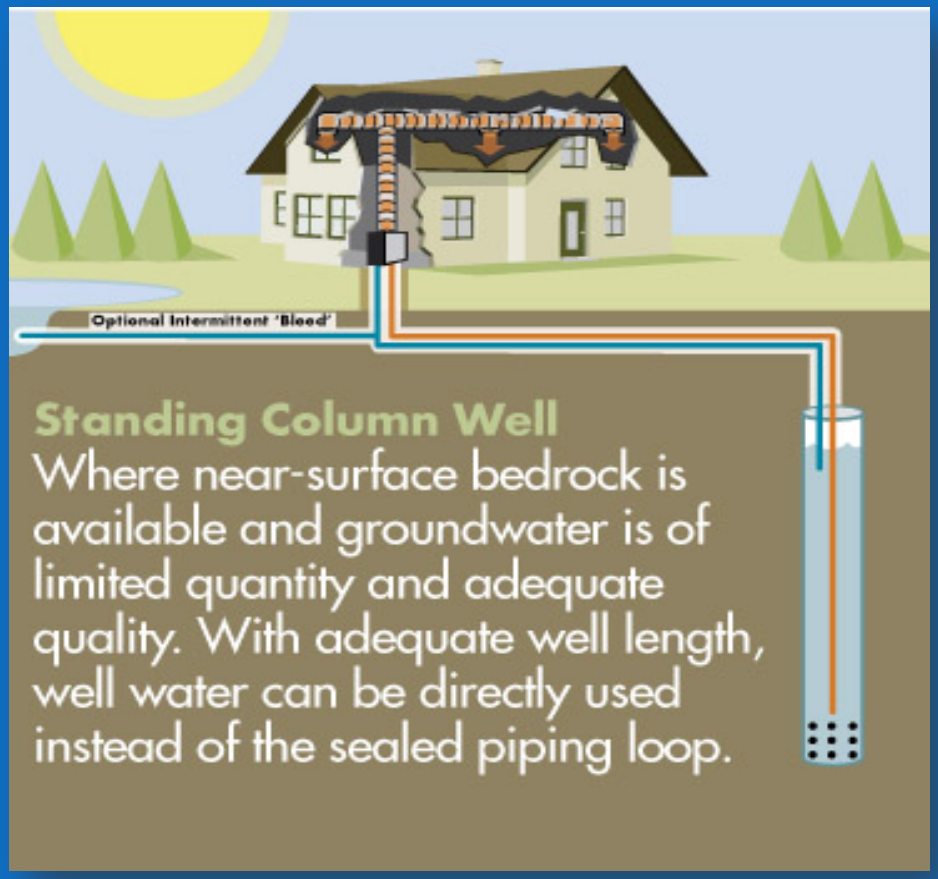
# EARTH COUPLING
# Closed Loop

- **Propylene Glycol (our choice)** — **Safe, non-toxic, effective, good heat transfer**
  - ***Increased viscosity at low temps***
- Methanol — Good heat transfer & viscosity characteristics
  - ***Poison & flammable***
- Ethanol — Good heat transfer characteristics
  - ***Denaturants can be toxic***

**Designing for success:**

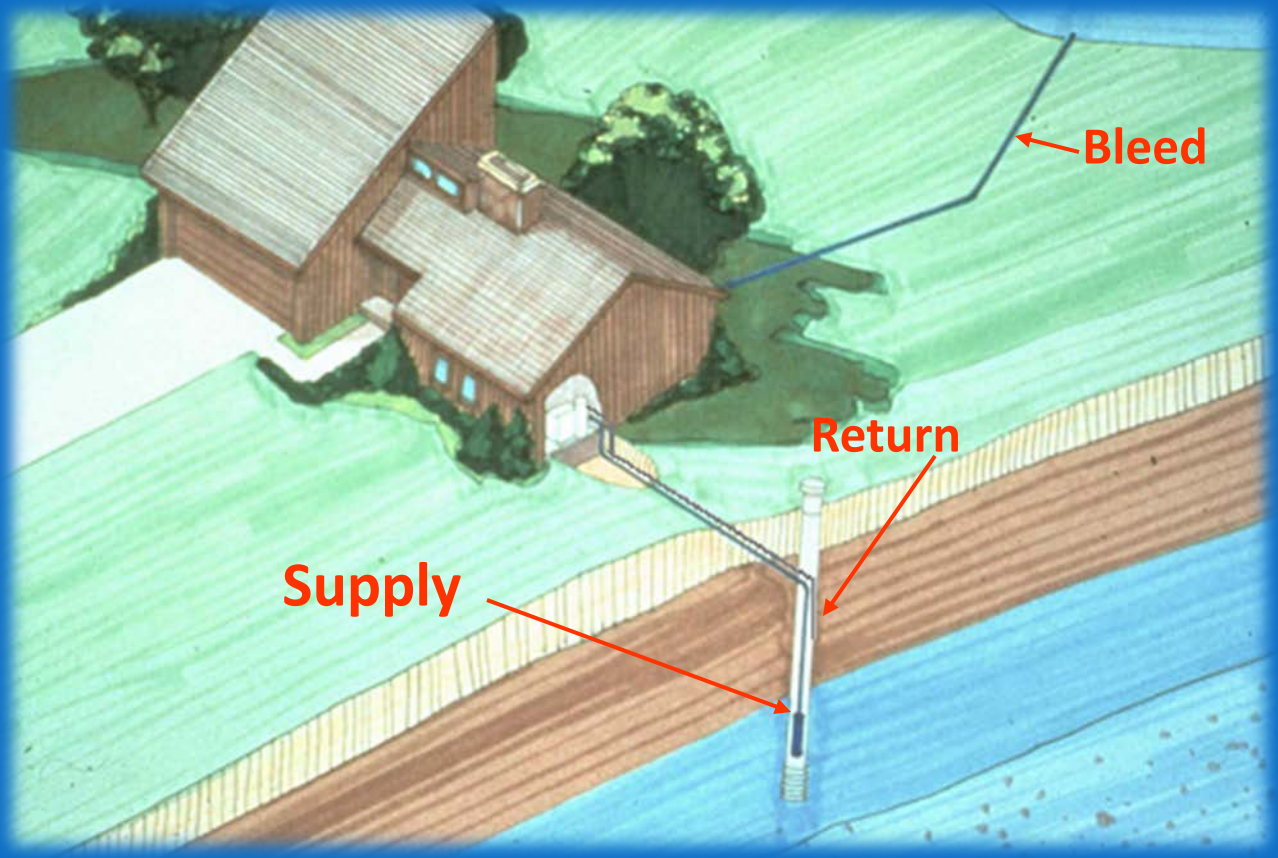
**Majority of European loops do not use antifreeze!**

