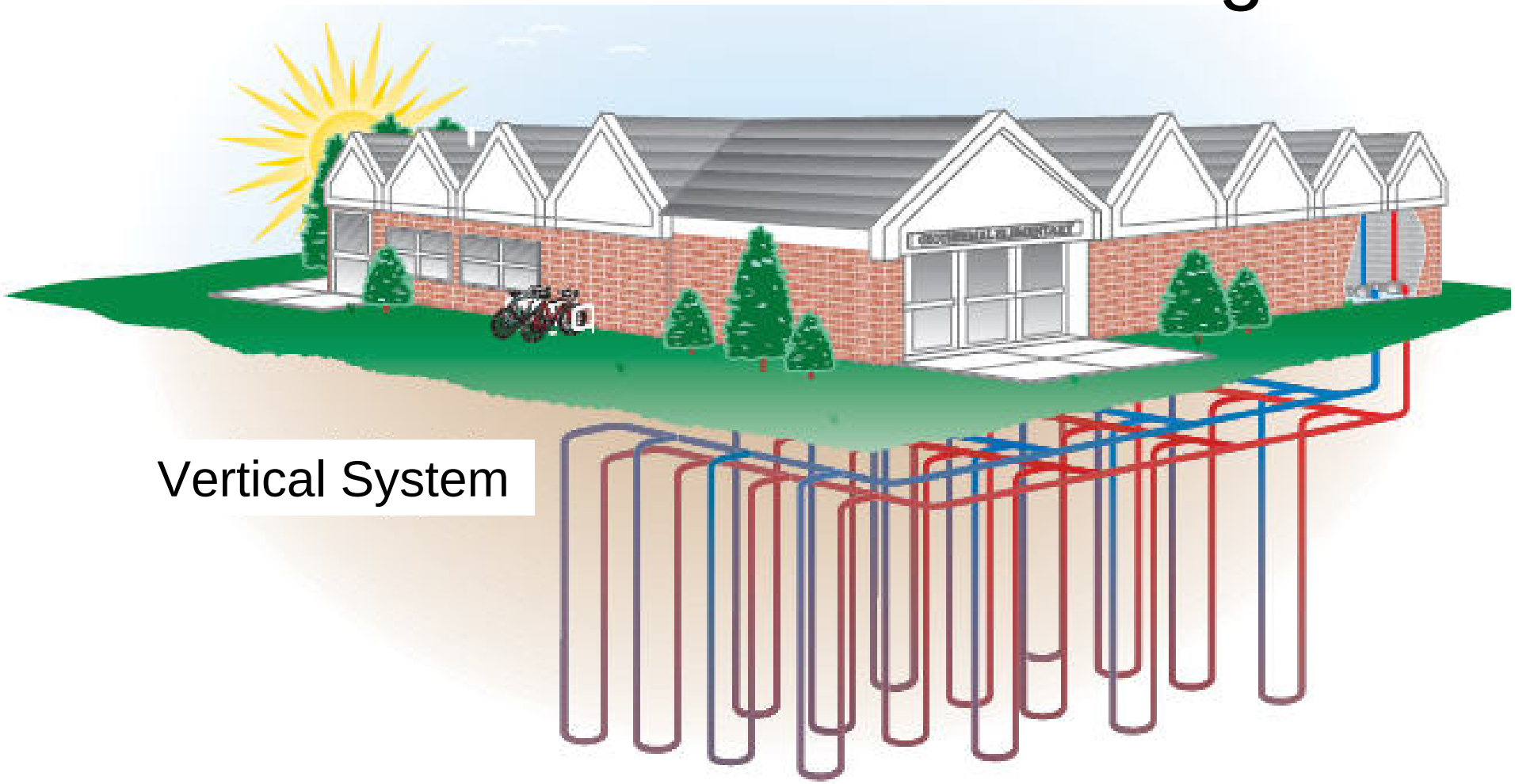
How a Ground Source Heat Pump Works for a School or College



Vertical System

IGSHPA

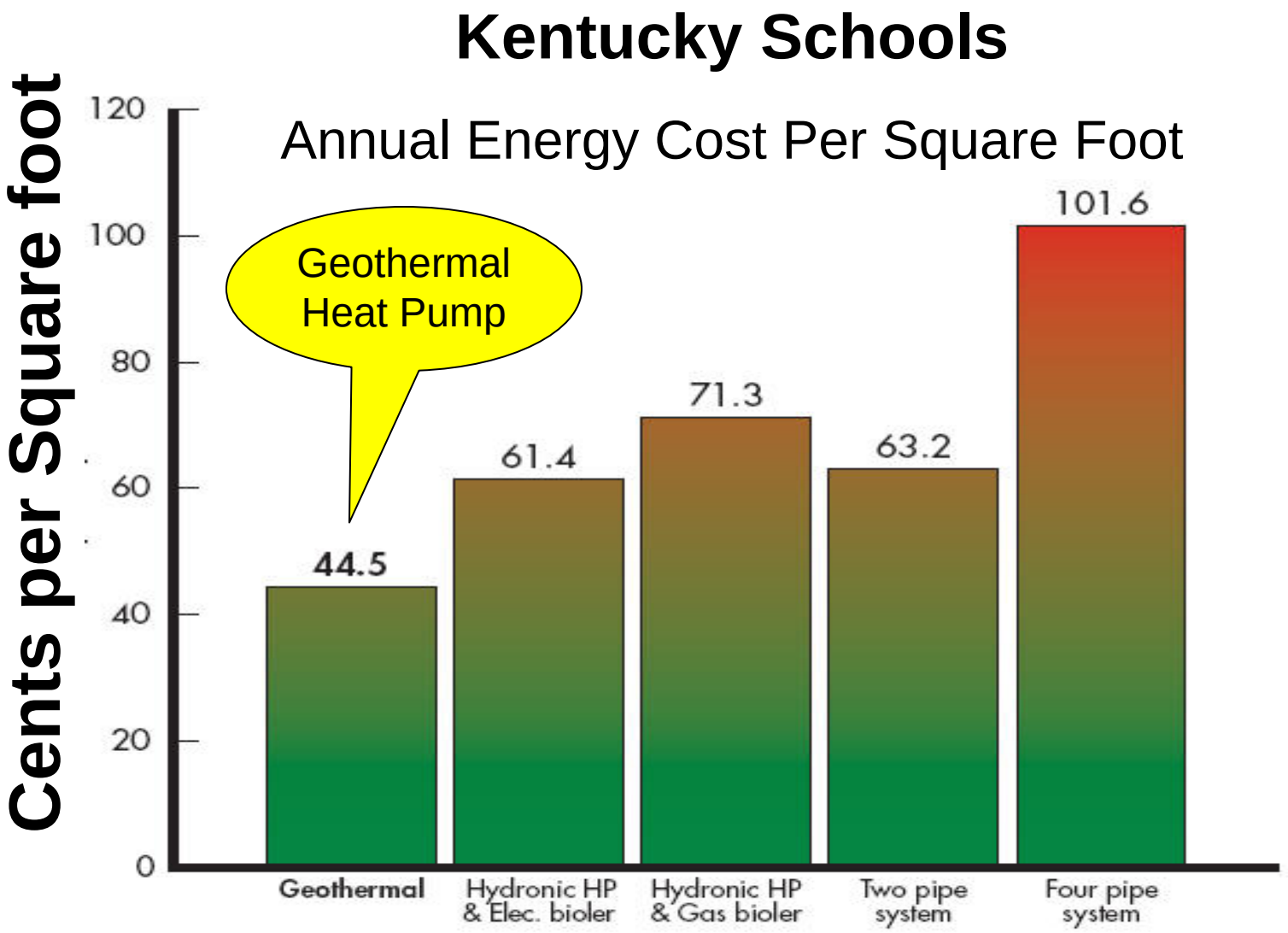
Image courtesy of Climate Master

Geothermal avoids the need for outdoor equipment…

..reducing vandalism and liability

Image courtesy of Climate Master

Benefits-Cost Comparisons



Source: Kaiser-Taulbee Associates, Inc "School Life Cycle Cost Studies & Case Histories, " report Kentucky Utilities, 1995, page 28

Benefits-Geothermal Heating and Cooling

- Operating unit inside and heat exchanger loop is underground…protects students.
- Low operating and maintenance cost 25% to 50% less than conventional system High energy efficiency all year long
- GSHP are among the quietest ever designed
- Geothermal has no flame, no flue, no odors, and no danger of fire or fumes and a long life.
- Less space for equipment – more space for classrooms

Benefits-Geothermal Heating and Cooling

- Heat one classroom and cool the other at the same time.
- No rooftop or ground mounted equipment to be damaged by the hail, roof leaks and vandalism.
- Cleaner site and building line, as minimal equipment surrounding or on building
- Increased humidity and Indoor Air Quality Control…Natural dehumidification
- "Ground-source heat pumps have the lowest life-cycle costs in several cost studies that I've done of heating and air-conditioning systems."

