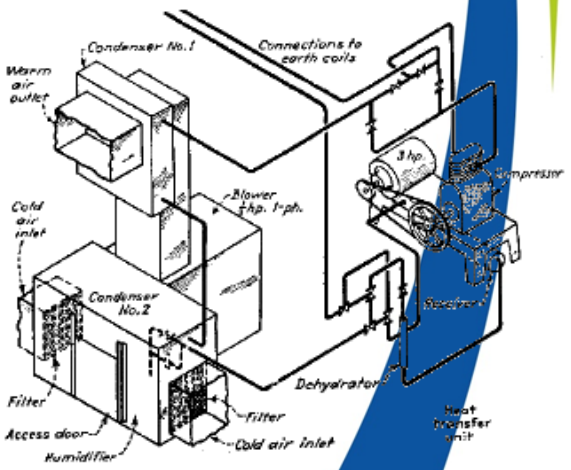
Introduction to Geothermal Comfort Systems in INDIA

History

- **Ancient earth sheltered homes**
- **1912 – Swiss Patent**
- **1945 - First GSHP operating in North America in Indianapolis**
- **1949 – Canada's first GSHP installation in Toronto**
- **1970 - First European installations**



First Geothermal Power Plant, 1904, Larderello, Italy

Alternate Energy Sources
30% Tax Credit

- Wind Generators
  - Wind farms, Wind turbines easy to see
  - Works great when wind blows
- Solar Panels
  - Solar panels on roofs easy to see
  - Works great when sun shines
- Ground Source Heat Pump (GSHP)
  - Homes, schools, businesses, gov
  - Can't see it work and no noise
  - Works 24hrs/7days per week /365 days a year

Defining “Geothermal” Energy

- **Dictionary definition**
  - **Relating to the internal heat of the earth**
- **“High Temperature” Geothermal**
  - **Refers to heat temperatures from typically hundreds of feet deep within the earth, sometimes exceeding 300°F.**
  - **These include geysers and other hydro-geothermal reservoirs.**

Defining “Geothermal” Energy

- **“Low Temperature” Geothermal**
  - Refers to shallow earth temperatures found anywhere, utilizing a mechanical device (geothermal heat pump) to transfer heat to and from the ground.

The Technology Goes by Many Different Names…

- ⇒ **Ground source heat pumps (GSHP)**
- ⇒ **Ground coupled heat pumps (GCHP)**
- ⇒ **Geothermal heat pumps (GHP)**
- ⇒ **Geo Exchange (GX)**
- ⇒ **Earth energy systems**
- ⇒ **Water source heat pump (WSHP)**

Refers to units used in boiler/cooling tower applications without a direct connection to the earth, WSHP systems are not geothermal applications

What is a Geothermal Heat Pump?

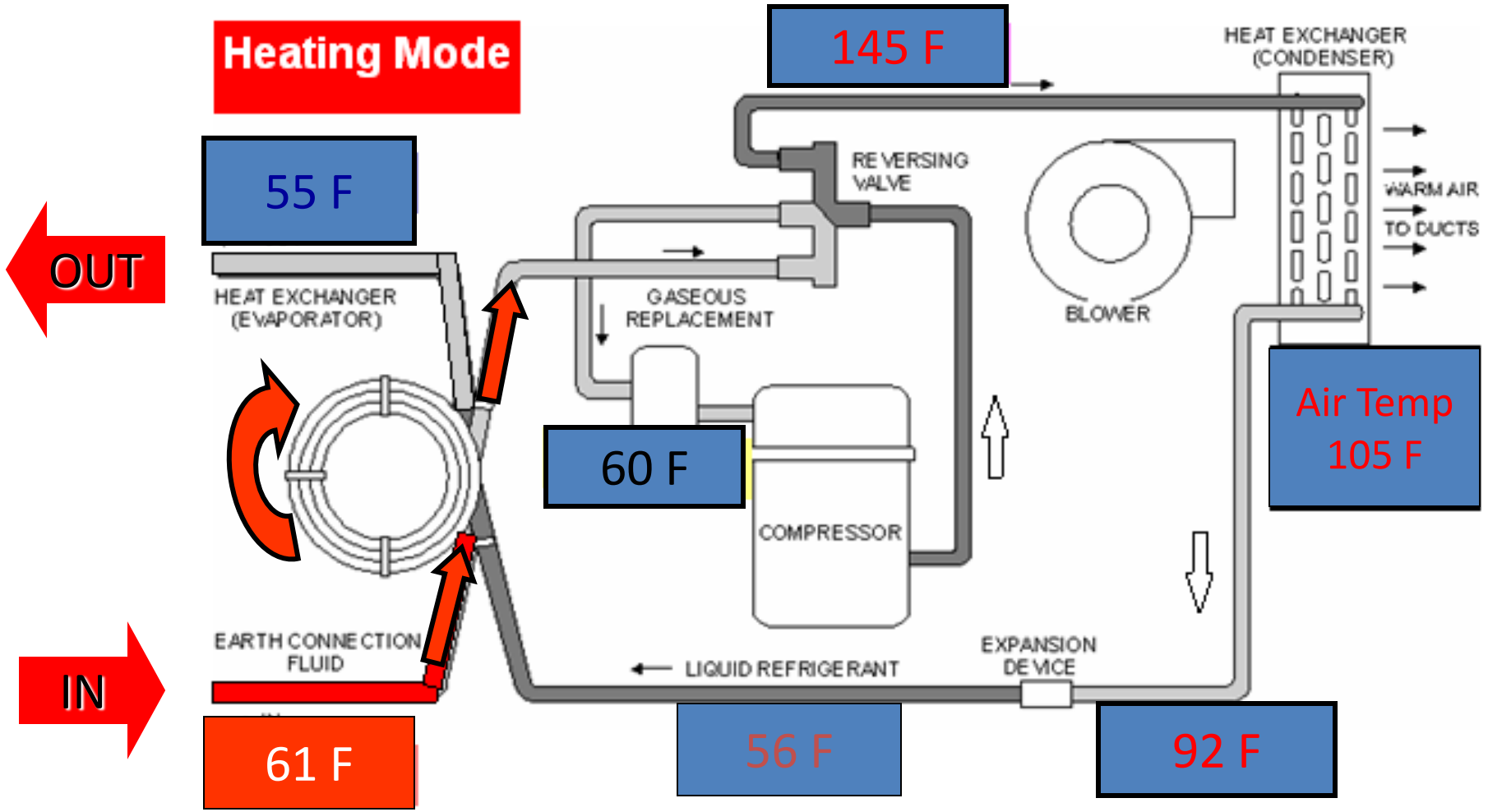
- The transfer of energy to and from the earth for the purposes of heating or cooling a building or process.

- Two primary energy sources or sinks:
  - Earth core dominated
  - Surface dominated

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.
- **Cooling-In the summer**, the system reverses and expels heat from your home 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 home.
- **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 home.