# Standing Column



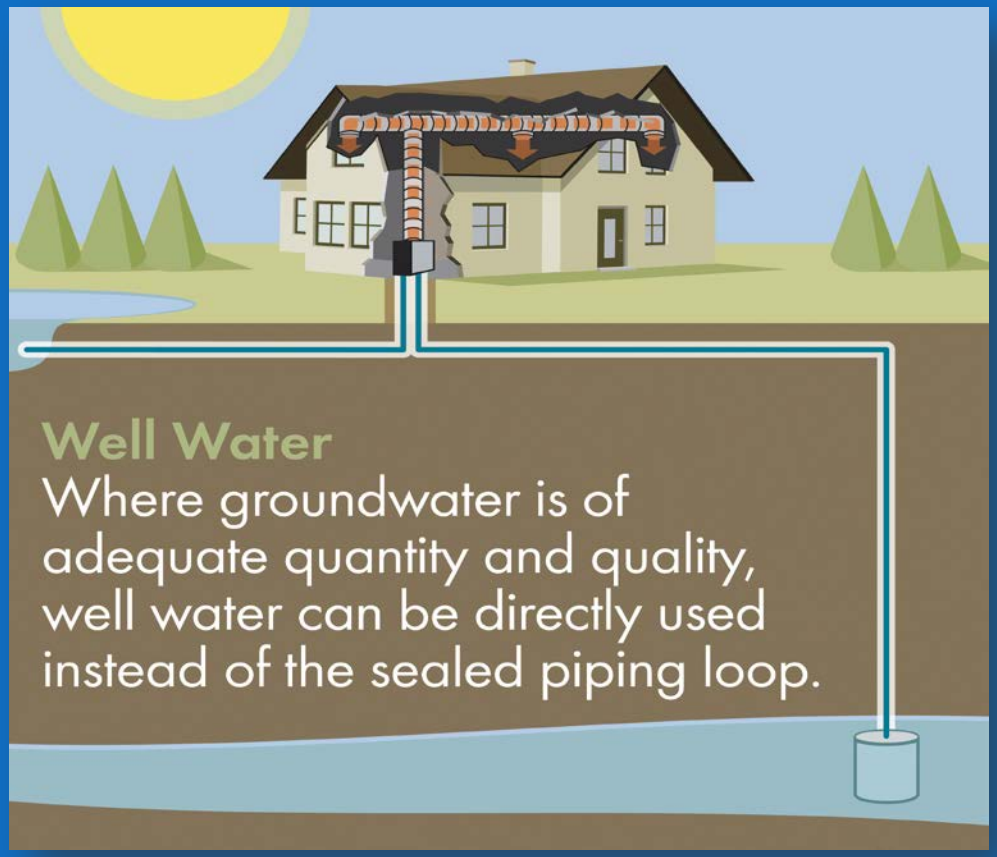
# EARTH COUPLING

## Standing Column Well




- Use Domestic Well
- 40-120 ft/ton
- 5%-30%Bleed on Command

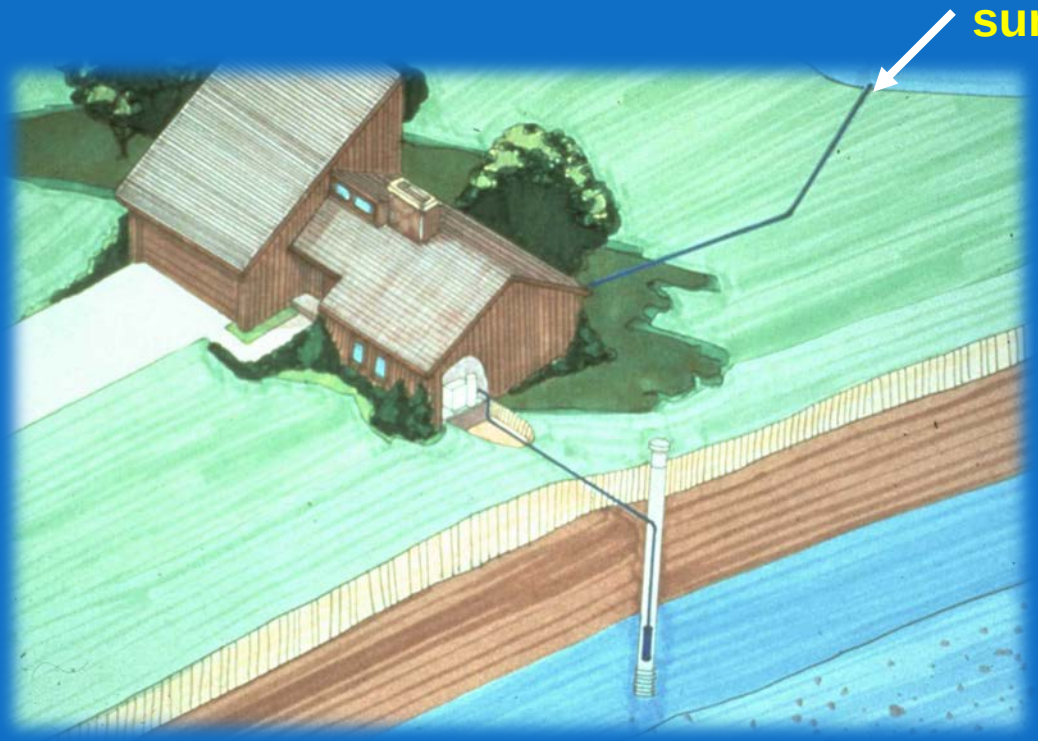
# Open to Diffusion



# EARTH COUPLING

## Open - Recycle

### *Best Efficiency & Best Performance*




- **Lots of wateer**
- **Responsible return to earth**

# DX or Direct Exchange groundsource systems

Refrigerant pipe buried directly underground with “direct” connection to the compressor inside the building

# Outside Earth Coupling Costs & Needs

✓**OPEN to RECYCLE**
**$ 1,200 - $ 1,700 per ton**

**-A lot of water and a responsible/permitted place to return it**

✓**STANDING COLUMN**
**$ 1,800 - $ 2,500 per ton**

**-Bedrock, clean water and high well static**

✓**CLOSED LOOPS**
**$ 3,800 - $ 4,400 per ton**

**-Add 20% more heat pump tonnage, (to deliver same efficiency as open and # of btuh in heating), and ample site space**

✓**DX LOOP**
**$ 4,200 - $ 4,800 per ton**

**-Non-acidic soil**
**-A lot of brazing, a lot of refrigerant**

# THERMAL EFFICIENCY

***Properly designed*** **Earth couplin**

- **CLOSED LOOPS - *Good***
  **32 ° F Winter**
  **COP’**

- **STANDIN** ***Better efficiency***
  **65 ° F Summer**
  **COP’s up to 5.1**

**If it is designed to AHRI specifications!!!**

- **OPEN to RECYCLE - *Best efficiency***
  **50 ° F Winter** **59 ° F Summer**
  **COP’s up to 5.1**

***per ARI/ISO** Standard - 13256*

# GEOLOGY

New England is a Geological

"Mixed Bag"