John Shonder of the Energy Department's Oak Ridge National Laboratory in Tennessee "With Energy in Focus, Heat Pumps Win Fans" LIZ GALST Published: August 13, 2008

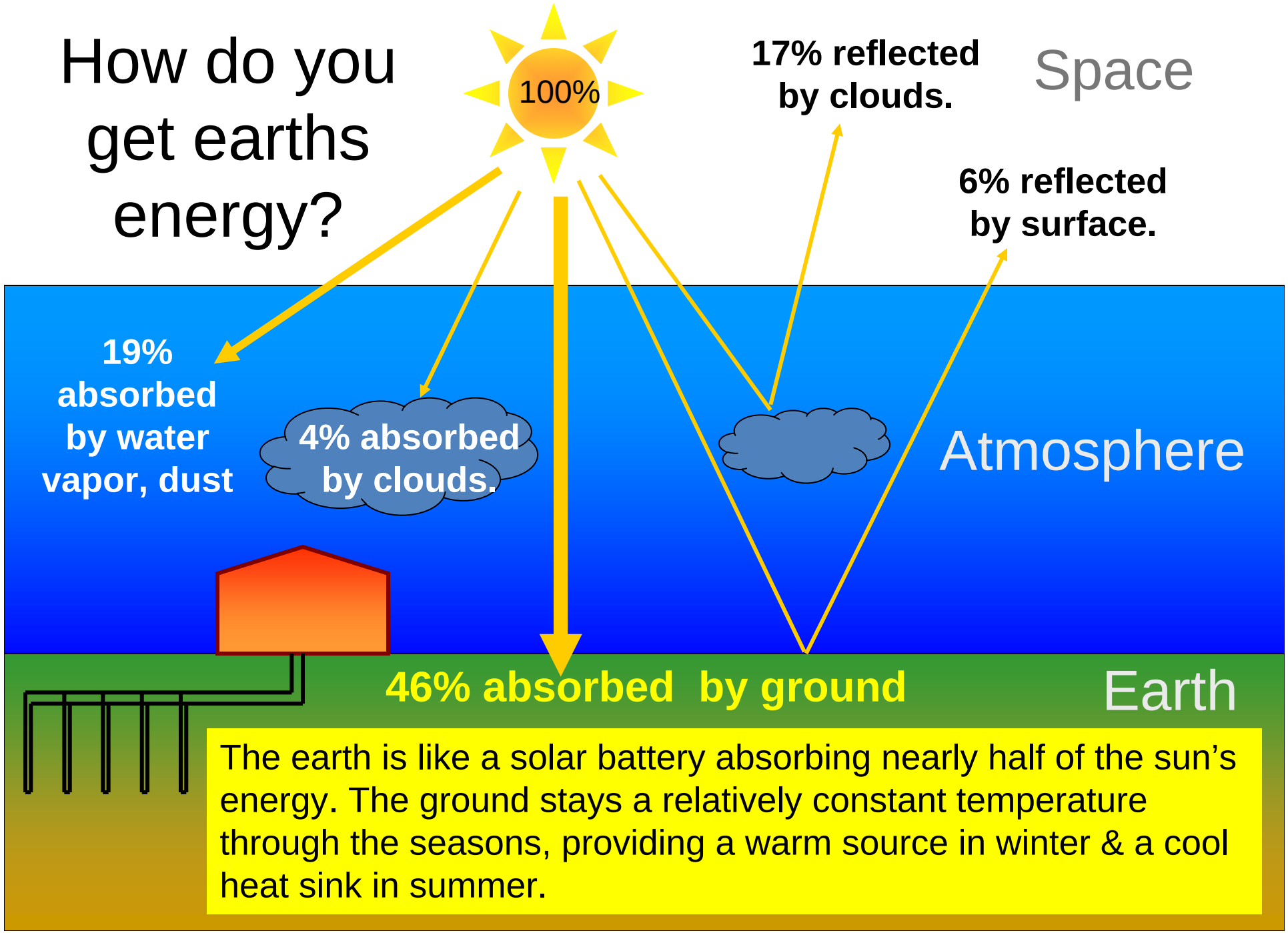
Benefits-Geothermal Heating and Cooling

- You can get heating, central air conditioning, and domestic hot water, three important benefits from a single compact unit.
- Dependable, Reliable, Long Service Life
- Ground Loop Tubing warranties of 50+ years
- Virtually Free Domestic Hot Water
- Boilerless/Towerless operation
- Significantly reduce full time maintenance staff and eliminate boiler maintenance
- Longer equipment life. Units are not running at temperature extremes.

Benefits-Geothermal Heating and Cooling

- Eliminate chemical and other costs associated with the prevention of scaling and bacterial growth.
- Eliminate year-round tower operation that requires a lot of expense especially during the colder weather months.
- Low source energy use and low air pollutant emissions- green technology.
- School GSHPS can be an open classroom for students to observe energy use.

How do you get earths energy?

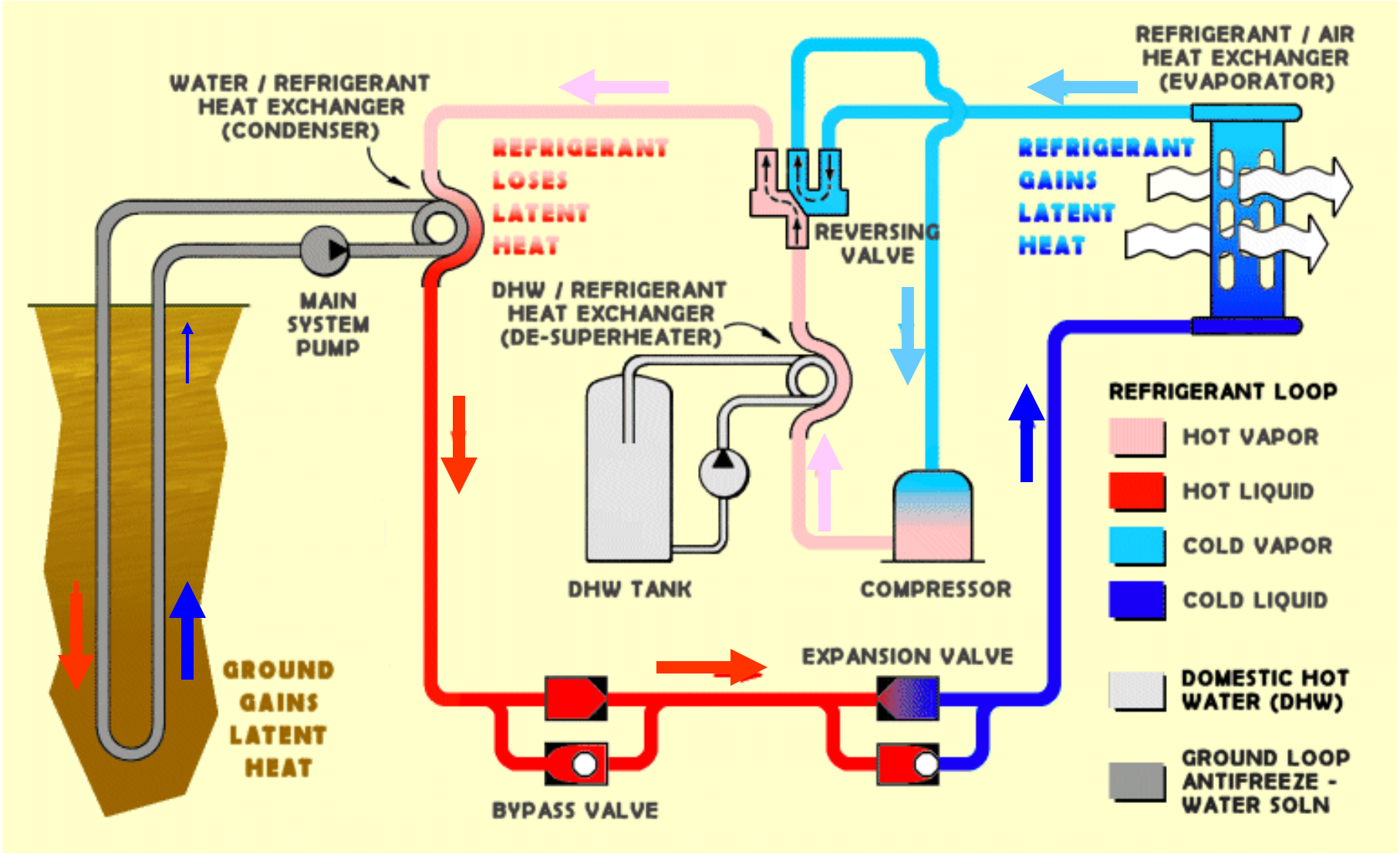


The earth is like a solar battery absorbing nearly half of the sun's energy. The ground stays a relatively constant temperature through the seasons, providing a warm source in winter & a cool heat sink in summer.