How Low Temperature Ground Heat is Converted to Home Heating



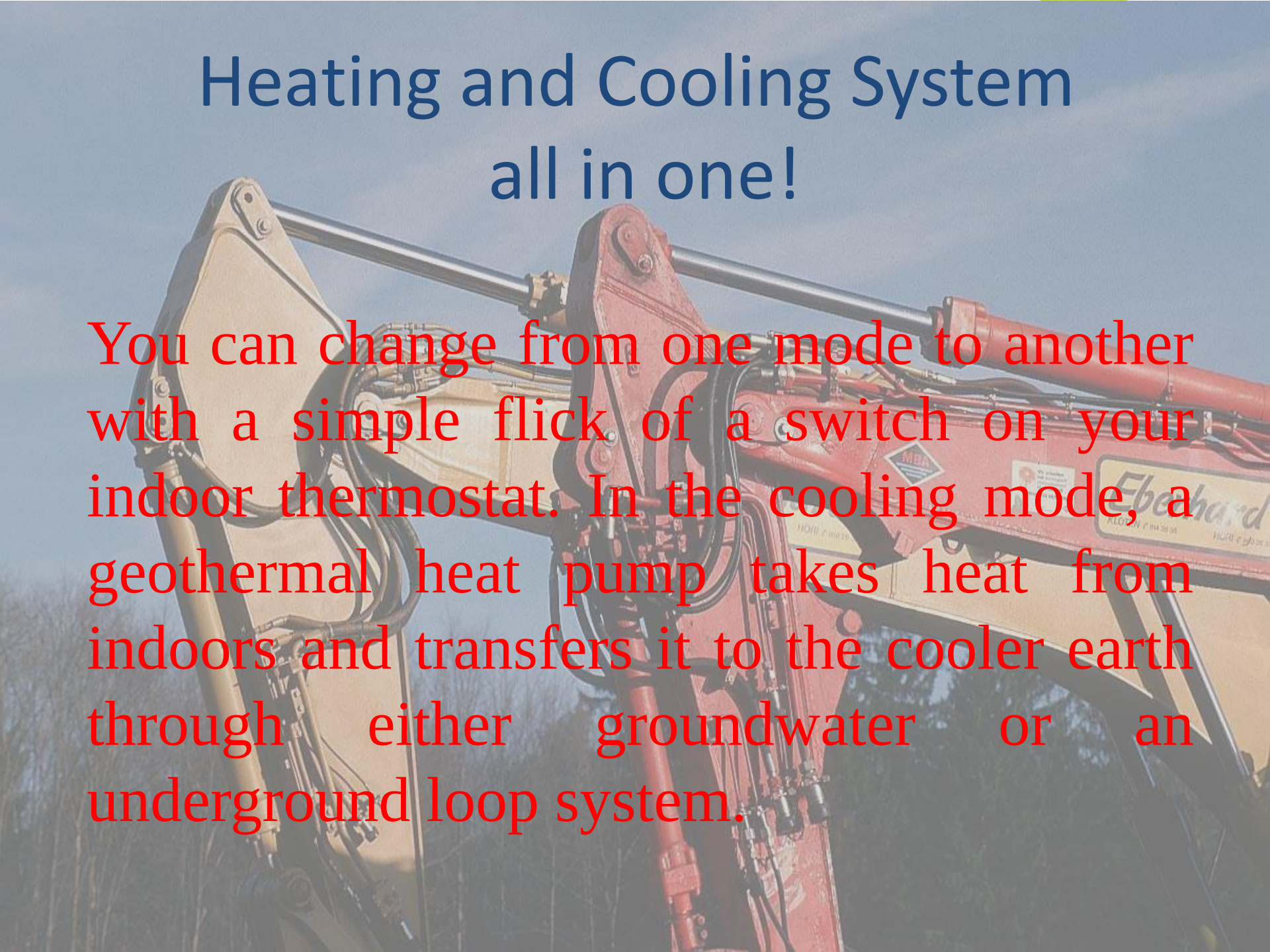
How does it work?

Like any type of heat pump, it simply moves heat energy from one place to another. Your refrigerator works using the same scientific principle. By using the refrigeration process, geothermal heat pumps remove heat energy stored in the earth and/or the earth's groundwater and transfer it to the home.

How is heat transferred between the earth and the home?

Using the stored energy of the earth, heat is extracted through a liquid medium (groundwater or an anti-freeze solution) and is pumped to the heat pump or heat exchanger. There, the heat is used to heat your home. In summer, the process is reversed and indoor heat is extracted from your home and transferred to the earth through the liquid.

Heating and Cooling System all in one!



You can change from one mode to another with a simple flick of a switch on your indoor thermostat. In the cooling mode, a geothermal heat pump takes heat from indoors and transfers it to the cooler earth through either groundwater or an underground loop system.

Overall Concept

- **A Ground Source Heat Pump System consists of a water-to-air or water-to-water heat pump, connected to a series of long plastic pipe buried below the earth's surface, or placed in a pond.**
- **These systems can also utilize well water in place of the earth loop. As fluid from the earth loop or well water is moved through the unit, the heat pump transfers thermal energy.**

Energy Source

- The earth serves as a giant solar collector, storing heat energy.
- Air temperatures may fluctuate as much as 50°F above and below the annual average. However, only a few feet below the surface, the changes in earth temperatures are much less severe.

Energy Source

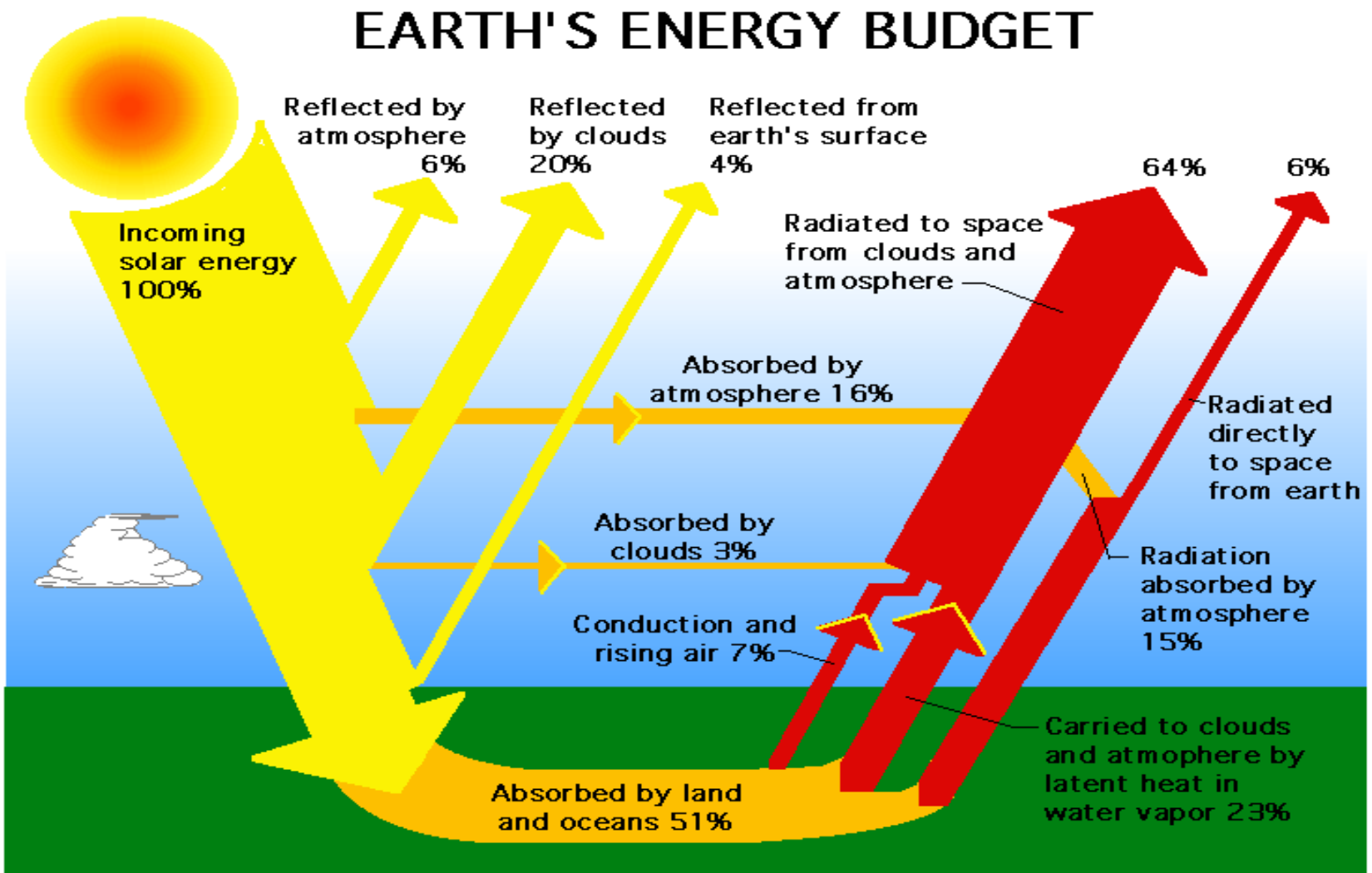
- During the heating season, the earth serves as a heat SUPPLY. (HE - Heat of Extraction)