Variations in Bedrock, Alluvial Till, Terminal Moraine & Shales

# Earth Coupling Installation Factors for GEOTHERMAL HEAT PUMPS

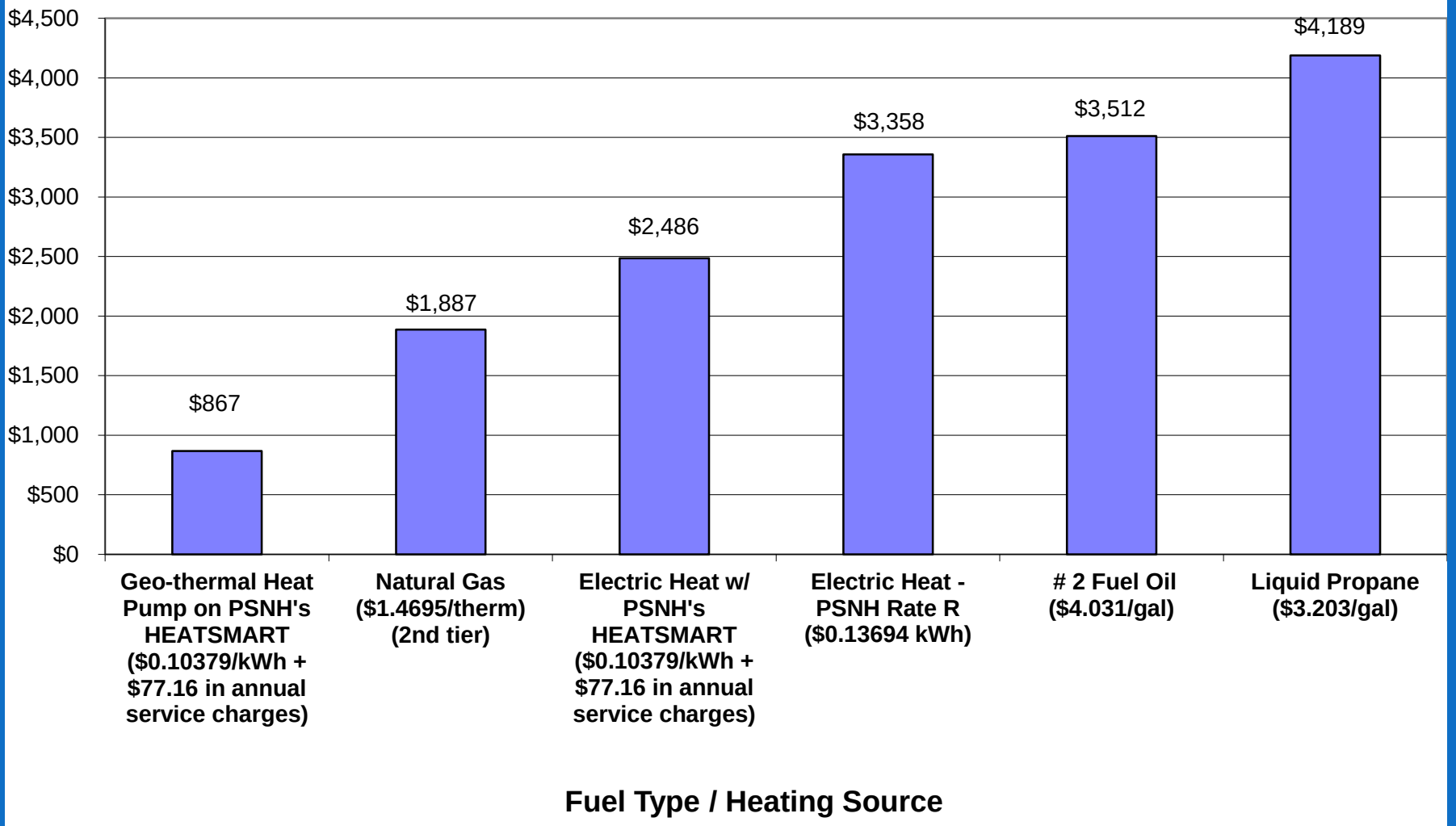
**EACH METHOD MUST BE EVALUATED FOR THE APPLICATION & LOCATION**

| | Open/Recycle | Standing Column | Closed |
|---|---|---|---|
| Efficiency | 1 | 2 | 2 |
| First Cost | 1 | 2 | 3 |
| Geology | 3 | 2 | 2 |
| Maintenance | 2 | 2 | 2 |
| Regulatory | 3 | 3 | 2 |
| Thermal | 1 | 1 | 2 |

1 = highest/best

# Comparison of Heating Systems / Fuels

Estimated Annual Heating Costs for a Typical 2,000 sq. ft. NH Home
(using PSNH's current rates and fossil fuel prices as of April 28, 2008 at www.nh.gov/oep)



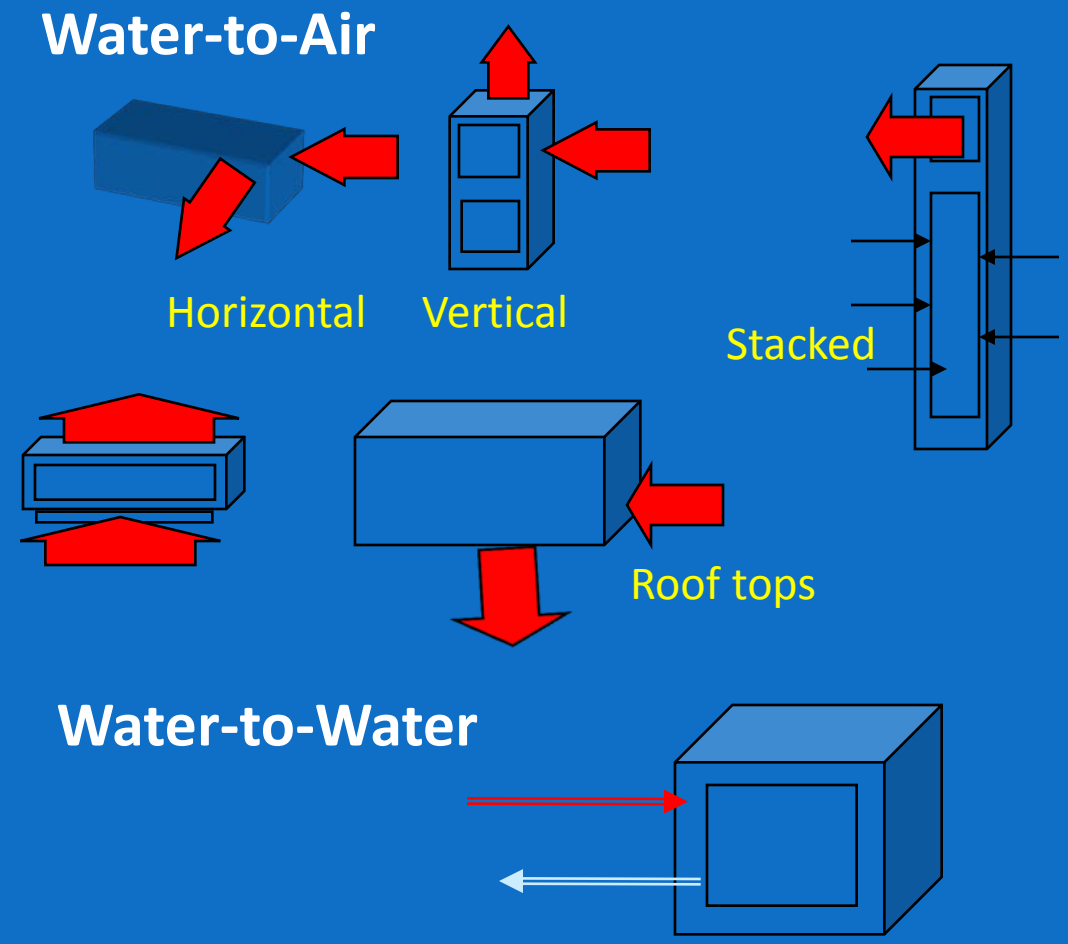
# Performance Comparison for Vermont

| Type of Energy | BTU/unit | Adj Effic | $/unit | $/MMBtu |
|---|---|---|---|---|
| Geothermal, kwh | 3,413 | 450% | $0.15 | $9.66 |
| Cold Climate Heat Pumps, kwh | 3,412 | 300% | $0.15 | $14.49 |
| Wood, cord (green) | 22,000,000 | 60% | $193.33 | $14.65 |
| Natural Gas, therm | 100,000 | 80% | $1.46 | $18.28 |
| Pellets, ton | 16,400,000 | 80% | $247.00 | $18.83 |
| Fuel Oil, gallon | 138,200 | 80% | $3.86 | $34.88 |
| Kerosene, gallon | 136,600 | 80% | $4.30 | $39.35 |
| Electricity, kwh | 3,412 | 100% | $0.15 | $43.46 |
| Propane, gallon | 91,600 | 80% | $3.39 | $46.21 |