How do you get earths energy?

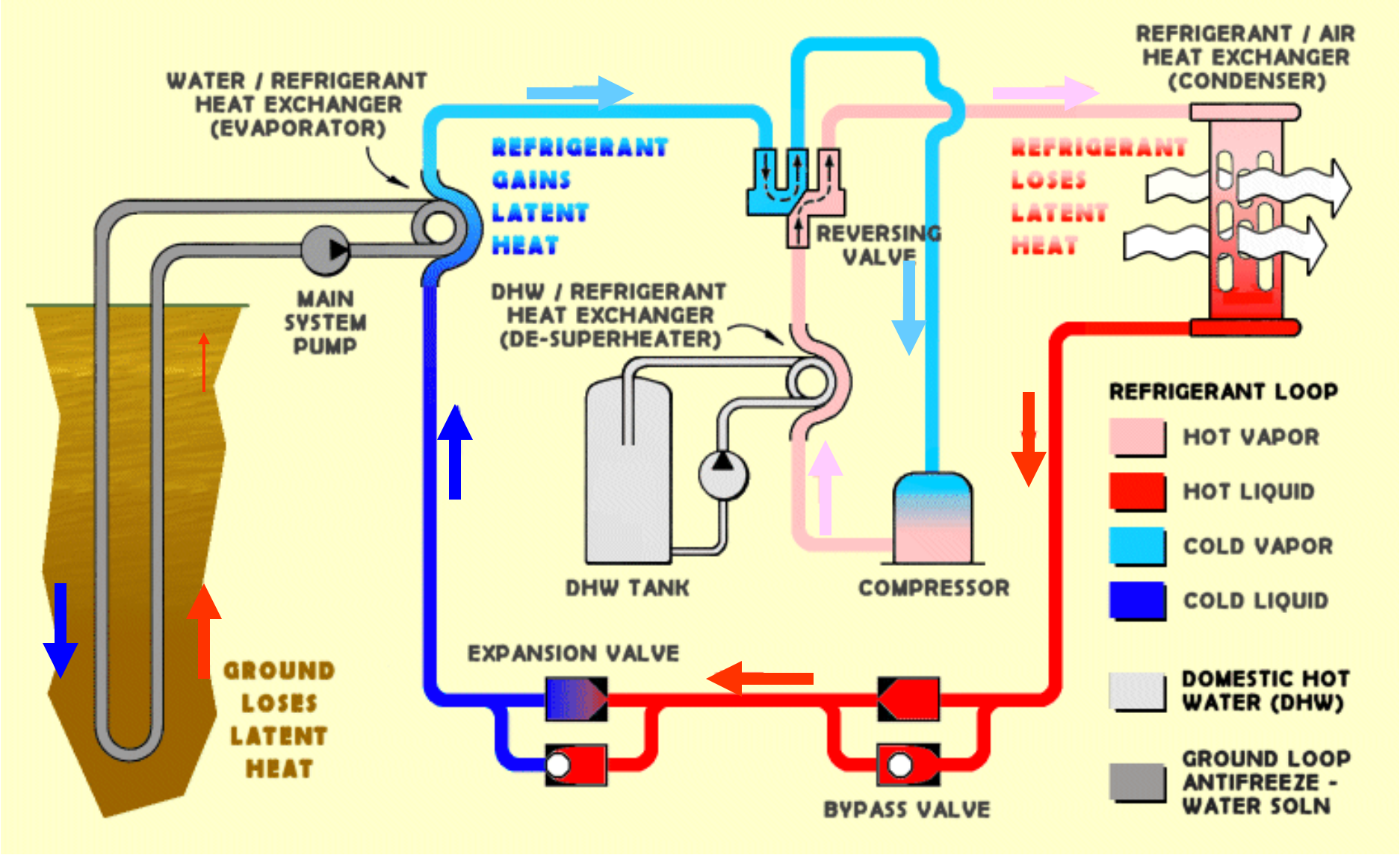
- Earth absorbs almost 50% of all solar energy and remains a nearly constant temperature of 50°F to 70°F depending on geographic location.
- Heating-In winter, water circulating inside a sealed loop absorbs heat from the earth. Here it is compressed to a higher temperature and sent as warm air to your indoor system for distribution throughout your school.
- Cooling-In the summer, the system reverses and expels heat from your school to the cooler earth via the loop system. This heat exchange process is not only natural, but is a truly ingenious and highly efficient way to create a comfortable climate in your school.

How the earth works to save you energy! Cooling



Geo4VA - This is a Special Energy Project funded by the U.S. Department of Energy's State Energy Program through the Virginia Department of Mines, Minerals, and Energy.

How the earth works to save you energy! Heating



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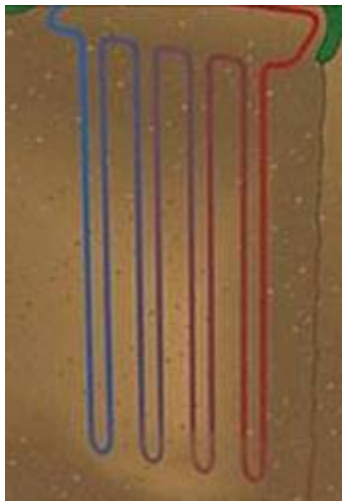
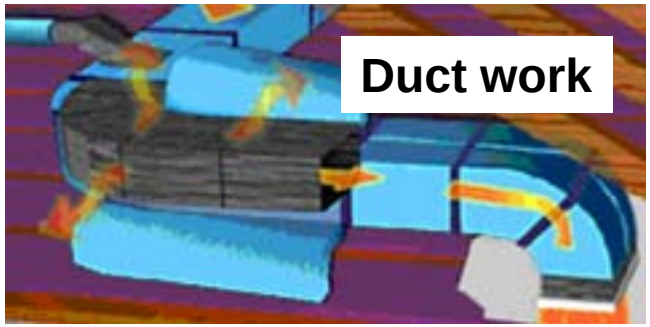
Parts of a Ground Source Heat Pump System