- During the cooling season, the earth serves as heat STORAGE. (HR - Heat of Rejection)

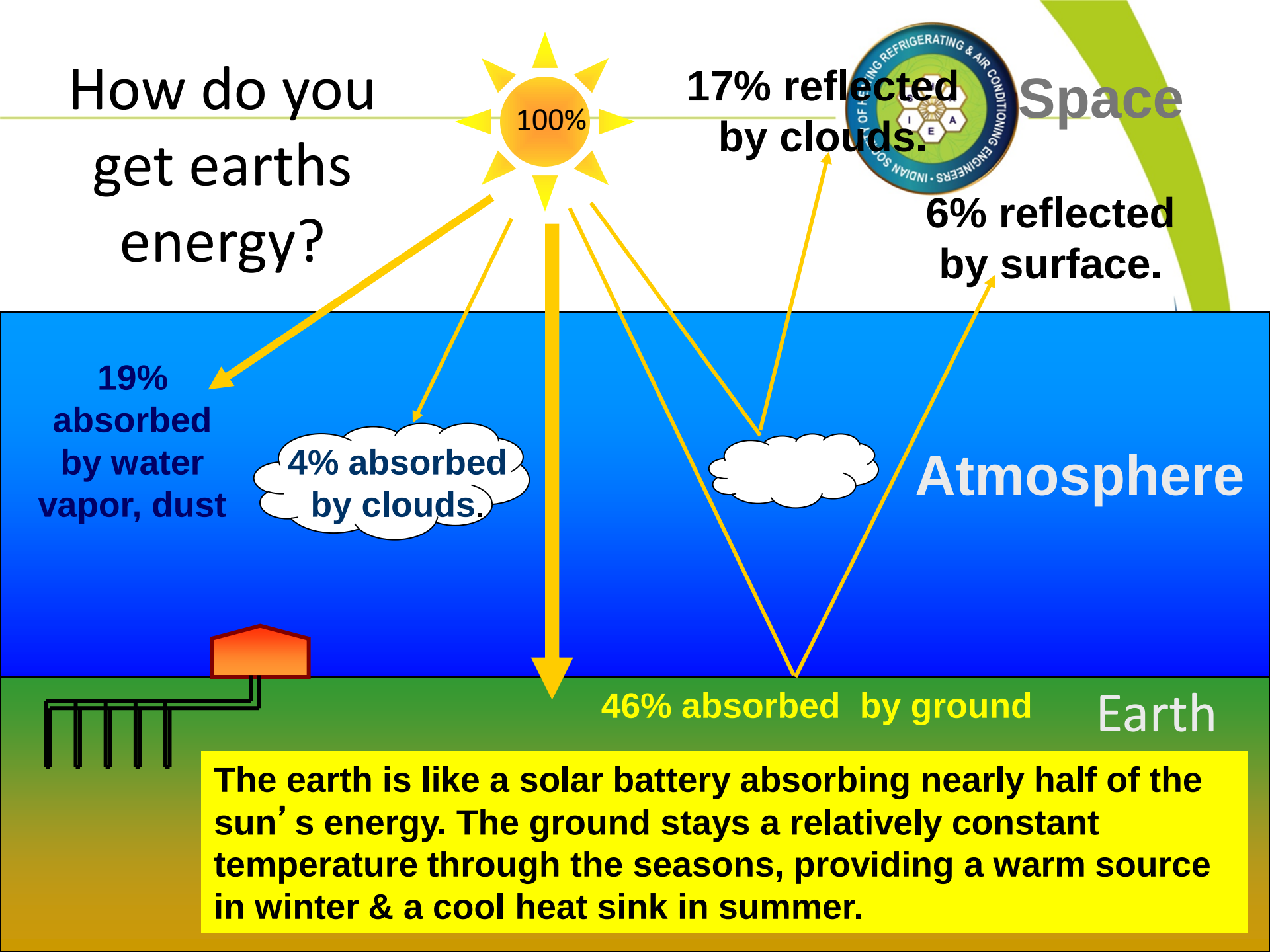
Source

Sink

Charging the Surface



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.

Laws of Thermodynamics

- In order to fully understand HOW a geothermal system works, you need a basic understanding of the First & Second Laws of Thermodynamics.

The First Law of Thermodynamics

- Otherwise known as the Law of Conservation of Energy—Basically, you can't get more energy out than you put in.