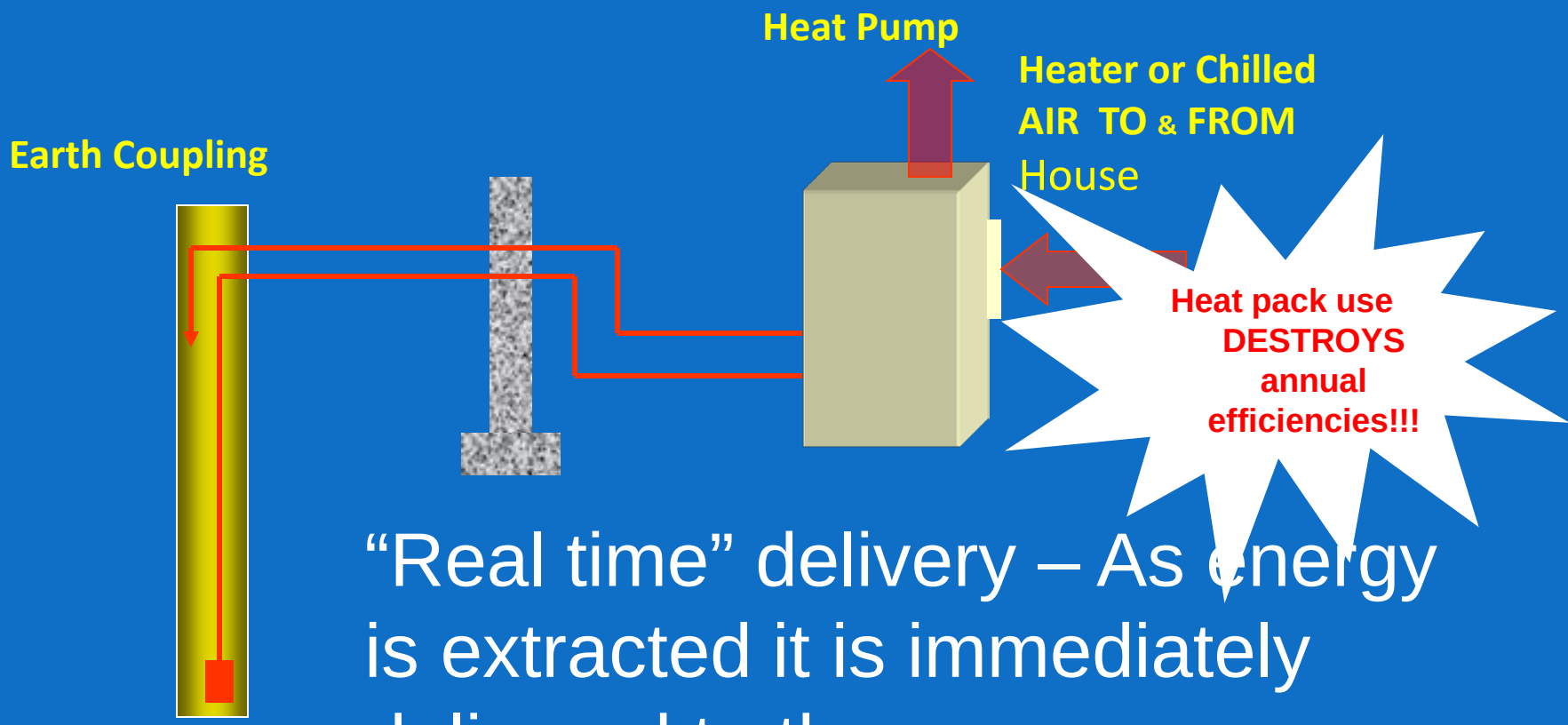
# GEOTHERMAL HEAT PUMPS
# Typical "Mechanism" Options

**Geothermal is MODULAR**

- ✓Multiple Water-to-Air
- ✓Mixture of Water-to-Air & Water-to-Water (for Radiant Floors & Retrofits)
- ✓Water-to-Air & Consoles
- ✓Central Water-to-Water



# **Water-to-Air**
# Geothermal Heat Pump




"Real time" delivery – As energy is extracted it is immediately delivered to the zone