Ground Loop

Heat Pump

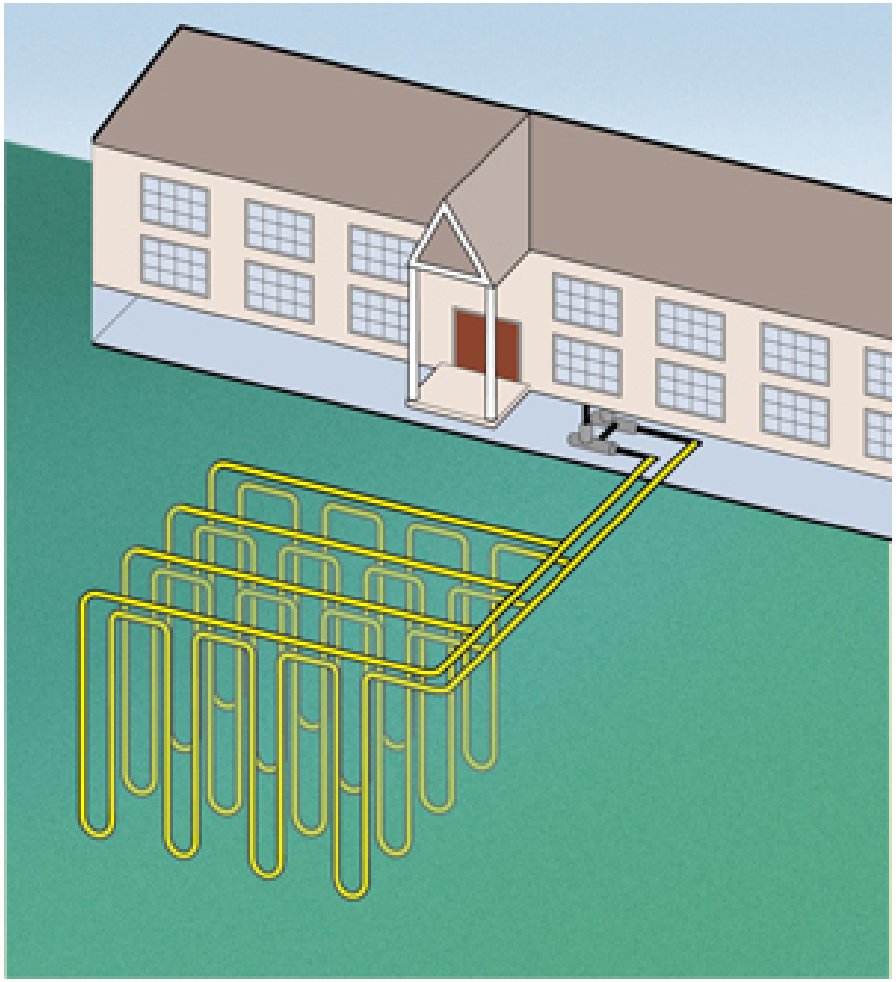


- Ground Loop (geoexchange)
  - Closed loop (most used)
  - Open loop
- Heat Pump
  - Water to Air HP
  - Water to Water HP (floor heating)
- Distribution System
  - Duct work
  - And/or Hydronic-water in piping in floor.

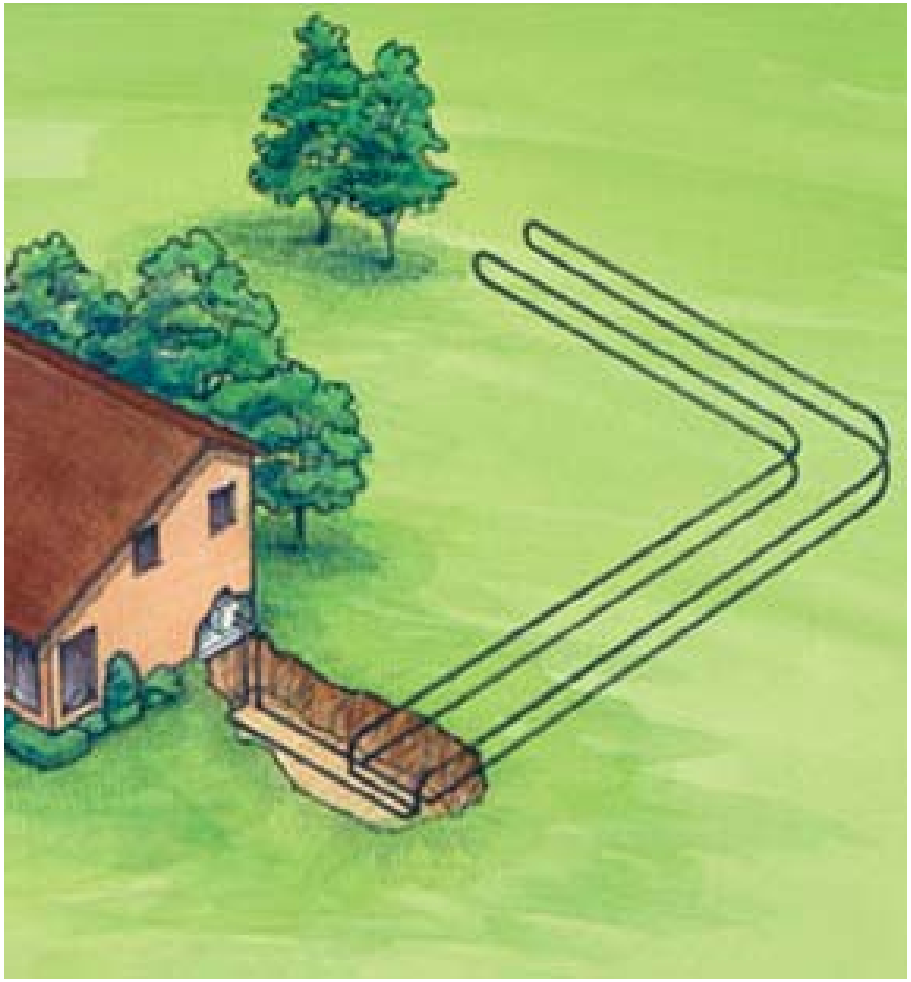
Installations of GSHP

- 5” Bore Holes usually 200 to 400 feet deep
- Space 15-20 feet apart
- Plastic pipe with U-Bend inserted in bore hole
- Grout filled around plastic pipe
- All pipe in bore holes connected to Header pipe
- Maximum header 4” would serve approximately 70 tons
- Header pipes connected to ground source heat pumps in building

Ground Closed Loop System



Vertical Bore holes



Horizontal Trenching

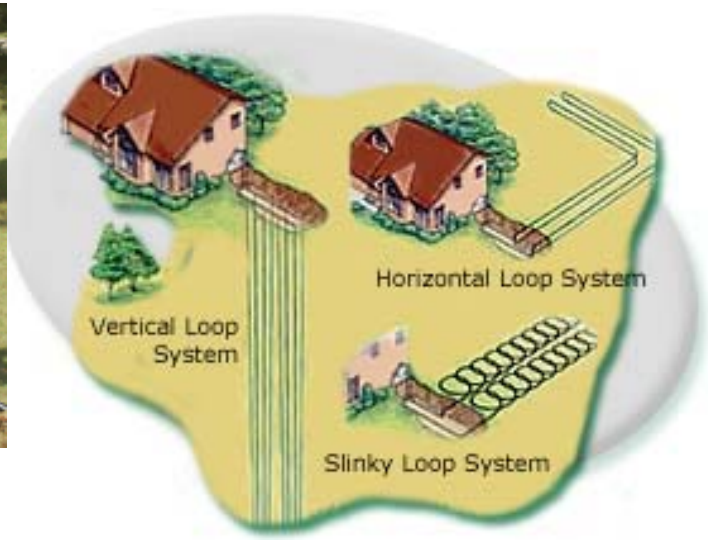
Ground Closed Loop System

Trenching

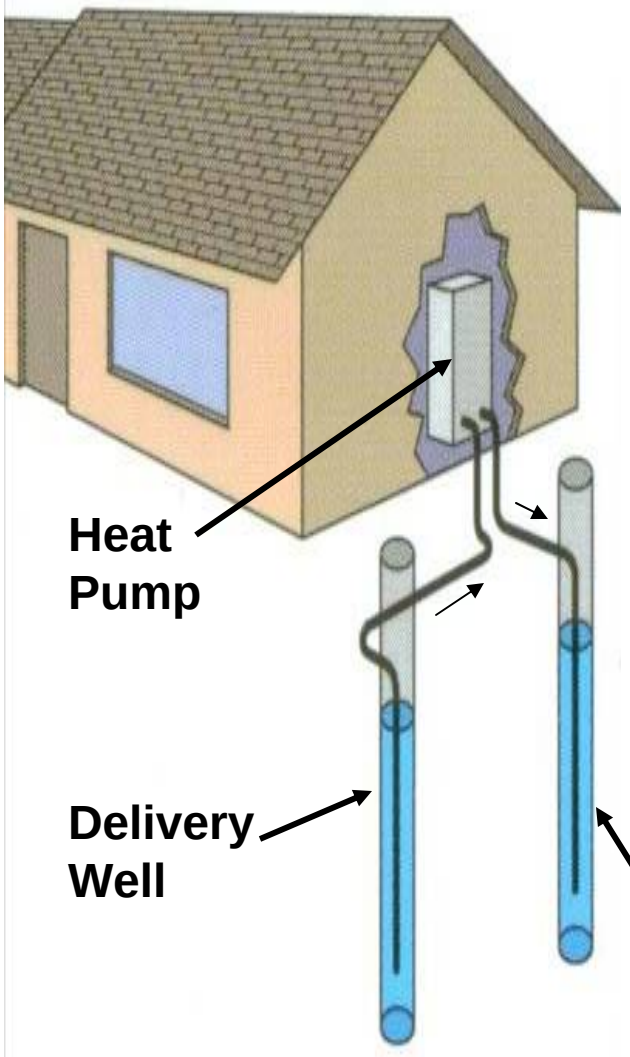
- Trenching-horizontal loops with one or more pipes in loops. 4’-6’ deep.
- Or Vertical Boring – vertical loop bore hole with one pipe down hole looping back to surface. Restricted space.
- Or Directional Boring - horizontal loop that can be under a building (limited space).