The Second Law of Thermodynamics

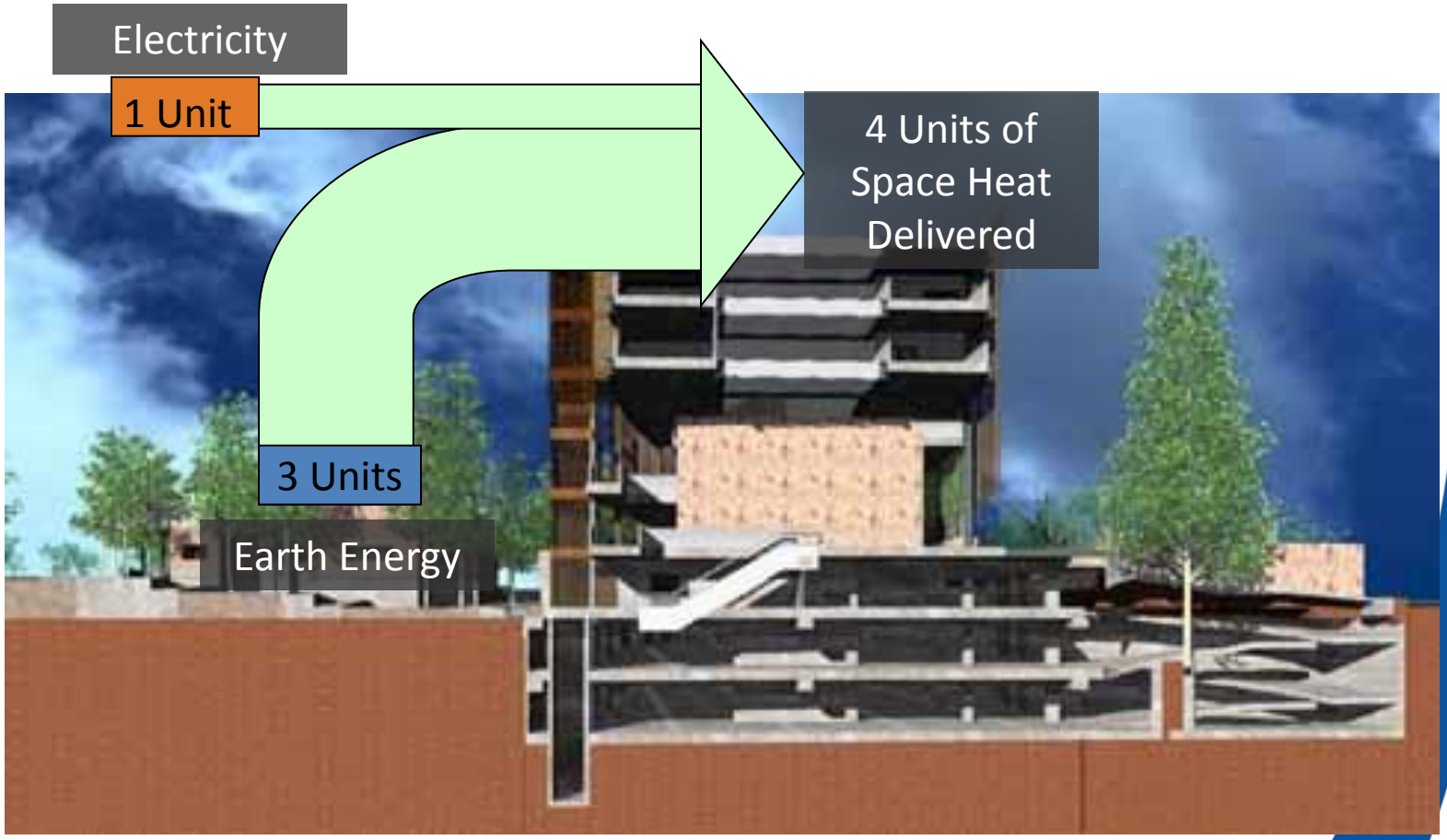
- The first statement in the Second Law of Thermodynamics is that heat energy flows from an area of high heat to a area of low heat.
- You cannot stop this process, only speed it up or slow it down.

How Does a Geothermal System "Fit" in an HVAC System???

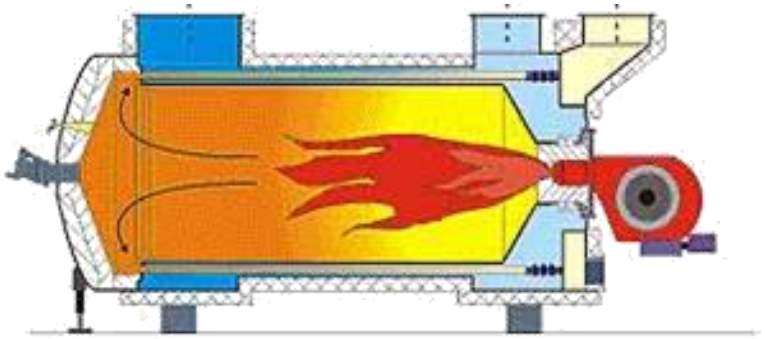
The Basic Ground Source Heat Pump System

- The earth loop is placed in the ground either horizontally or vertically, or it can be placed in a pond.
- Water and anti-freeze is circulated through the pipe, transporting heat to the heat pump during the heating mode and away from the heat pump during the cooling mode.
- The heat transfer takes place inside the heat pump in a water-to-refrigerant heat exchanger called the coax.

The Renewable Energy Component



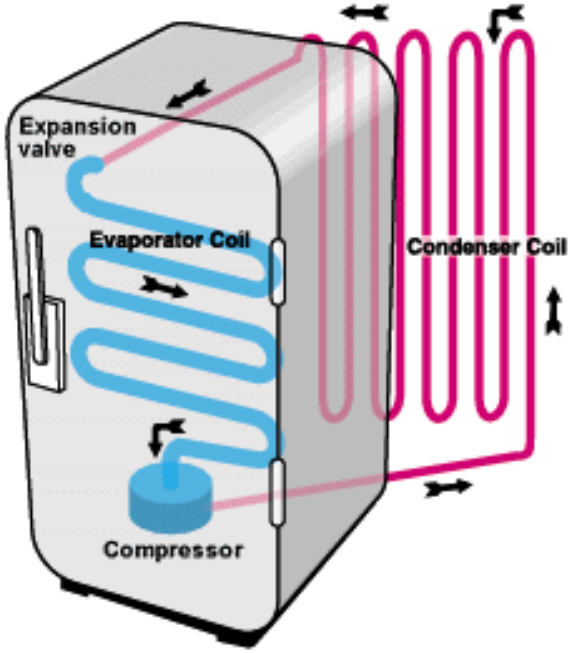
Transfer Rather Than Generate

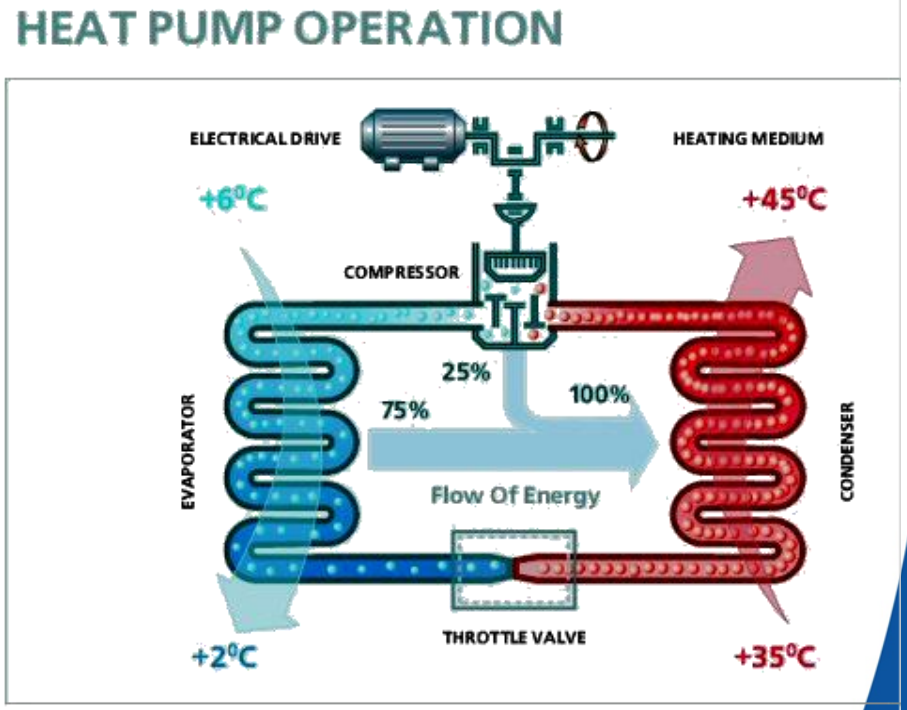


- It requires less thermodynamic effort to transfer heat than to generate it through combustion.