**Average inside cost: $5,000 to $6,000/ton**

# Water-to-Air

## Geothermal HEAT PUMPS

## Air Ducted Distribution

Discreet Water-to-Air Heat Pumps

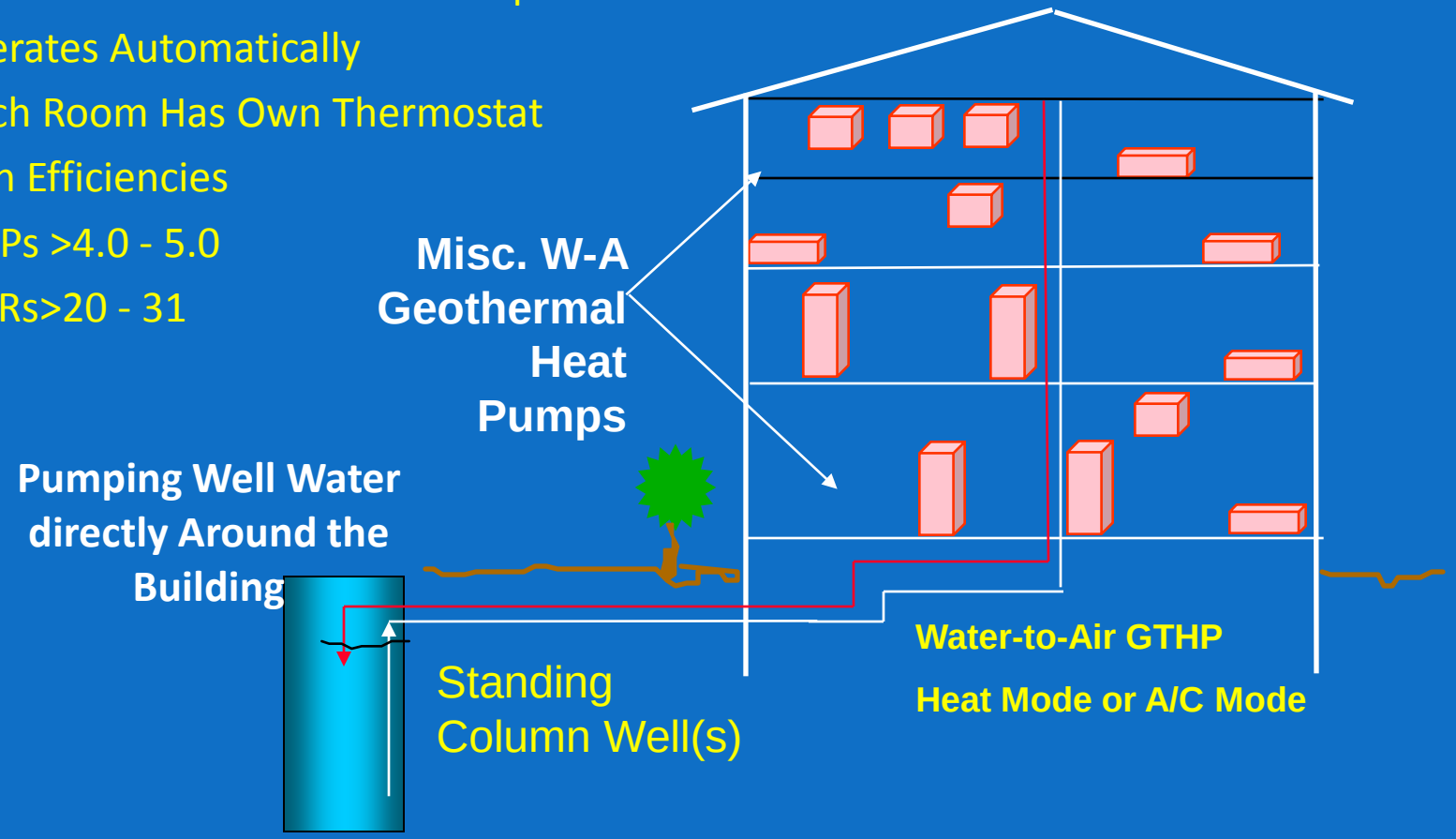
Operates Automatically

Each Room Has Own Thermostat

High Efficiencies

COPs >4.0 - 5.0

EERs>20 - 31



# Water-to-Air Installations

# GEOTHERMAL HEAT PUMP

## Water-to-Water

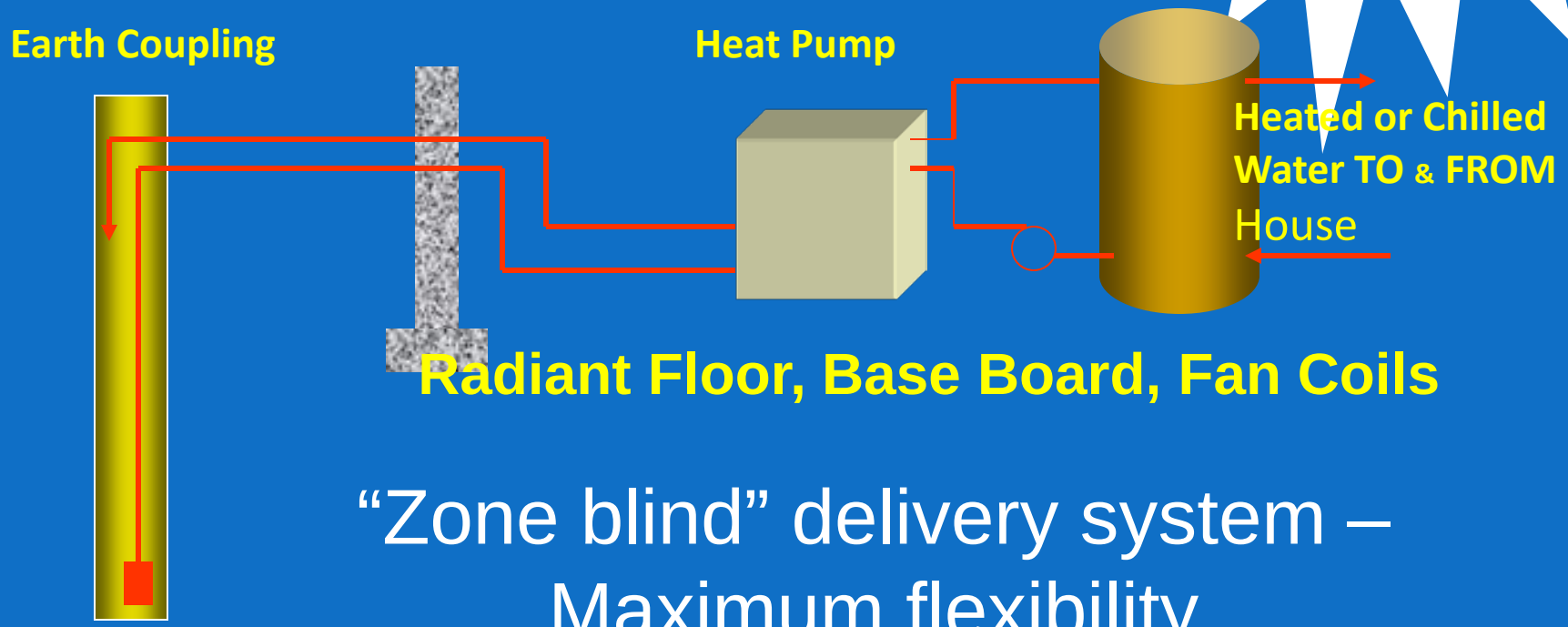
## **Boiler & Chiller in a Single "Box"**


- **Water-to-Water Geothermal Heat Pump**
- **Provides either:**
  - **HEATED WATER for Base Board, Radiant Floors, Fan Coils, Air Handler Units – or Domestic Water Heating**
  - **CHILLED WATER for Fan Coils, AHU**
- **Various sizes**