Vertical Boring

Directional Boring

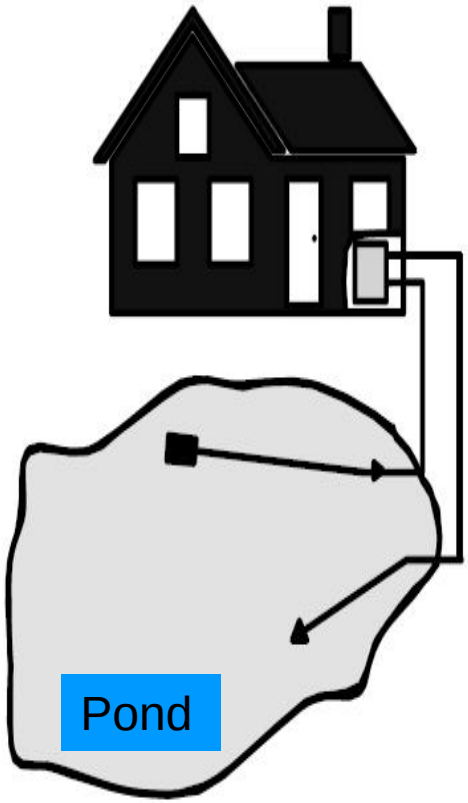


Ground Open Loop System



- Groundwater systems - groundwater is available at reasonable depth and temperature.
- The groundwater is pumped from the delivery well to the heat pump and from there to the sink well.

Ground Open Loop System



- Lake or pond – loops in water will require some horizontal trenching from house to the pond or lake.
- Lake level must be sustainable during dry season and at least deep and large enough to maintain temperature during drought periods.

School may have several Heat Pumps

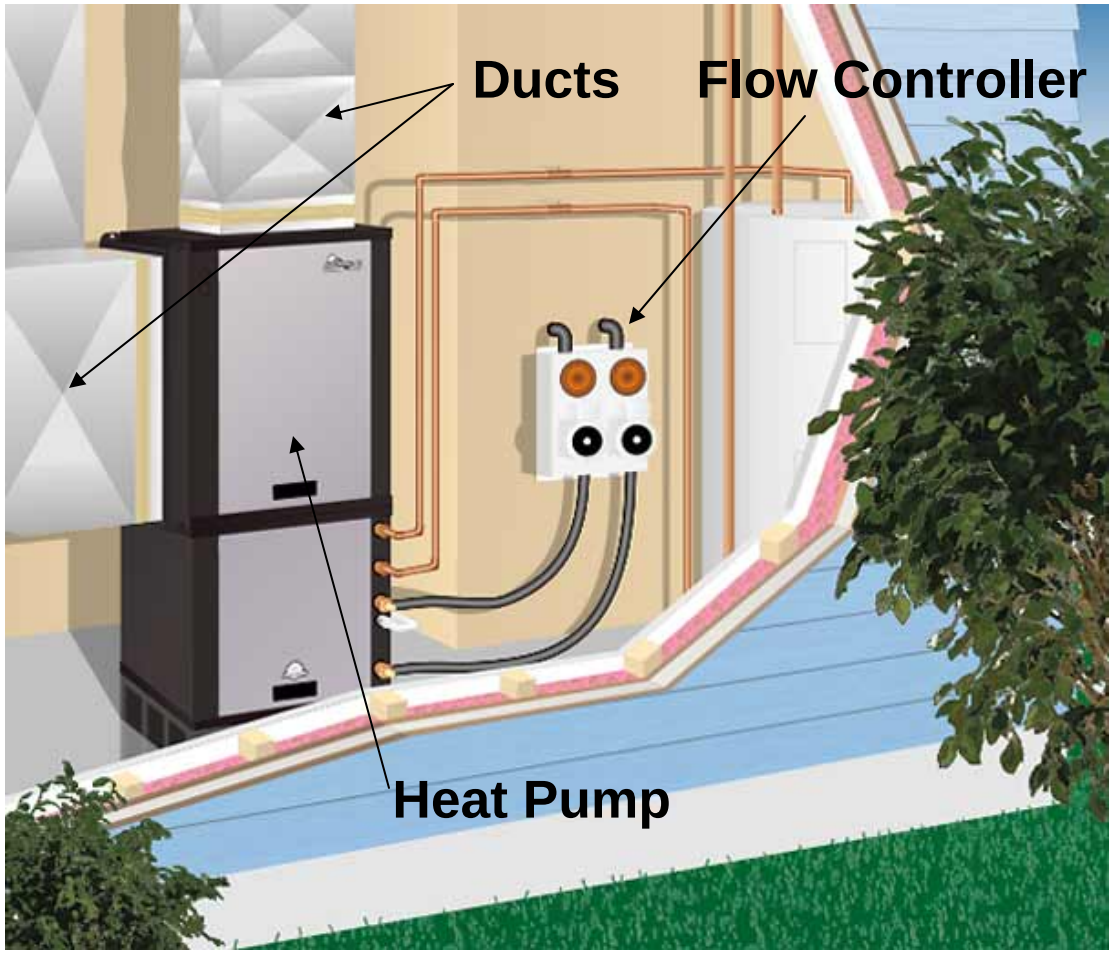
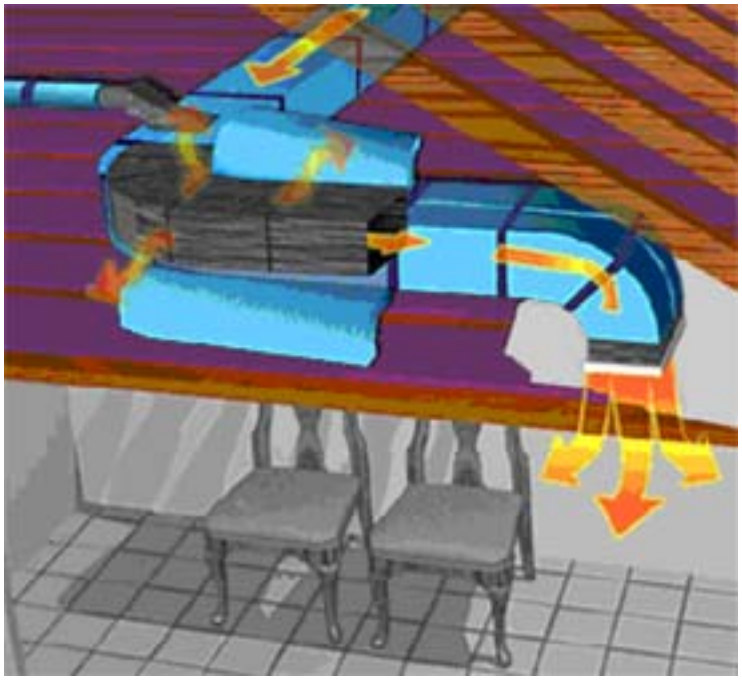


Image courtesy of Climate Master

- Water to air heat pump for air duct heating and cooling
- Water to water heat pump for use as Radiant Floor Heating, Baseboards, and Fan coil heating/cooling.