How do we “Pump” Energy?

- **The mechanical refrigeration cycle!**





Heat Pump Operation

- **Geothermal heat pumps consist of four circuits:**
  - **Distribution circuit**
    - **The system that distributes the conditioned air or water solution throughout the home or building and returns it to the unit.**
  - **Refrigerant circuit**
    - **A sealed and pressurized circuit of refrigerant including compressor, expansion valve, water-to-refrigerant heat exchanger(s), air coil, reversing valve. The refrigerant is either R-22 or R-410A.**

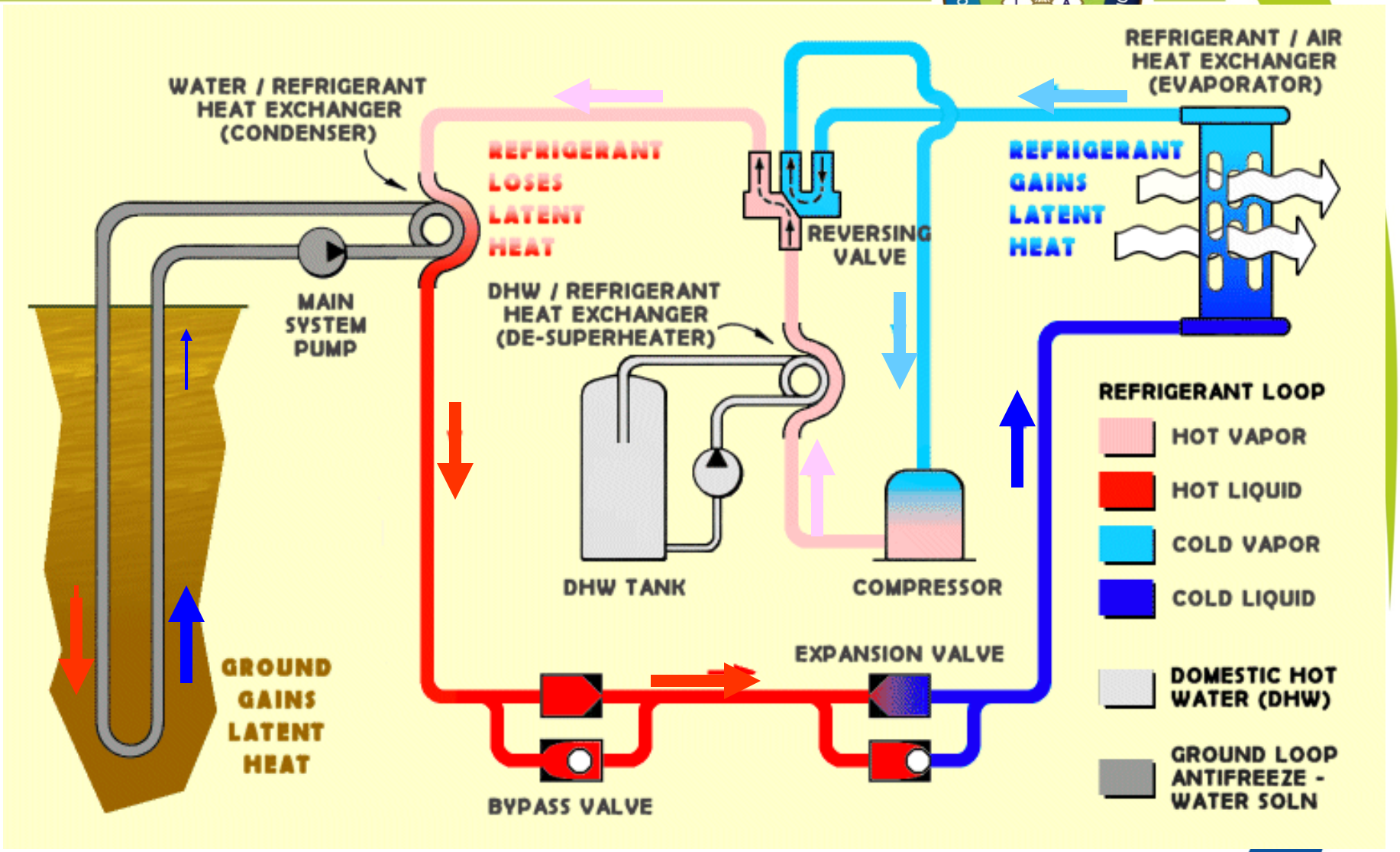
Heat Pump Operation

- Geothermal heat pumps consist of four circuits:
  - Ground loop circuit
    - The piping system buried in the ground has fluid that is circulated by pumps to and from the geothermal unit.
  - Hot water circuit
    - Domestic water can be heated in a geothermal unit with a device called a desuperheater. A piping connection is made from the geothermal unit to the water heater.

Geothermal System Components

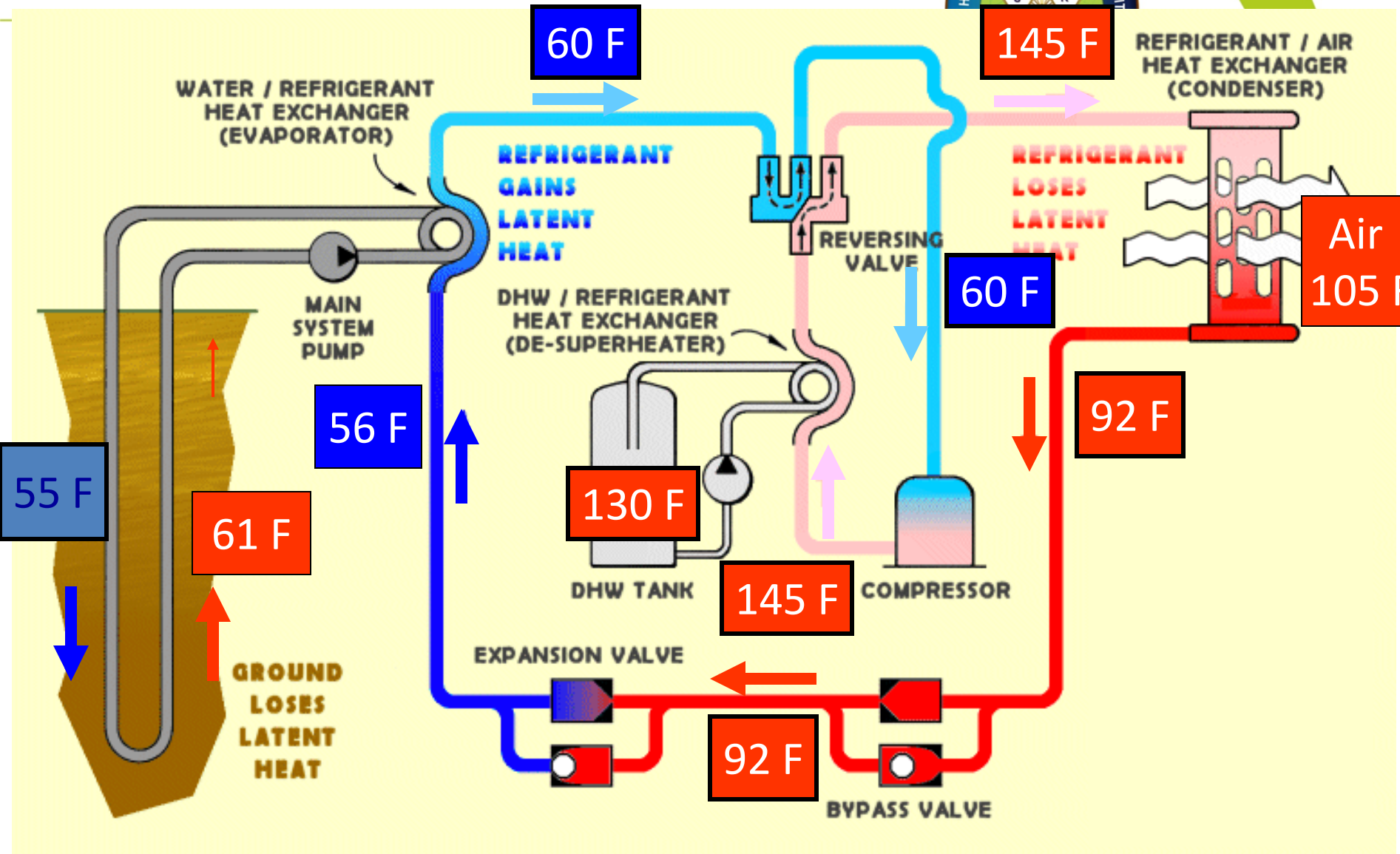
- Ground-Loop
- Ground-Loop Pump (in unit)
- A Source Heat Exchanger
- A Refrigeration Circuit
- A Compressor
- A Metering Device
- A Load Side Heat Exchanger
- A Load Side Fan or Pump