# Water-to-Water
# Geothermal Heat Pump

**Great for Retrofits & Vacation Homes**

Electric tank Heaters as "second stage" are also **EVIL!!!**




**Radiant Floor, Base Board, Fan Coils**

"Zone blind" delivery system – Maximum flexibility

**Average *inside* costs: $7,000 to $8,000/ton**

# Water-to-Water

GEOTHERMAL HEAT PUMPS

## Hot Water or Chilled Water

Water-to-Water GTHP

Operates Automatically

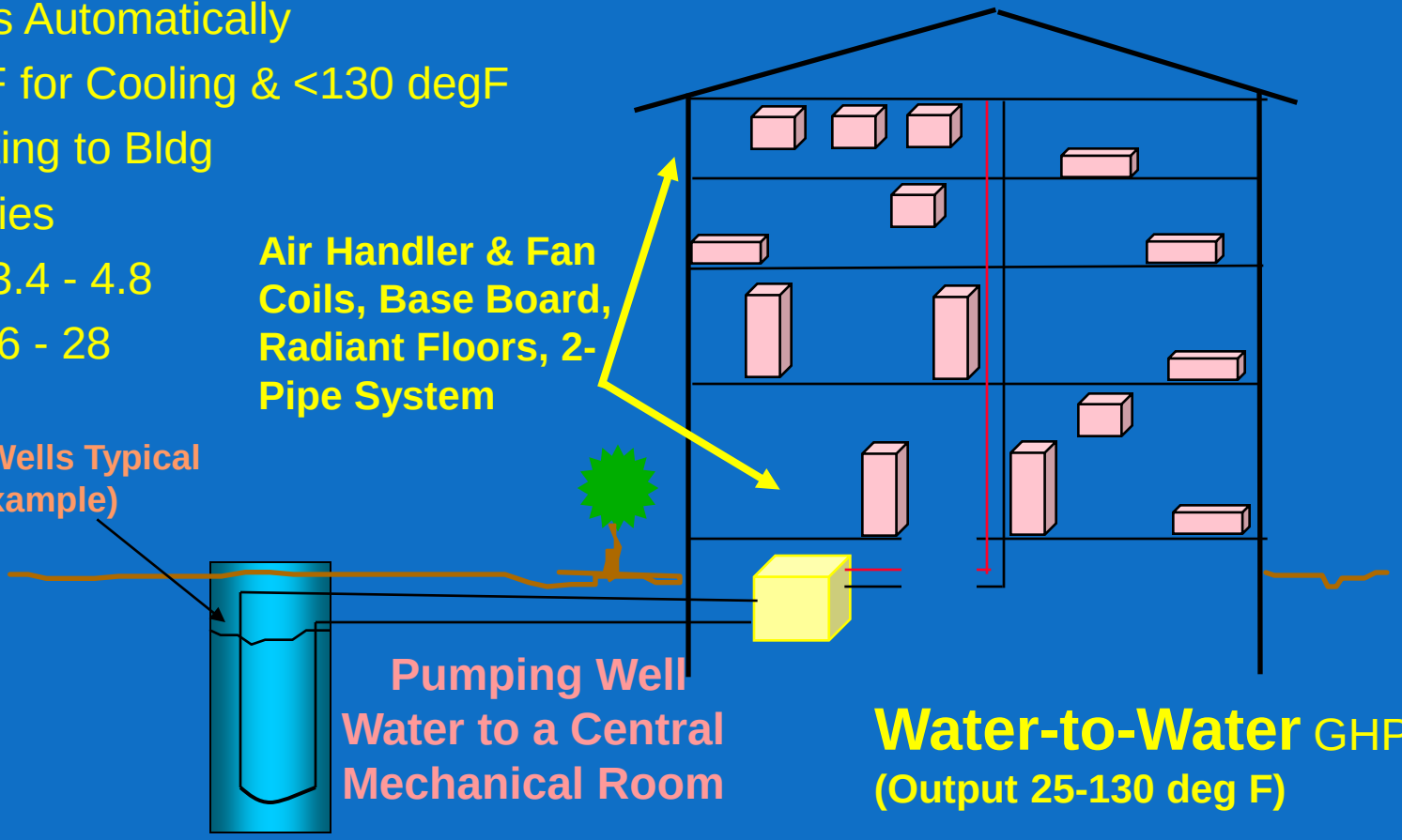
45degF for Cooling & <130 degF

for Heating to Bldg

Efficiencies

COPs 3.4 - 4.8

EER 16 - 28



# Water-to-Water Installations

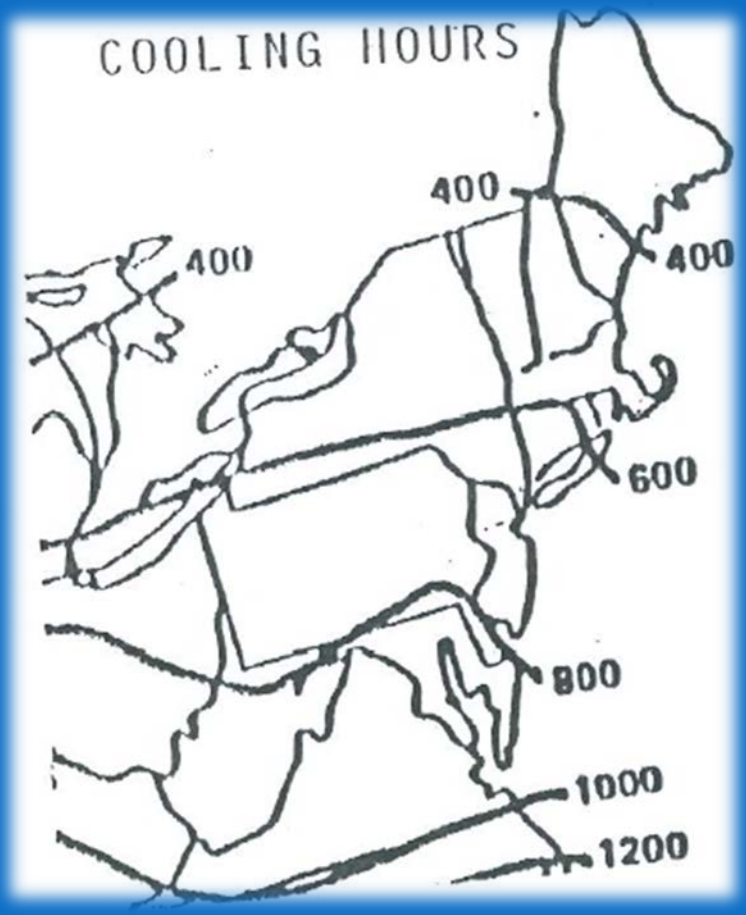
# "I heard geo isn't as efficient as the *ads* claim!"

**ARI/ISO ratings are NOT manufacturer claims. They are proven performance #s!**

- ☹ Inaccurate building load analysis (under OR oversized)
- ☹ Poor/inadequate earth installation
- ☹ Oversized earthside fluid pumping and/or undersized lines
- ☹ High duct static – Kills system efficiency and longevity A fan energy
- ☹ Poor system install that does not respect published ARI/ and pressure deltas
- ☹ Undersized system relying on ELECTRIC DUCT HEATERS to make up the shortfall in heating capacity!
- ☹ Uniformed system operation (set back often brings on electric resistance)
- ☹ Intermediate devices that reduce system efficiency (eg. Flat-plate exchangers, poorly sized circulators, etc.

Demon Seed!

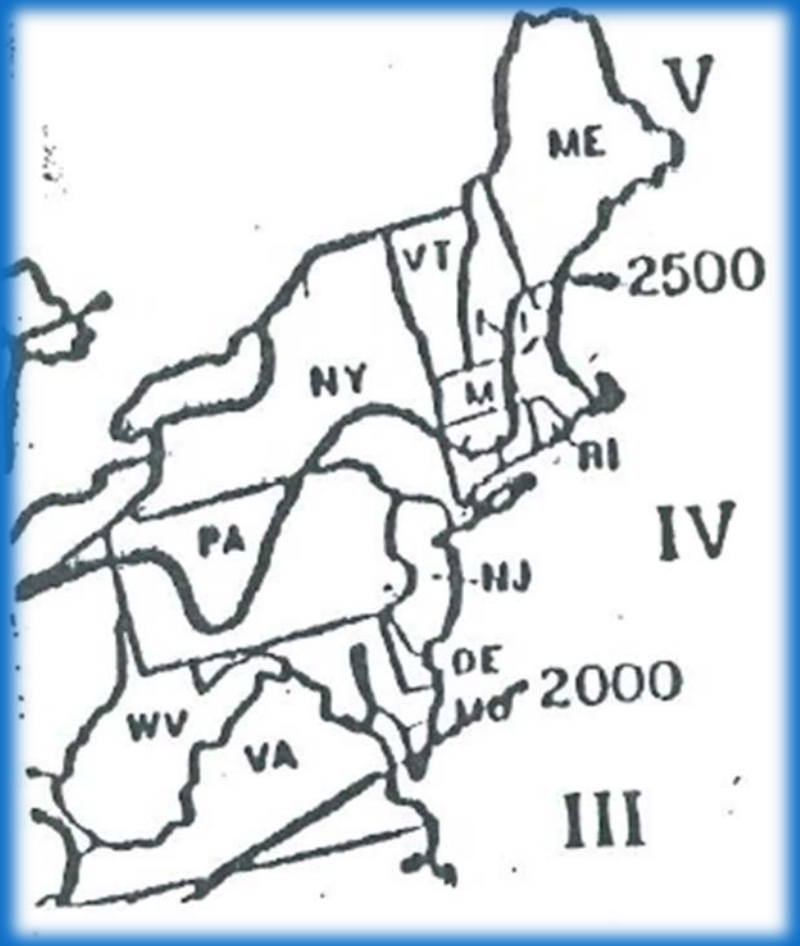
# The partial resistance heat dilemma!