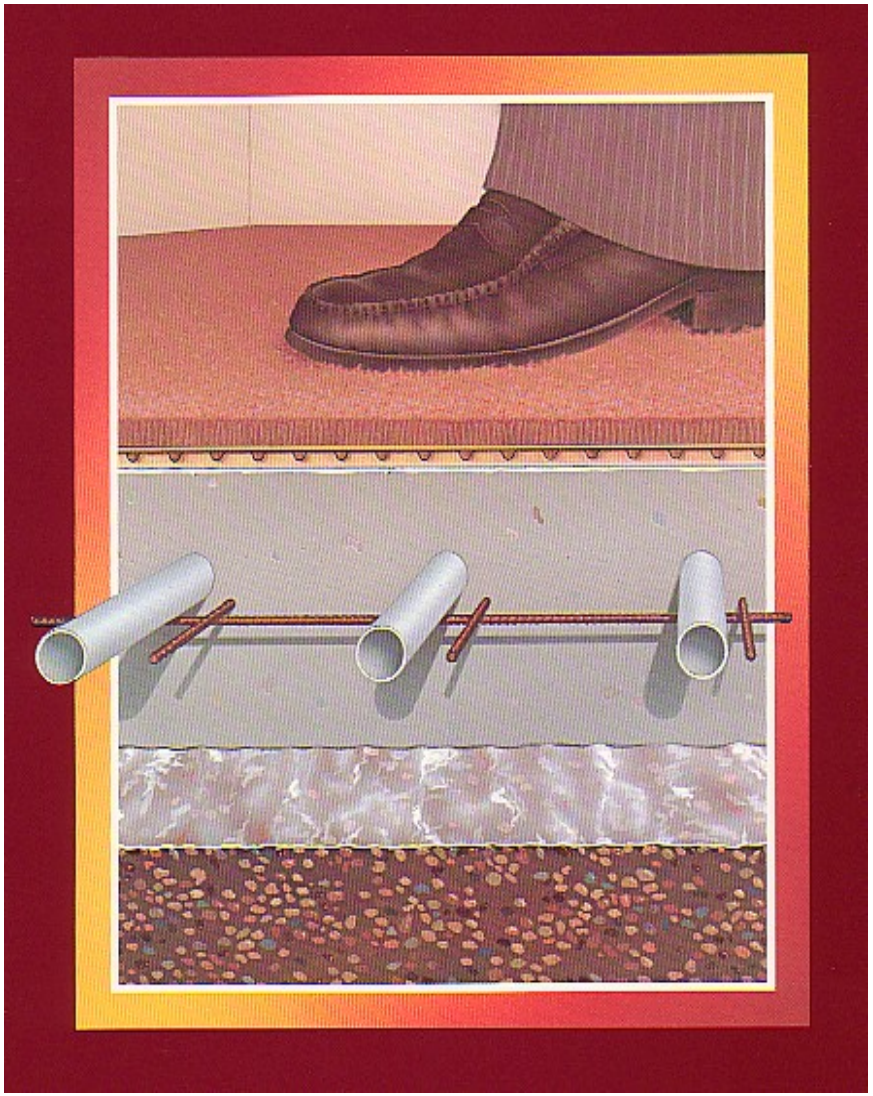
Distribution Systems-Duct Work



- Warm or cold air blown through ducts
- Zone Control and/or Remote Master Control
- Outstanding Comfort

Innovative Air Systems

Distribution Systems-Hydronic Systems

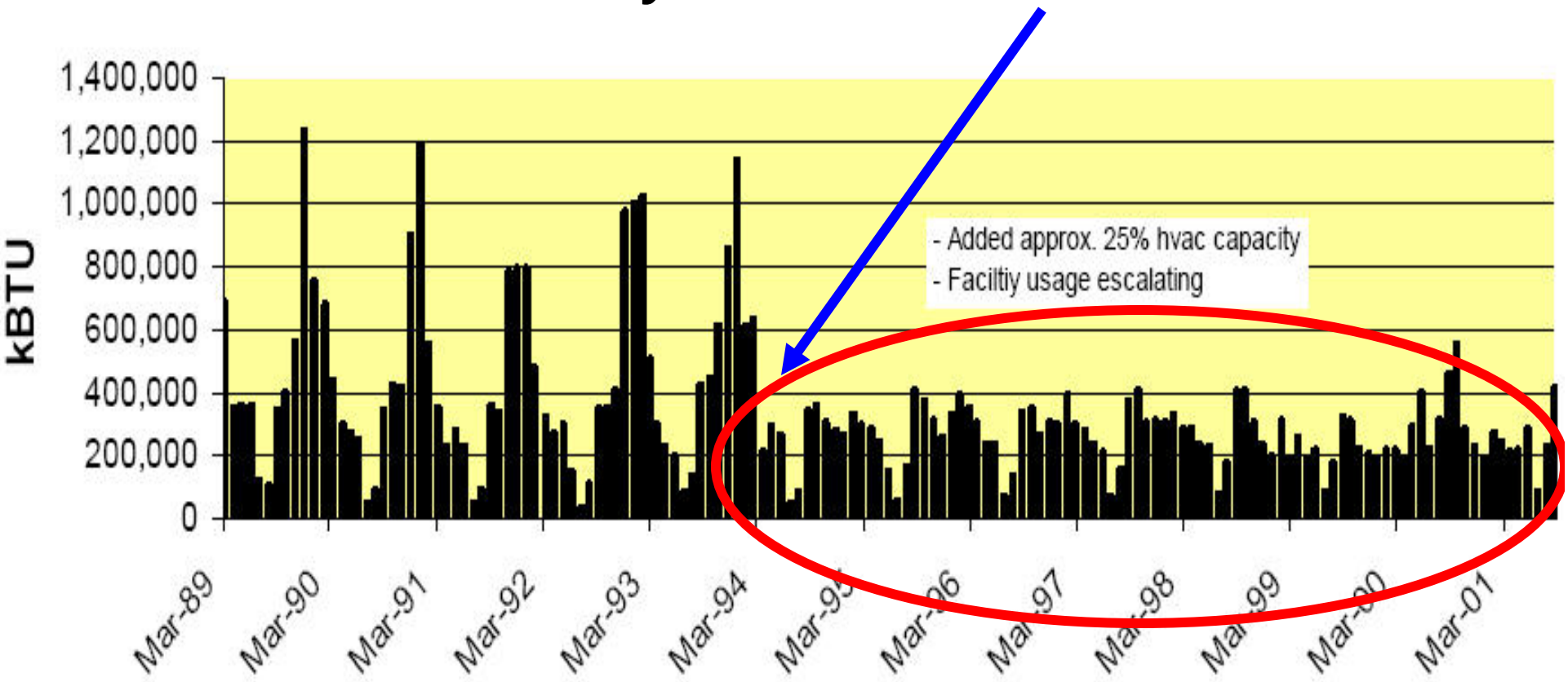


- Hydronic Systems – Floor Heating providing warm water distributed in floor
- Room Zone Control
- Outstanding Comfort
- When your feet are warm your body feels warm too.

Richland Middle School

Richland Hills, Texas

Geothermal System Installed in 1995



From Don Penn Consulting

Cost and Payback for School

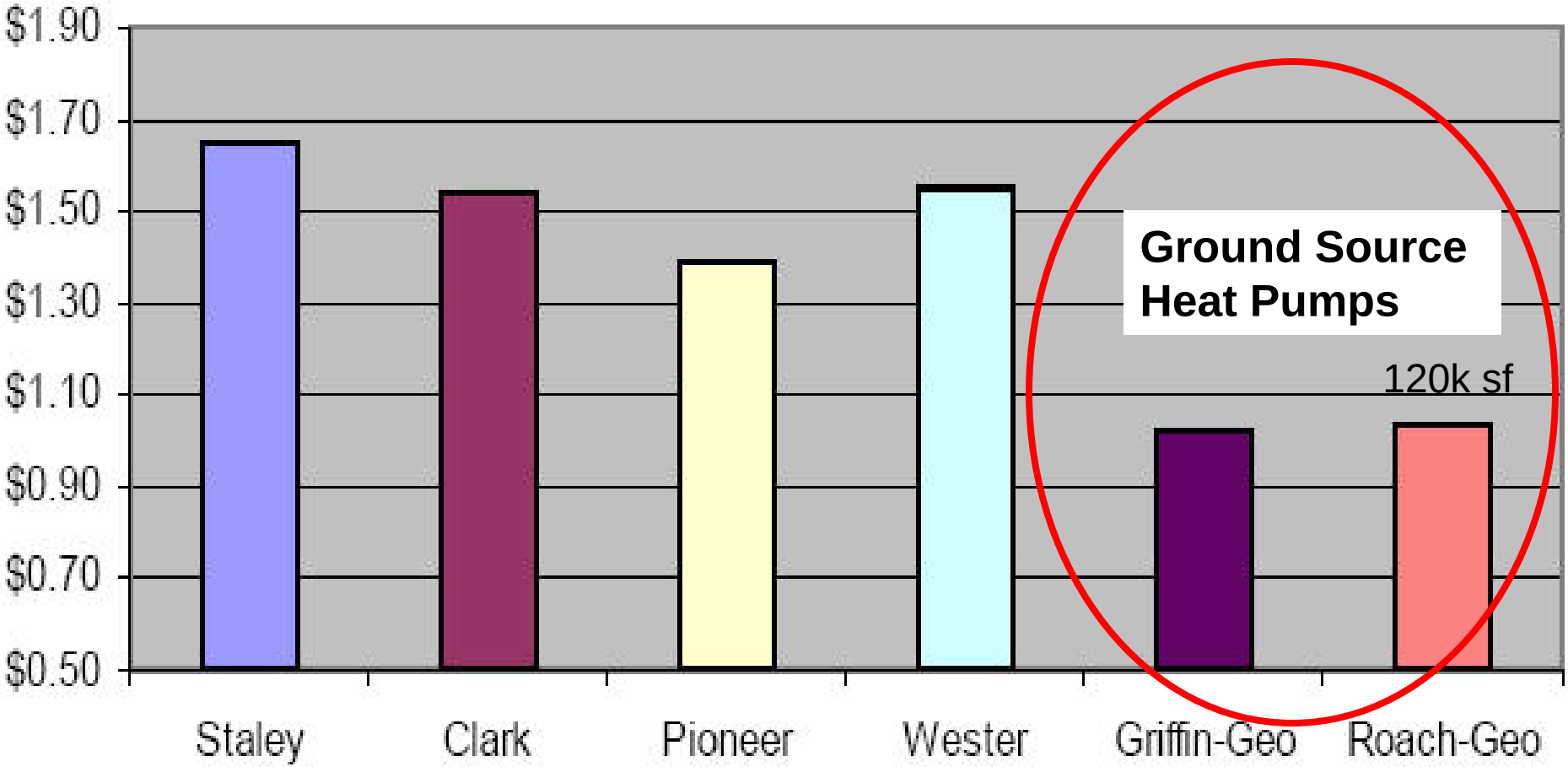
- "In fact, heat pump systems may offer the greatest savings to the owners of commercial buildings, where you have a fairly large heating and cooling load, the payback period could be two to three years." John W. Lund, director of the Geo-Heat Center at the Oregon Institute of Technology.
- How much more depends on where your school is located and which GSHPS you use.
- Cost depends on available contractors who are accredited installers in your area.
- Open Loop systems do not require some specialized contractors such as drillers and trenchers and are less affected by this problem.