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



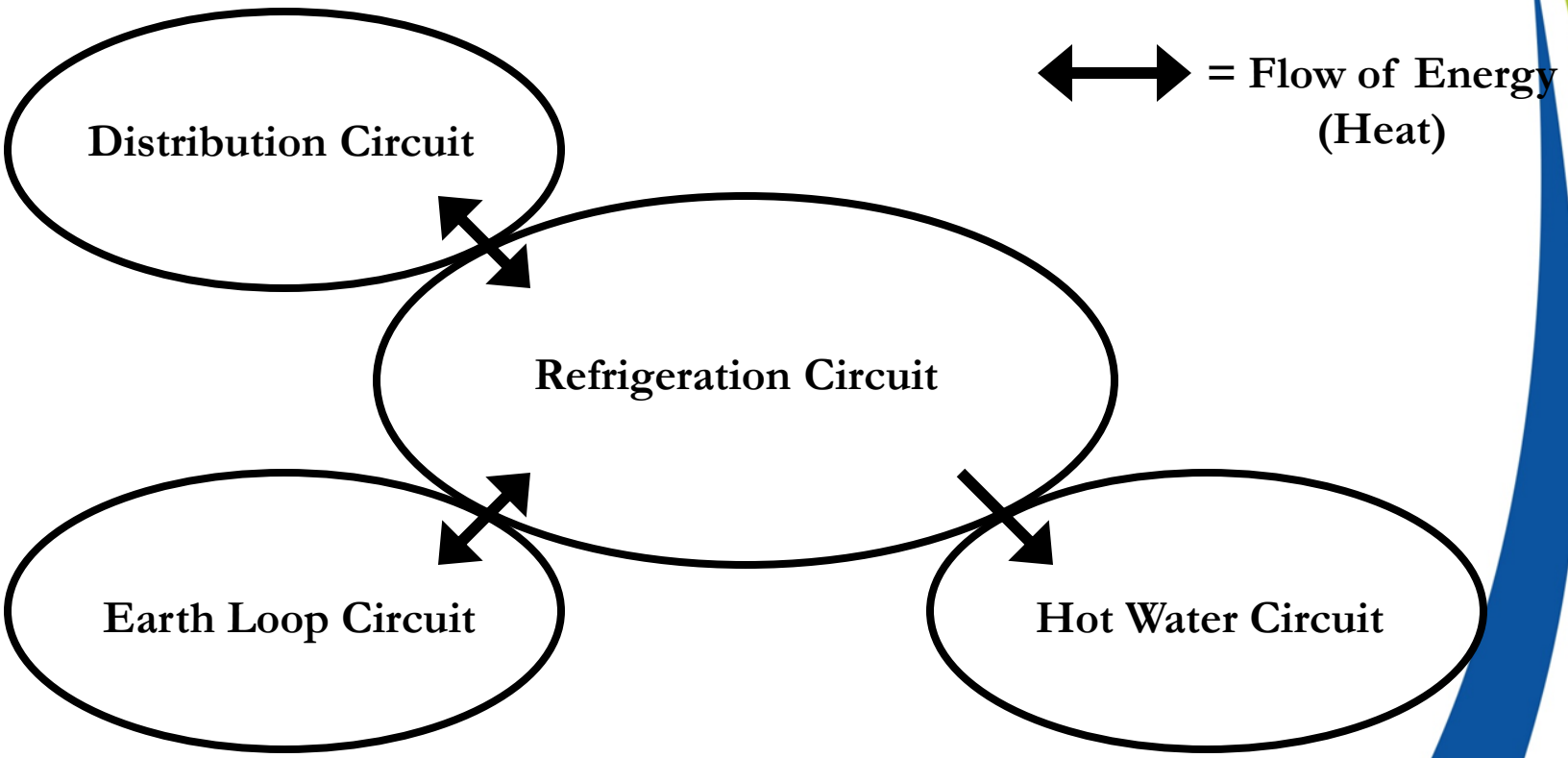
Geo4VA - This is a Special Energy Project funded by the U.S. Department of Energy's State Energy Program through the Virginia Department of Mines, Minerals, and Energy.

Heat Pump Operation

- Each of these circuits is closed and sealed from the others—there is no direct mixing.
- However, heat energy does transfer from the refrigeration circuit to the other three circuits.
- The refrigerant flow will change direction when the unit changes modes (heating or cooling).

Heat Pump Operation

- **The Four Circuits in a Geothermal Heat Pump**



Equipment Performance Ratings

- Geothermal and ground water heat pumps are tested under ISO Standard 13256-1, which replaces the former standards of ARI-330 (ground loop), ARI-325 (ground water / open loop) and ARI-320 (water loop / boiler-tower).

Equipment Performance Ratings

- This standard uses different entering water temperatures for heating and cooling.
- The following are rating points for ground water and ground loop heat pumps.