**-ARI 210-**
**FULL LOAD**
**COOLING**
**HOURS**

In cooling it's a "no brainer" as both air-to-air and geo use electricity. (Compare a 16 SEER to a 51 EER)

# The partial resistance heat dilemma!




**-ARI 210-**
**FULL LOAD HEATING HOURS for New England**

***For heating it is a different matter ENTIRELY!***

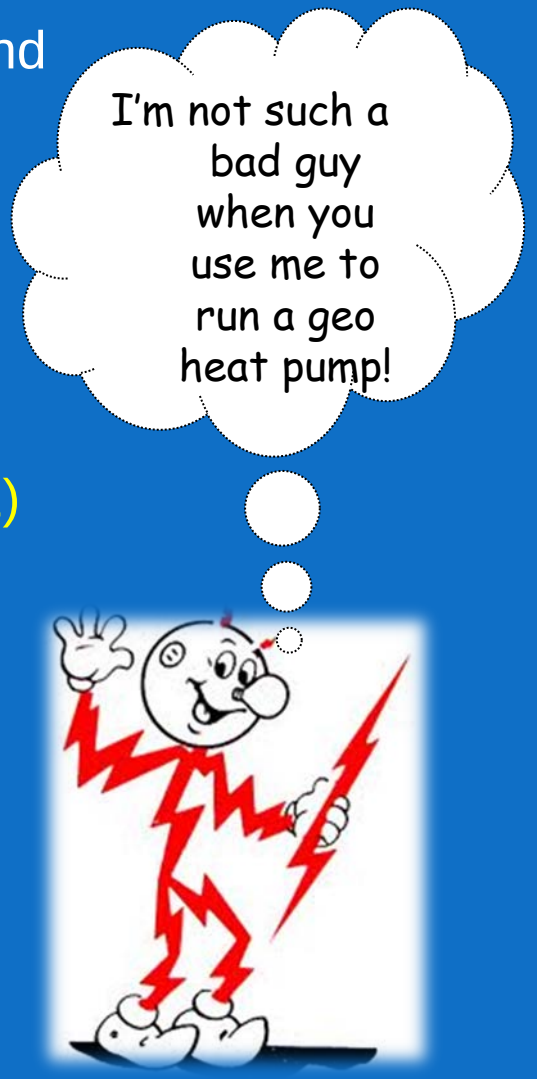
# The partial resistance heat problem…

Geothermal is proven by AHRI/ISO as ***MOST*** efficient, and electric resistance heating is the ***LEAST*** efficient …

***But both mechanisms operate using electricity! The problem with using electric resist as a back-up/second stage***

New England Heating season = 3,000 hours (ASHRAE)
Consider properly installed geo
with an operating COP of 4.0…
You installed an 80% or "average" coldest temp
(not design temp) system?

**So… 2,400 hours times 80% of the heating season**
**= 2,400 hours 4.0 COP GREAT!**



# The partial resistance heat problem…

**However this means**
**600 hours of resistance heat at a COP of only 1**


…So 600 hrs. times 4 = 2,400 additional hours at COP of 4
Yields an ANNUAL efficiency of 2.0!
AND
creates an electric power "peak" during winter design days!

***Translation*** – Running a heat pack for a week is the same as running the geothermal for a month!
***100% system = Annual of COP of 4***
***80% with resistance "back up"***
***= Annual COP of 2 or less!!!***

***THIS DOUBLES LENGTH OF SIMPLE PAYBACK***
***And cuts in 1/2 the operating efficiency annually.***

# Radiant Floors

- **Moderate Water Temperatures**
  KNOW Floor Design temps – maximum of 120° F
  (consider outdoor reset to maximize efficiency)
  Floor Surfaces < 85 °F
- **Know & Anticipate Floor Coverings**
  Unplanned Rugs can Destroy Radiant Designs
- **MOST COMMON PROBLEMS:**
  **Designer being geothermal “uninformed”**
  **Homeowner/client does not inform intended “vision” of use**
  **Floors not edge insulated**

# Air Handlers & Fan Coils


- **HEATING** - Moderate Water Temperatures
  KNOW Heated Water Design Temps – maximum of 120° F
  Reduce 180 °F capacity rating by ~55%
- **CHILLING** - 45 °F or lower w/some geo models

Know Heating & Cooling Requirements

## MOST COMMON PROBLEMS

**Designer being Geothermal “uninformed”**
**Designer Not Selecting proper hydronic Coils**
**Ductwork undersized for moderate temp of delivery**
**Installer does not install as specified**

# The MOST COMMON Installation Problem…

…un-insulated or poorly insulated ducts in unheated spaces

***NOTE:***

Refrigerant-based delivery is more dramatically affected when ductwork is undersized and/or has high turbulence

# *There is no better Return on Investment than geo!*

FORBES MAGAZINE

Investment Guide - **Underground Cash -** Emily Lambert 06.04.07

"…geothermal provides the best ROI of ANY investment…"

**Average ROI of .39¢ on the dollar.**

***TAX FREE!!!***


**...and our new Saving Account Program will earn you 0.5% per year!**

**Compare the potential of a high ROI from a geo investment to interest on your bank savings account…**

***or your investment portfolio!***

# Geothermal Heat Pump COSTS

**SAVING OPERATING COSTS**

**35%- 80%**

**MAINTENANCE SAVINGS**

**30% - 60%**

# Other Benefits…

- ✓Home/building resale – ½ Utility bill and Green!
- ✓Aesthetics – Nothing on the roof or outside!
- ✓System life – MTBF = 46 years (small)
  19 years (large) source DOE by PRC corp.
- ✓Safety – No Carbon Monoxide danger
- ✓ Up to 19 DIRECT LEED points!

# Geothermal Heat Pumps Make a Better Environment!

**Typical geo system reduces overall carbon by over 50%**

- **Dirty bird! - One Gallon of Fuel Oil= emission of 21 pounds of Carbon Dioxide to the Environment!**
- **"The CLEANER blue flame" - One Gallon of propane or CCF of Natural Gas = Emission of about 10 pounds of Carbon Dioxide to the Environment**