Frisco ISD Schools Comparison

Year 2005-2006

Middle School Annual

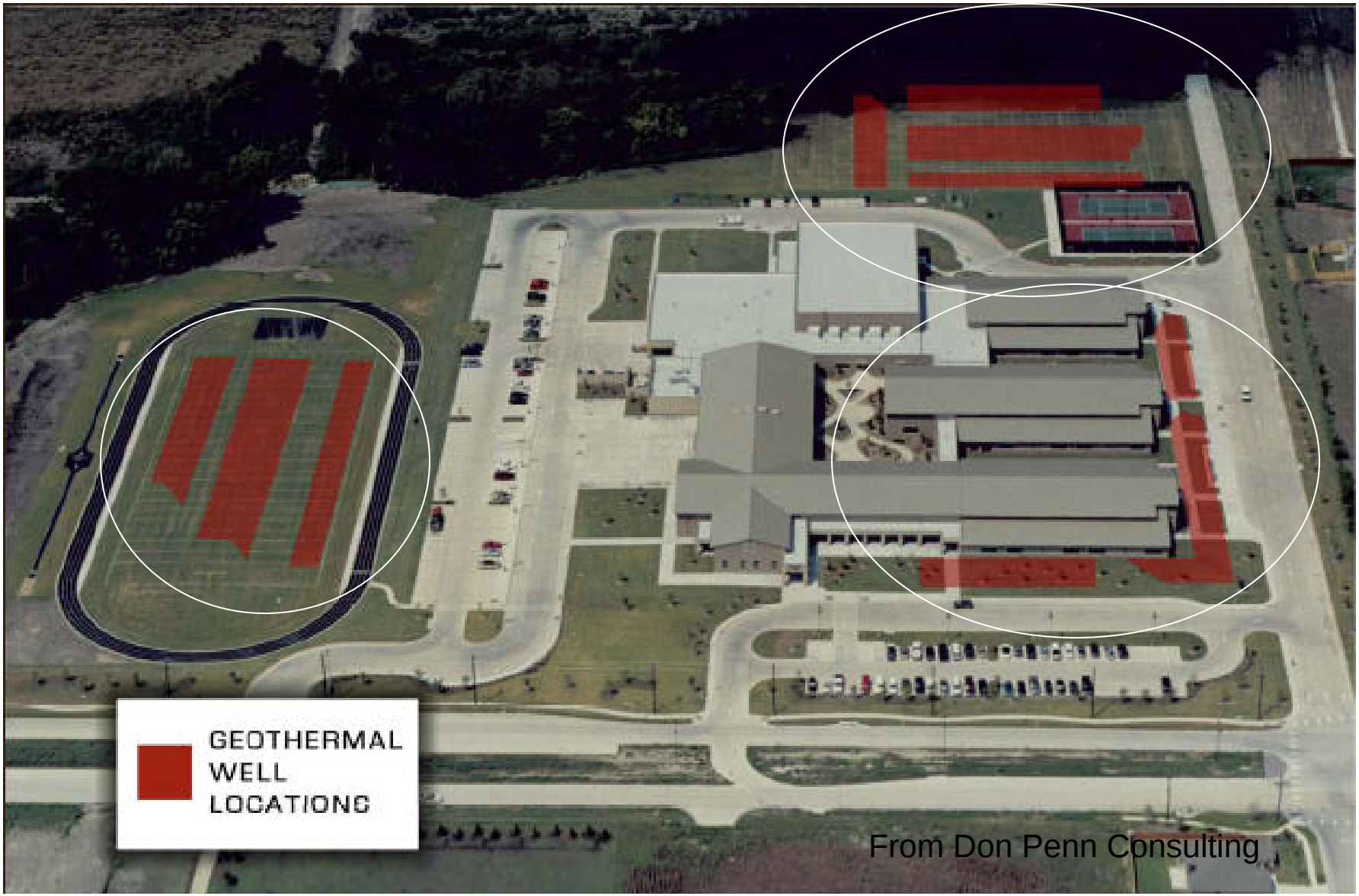
Utility Comparison - $/SF



From Don Penn Consulting

Roach Middle School-120,000 sf

Well Field Locations Texas



From Don Penn Consulting

School GSHP System Research*

Over 200 schools in Missouri that now operate with geothermal heat pumps.

The cost per Million BTU comparisons with current energy cost:

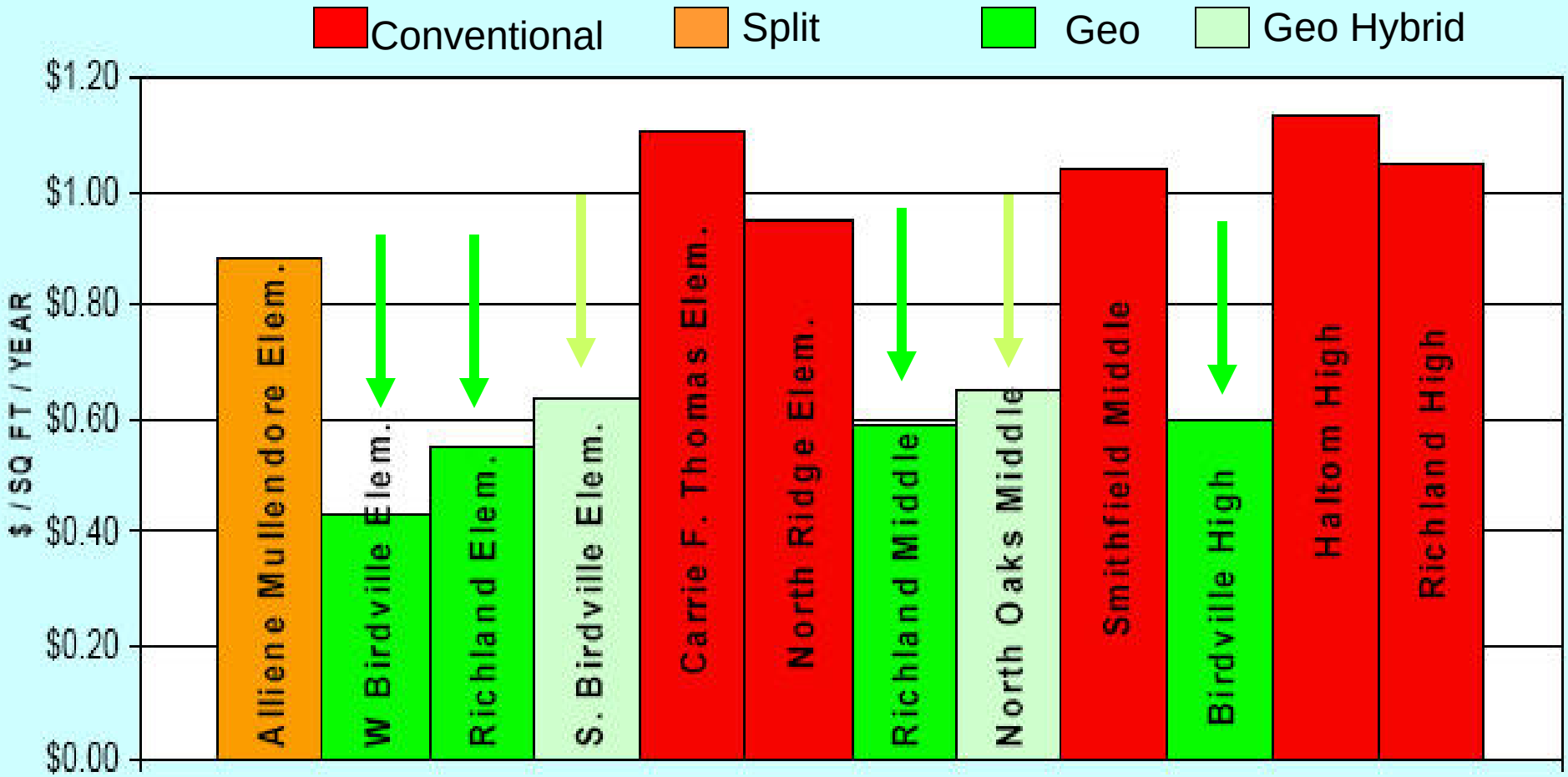
- **Natural Gas (77% Efficiency) $17.53**
- **Propane Gas (77% Eff.) $21.29**
- **Fuel Oil (70% Eff.) $16.67**
- **Electricity Resist. Heat (100% Eff.) $12.01**
- **Ground Source Heat Pump(410% Eff.) $ 2.93**