ISO Standard 13256-1 Testing Criteria

Ground Water Units

Units @ Part and full capacity operation

- Entering water temperature cooling 59°F (15C)
- Entering water temperature heating 50°F (10C)

ISO Standard 13256-1 Testing Criteria

Ground Loop Units

Units @ full capacity operation

- Entering water temperature cooling 77°F (25C)
- Entering water temperature heating 32°F (0C)

Units @ part capacity operation

- Entering water temperature cooling 68°F (20C)
- Entering water temperature heating 41°F (5C)

Equipment Performance Ratings

- The efficiency ratings for water-to-air heat pumps as:
  - **Energy Efficiency Ratio (EER)**
    - EER = BTU output divided by power watt input
    - For cooling operation under steady state test conditions
  - **Coefficient of Performance (COP)**
    - COP = BTU total output divided by BTU input
    - For heating operation under steady state test conditions

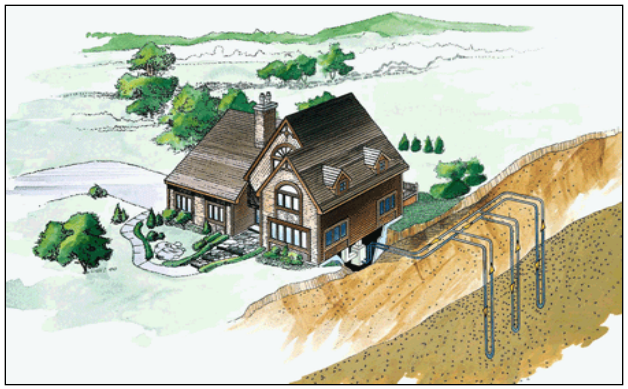
The Ground Loop.

- **The ground/earth loop provides the infrastructure for accessing and continually exchanging thermal energy between the earth and the building.**

➢ **Closed-loop system** – a continuous, sealed, underground or submerged heat exchanger through which a heat-transfer fluid is circulated between the ground and the heat pump during a run mode.

➢ **Open –loop or groundwater system** – a system designed to use groundwater for the purpose of extracting or rejecting heat by use of a liquid-source heat pump.