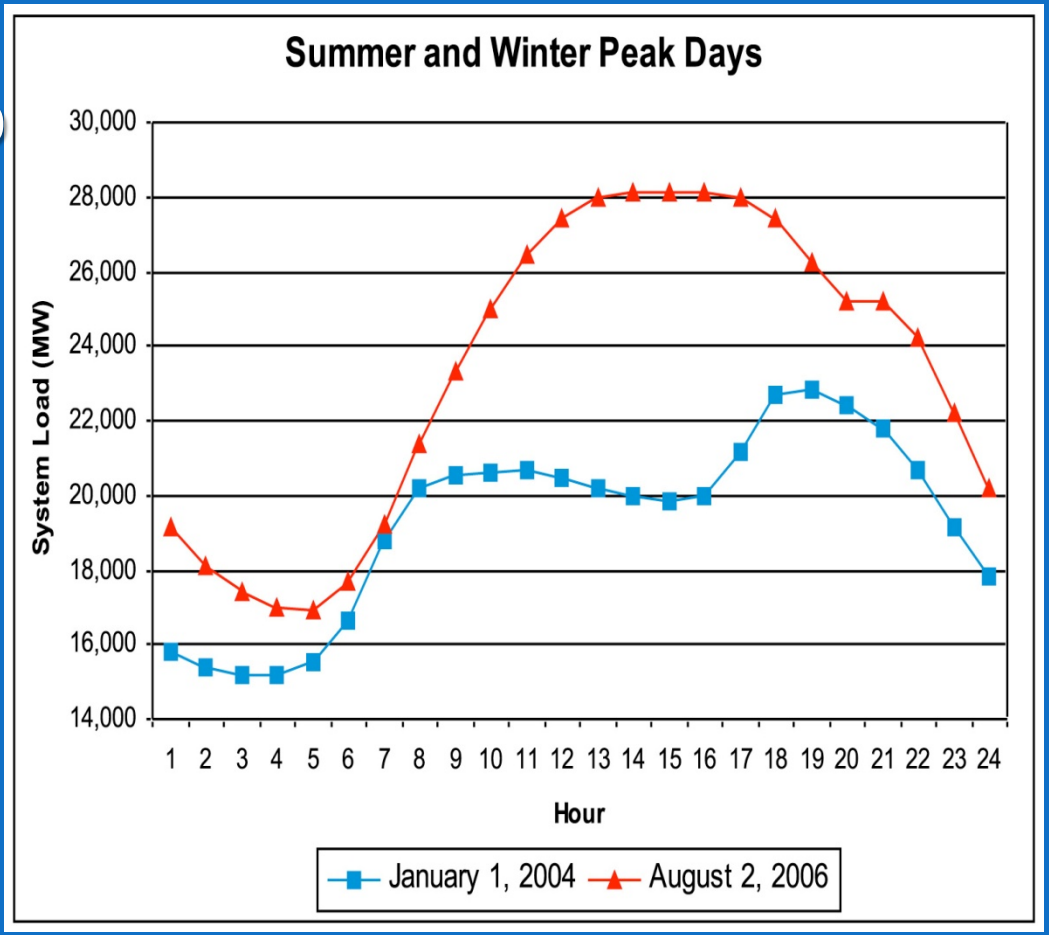
But wait, there's more!!!

**ADD 11.6 # of $CO_2$ per gallon/CCF for TRANSPORTATION of fossil fuels to the home or business!**

# Reducing Peak Demand on the Grid

Constant earth temp "source" used via geo heat exchange process means dramatic reduction in peak load management for the utilities!!!

***AND*** up to 6 Xs the btus for each kilowatt purchased!



# The Daddy of all federal tax credits!

## RESIDENTIAL

- "30% of the entire geothermal install"
- Most N.E. states have utility rebates too!

## COMMERCIAL

- "10% tax CREDIT and 5 year accel. depreciation"
- USDA Rural Development Grants
- DOER tax credits for private owners and municipal designer/project leaders

# Primary Rule for GeoExchange

## Pay Attention to the Little Things or they will BITE you Where Least Expected!

**The Importance of Bundling the Earth Side with the Building Side.**

***Keep a single point of Professional Geothermal Management***

NEGPA™
New England Geothermal Professional Association

# Thanks!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**Resources**

**www.negpa.org**
**www.northeastgeo.com**
**www.geoexchange.org**

WATER ENERGY
NORTHEASTGEO.COM

Geothermal with Confidence!

**Installed efficiency for ANY heating and cooling system – Not all installs are create equal!!!**

**www.northeastgeo.com**
Homeowner's section – Calculate your savings EXCEL worksheet

## APPLES to APPLES?

EQUIVALENT ENERGY COST
COMPARISON OF CONVENTIONAL ENERGY SOURCES w/ GEOTHERMAL HEAT PUMPS



Geothermal with Confidence

**FIRST** - in **PINK** AREA Enter your Geo Heat Pump's *OPERATING* Htg. and Cooling Efficiencies & Your Elec. Rates

Enter the Heat Pump efficiencies and electric unit costs for Summer and Winter

| | | |
|---|---|---|
| Geothermal Heat Pump with a Heating Efficiency* of | 4 | = TOTAL operating system efficiency/COP |
| Geothermal Heat Pumps with a Cooling Efficiency* of | 24 | = TOTAL operating system efficiency/EER |
| and local delivered electric utility costs of | $0.1800 | per kWh (delivered) for Heating (Winter) |
| *Use ISO-13256 Efficiencies (Includes pump correction factors) | $0.1955 | per kWh (delivered) for Cooling (Summer) |

**SECOND**- in **GREEN** AREA - Read the EQUIVALENT COST of Purchased Energy

COMPARATIVE COST TABLE USING TYPICAL TECHNICAL VALUES - HEATING and COOLING
*TYPICAL VALUES ARE AS LISTED IN ENGINEERING SECTION BELOW - MAKE CHANGES CAREFULLY*

SUMMARY - If you install a Geothermal Heat Pump, the following conventional fuels would have to cost:

| | | | |
|---|---|---|---|
| #2 FUEL OIL MUST cost or LESS than | $1.27 | per gallon | *Heating* |
| NATURAL GAS MUST cost or LESS than | $1.02 | per CCF/gal. | *Heating* |
| PROPANE MUST cost or LESS than | $0.84 | per gallon | *Heating* |
| ELECTRICITY MUST cost or LESS than | $0.045 | per kWh | *Heating* |
| Air Conditoner Electric Must cost or LESS than | $0.106 | per kWh | *Cooling using SEER rating point* |
| Air-Air Heat Pump Electric Must cost or LESS than | $0.095 | per kWh | *Heating* |
| Air-Air Heat Pump Electric Must cost or LESS than | $0.092 | per kWh | *Cooling using SEER rating point* |

**THIRD**- in **PINK** AREA - input your current annual fuel and maintenance cost(s)

| | | | |
|---|---|---|---|
| Annual $ with #2 fuel oil | | Computation for Geo vs. my Oil | $0 |
| Annual $ with Nat. Gas | | Computation for Geo on vs. Nat. Gas | $0 |
| Annual $ with Propane | | Computation for Geo on vs. Propane | $0 |
| Annual $ with electric heat/hot water | $3,000 | Computation for Geo vs. my Elec. Heat | $750 |
| Annual $ with high SEER A/C | $600 | Computation for Geo vs. my Elec. Cooling | $325 |
| Annual system maintenance cost | $300 | Annual Geo maintenance | $150 |
| *TOTAL current annual heating/cooling/AC costs* | $3,900 | *Total estimated annual Geo cost* | $1,075 |
| *Estimated annual savings by going geo* | $2,825 | *Estimated Simple Annual ROI* | 72.4% |
| *Total installed cost of geo including tax credits and rebates* | $20,000 | *# of years for simple payback with estimated current energy prices* | 7.1 |

***Engineering Section - Items below based on typical HVAC performance factors***

The below information provides the assumptions and efficiencies used in the computation of the above equivalent fossil and electric HEATING and COOLING COSTS. Also listed for comparison are normalized

**Installed efficiency**

**Your electric rate**

**What you would pay?**

**Installed fossil efficiency math from** eia