***Ground Source Heat Pumps: A Good Fit For Schools**
By: John M. Vanderford, Vanderford and Associates - Tuesday, Jan 24, 06

Birdville ISD Schools

Comparison – 2000-2001

$/SF/Year



Birdville Schools Comparison – Year 2001- Install Cost

School Name	Cool Tons	System Type	Install Cost	Heat Type	Controls	Sq Foot
Alliene Mullendore Elem.	129	Split System	$265,198	ELEC	Time Clock	37,632
Richland Elem.	121	Geothermal	$266,940	ELEC	Time Clock	51,689
Snow Heights Elem.	124	Geo Hybrid	$216,720	ELEC	Time Clock	34,623
South Birdville Elem.	149	Geo Hybrid	$243,674	ELEC	DDC	39,654
West Birdville Elem.	106	Geothermal	$246,250	ELEC	Time Clock	67,052
Carrie F. Thomas Elem.	200	Central	$460,000	GAS	DDC	70,600
North Ridge Elem.	200	Central	$480,000	GAS	Time Clock	74,123
Richland Middle	273	Geothermal	$575,038	ELEC	Time Clock	96,022
North Oaks Middle	204	Geo Hybrid	$444,760	ELEC	Time Clock	79,856
Smithfield Middle	320	Gas Chiller	[illegible]	GAS	DDC	94,908
Haltom High →	1,100	Central	$2,530,000	GAS	DDC	305,000
Richland High	913	Central & Split System	[illegible]	ELEC/GAS	DDC	[illegible]
Birdville High →	1,046	Geothermal	$2,415,000	ELEC	DDC	301,000

From Don Penn Consulting

Few Comments

- “Salamanca High School/Middle School, NY showed a $81,230 per year saving after installing Geothermal Heat Pump Systems.” Report from School Board President Robert Crandall, Salamanca Public Schools, NY
- “The ground-source heat pump has reduced Madison Middle School’s environmental footprint by 300 tons of carbon dioxide annually and has saved the district $15,000-20,000 in natural gas costs each year.” Don Gillmore Building Excellence Program, Seattle Public Schools, Washington

Environmental Protection Agency (EPA)

According to EPA*

- "GeoExchange systems are
- the most energy efficient,
- environmentally clean,
- cost-effective space conditioning systems available."
- Geothermal operates efficiently because the energy source, the sun, has already created the energy and stored it in the earth.

*Environmental Protection Agency, Space Conditioning: The Next Frontier. Office of Air and Radiation, 430-R-93-004 (4/93).

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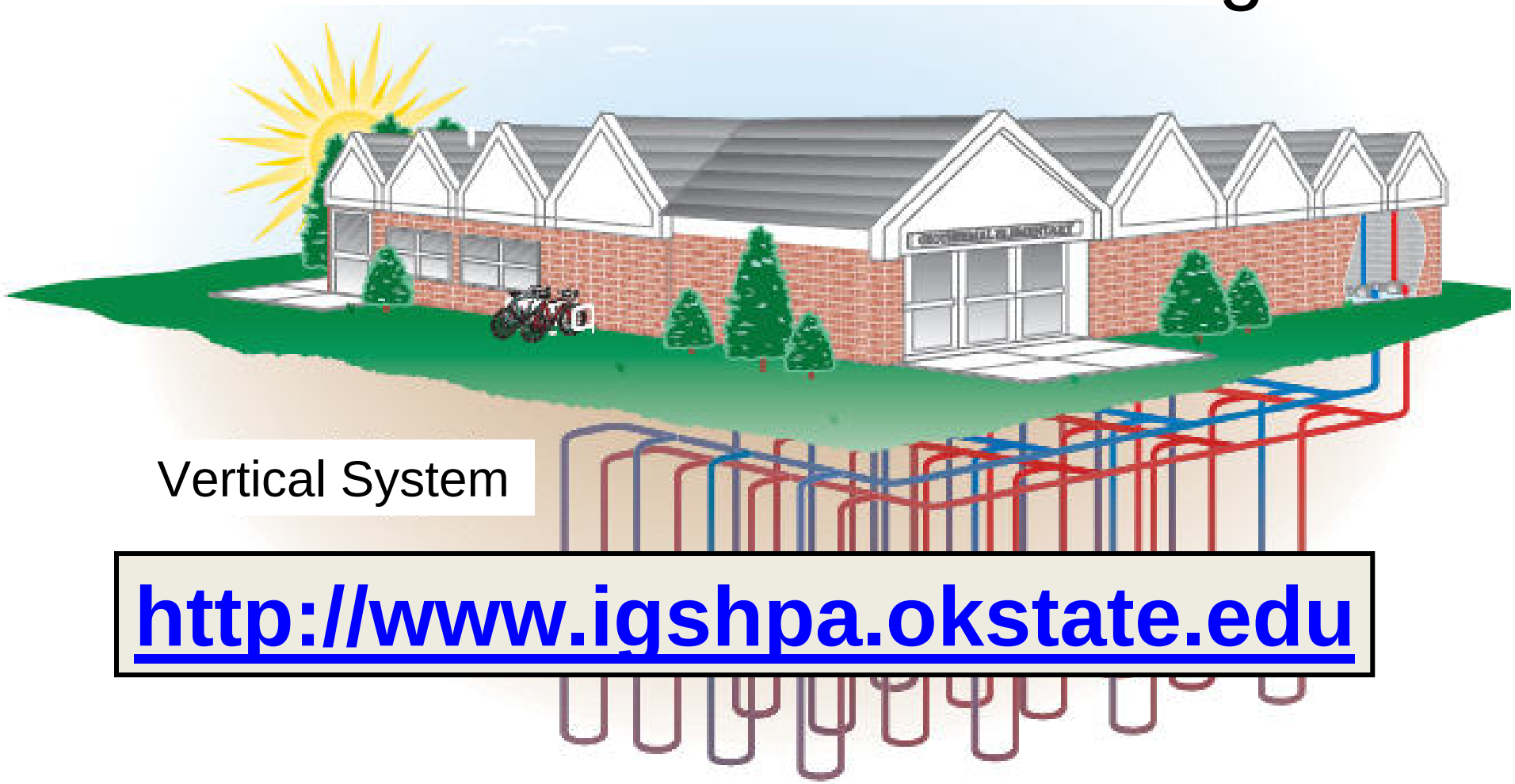

Vertical System

http://www.igshpa.okstate.edu

Image courtesy of Climate Master