Closed Ground Loop



www.ishrae.in

How a Ground Source Heat Pump System Works for a Residence

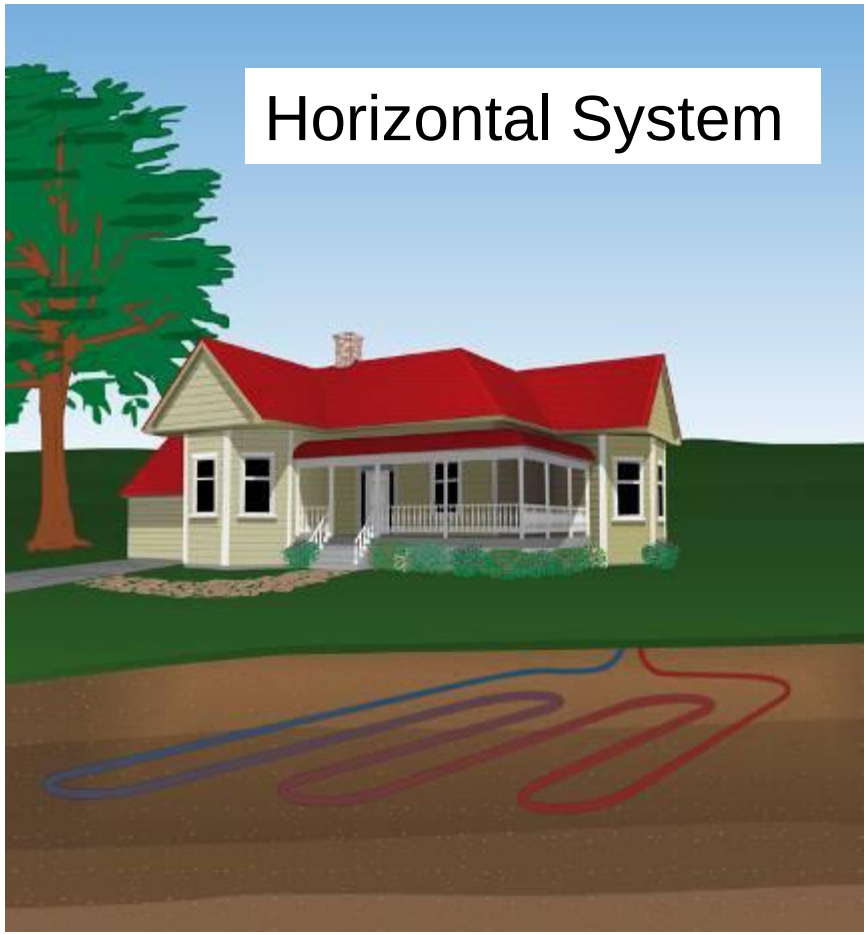


Image courtesy of Climate Master

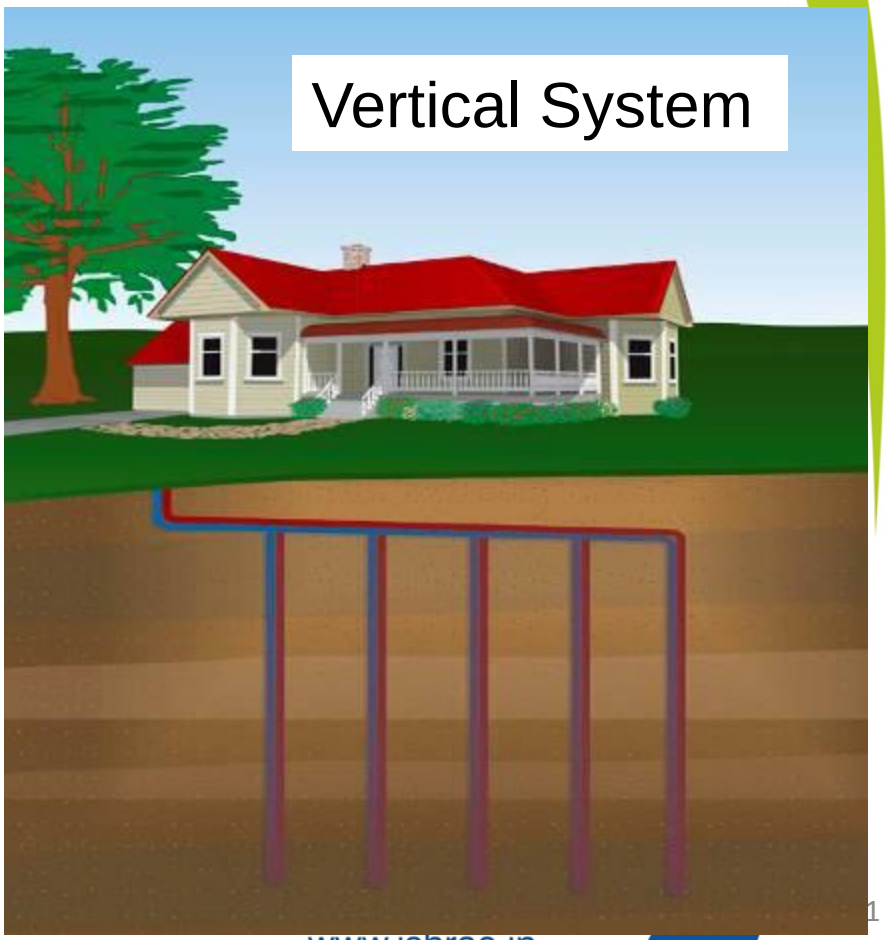


Image courtesy of Climate Master

Other Ground Source Systems

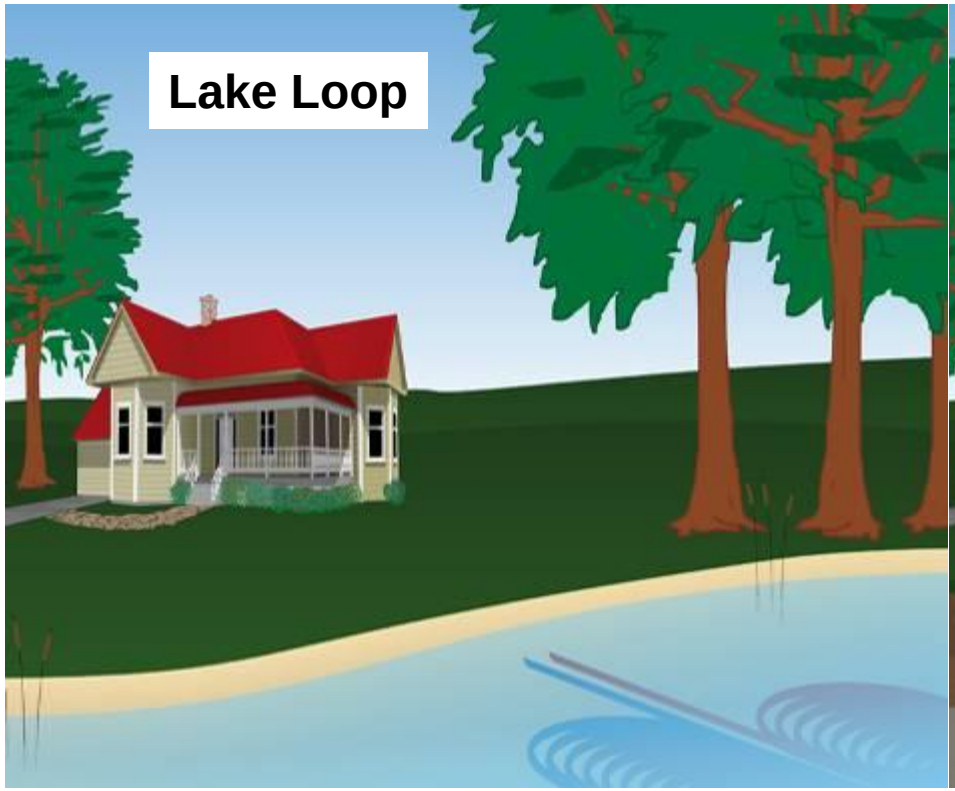


Image courtesy of Climate Master

Lake Loop are usually very economical to install. If a pond or lake at least 8 feet deep is available, lake loops can utilize the water (rather than soil) for heat transfer. Reduced installation costs are characteristic of this type of loop system.

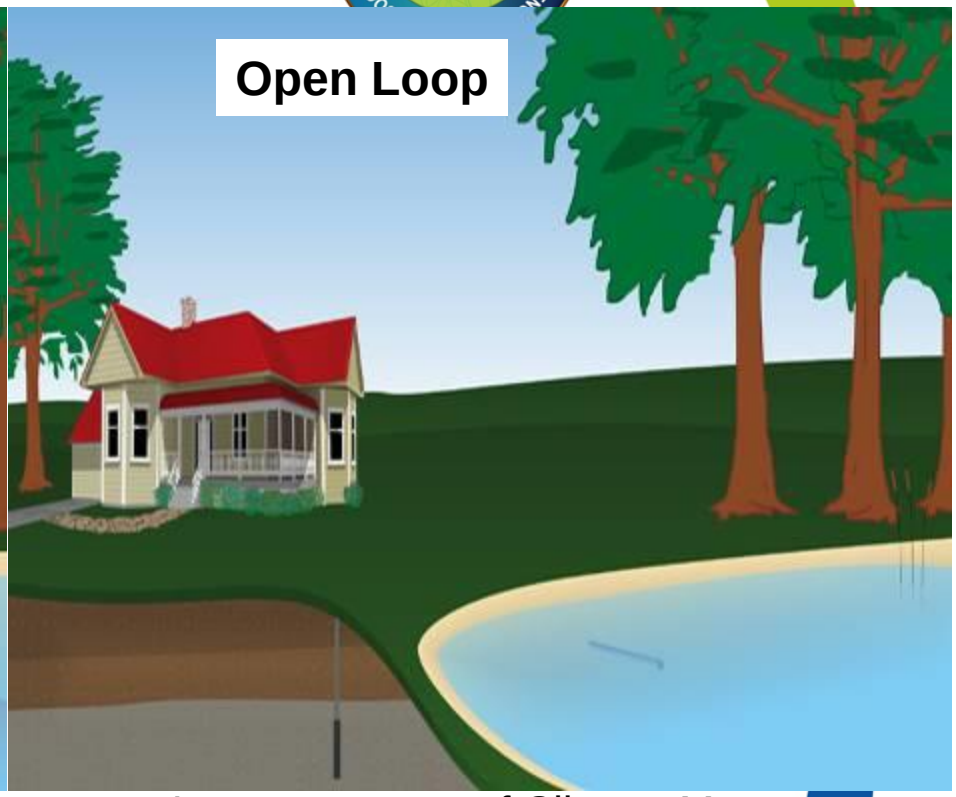
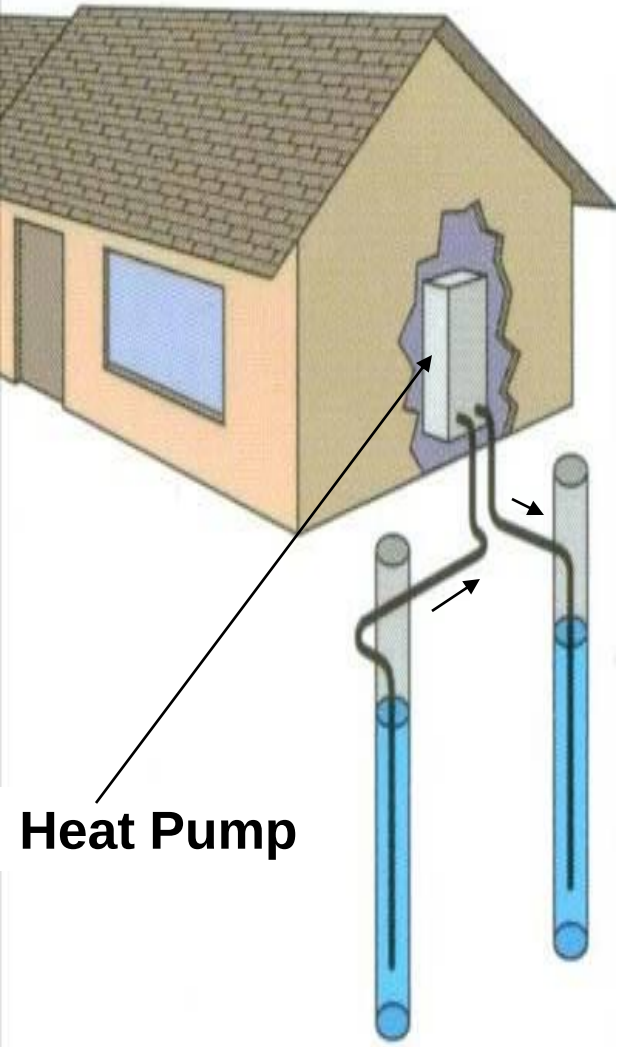


Image courtesy of Climate Master

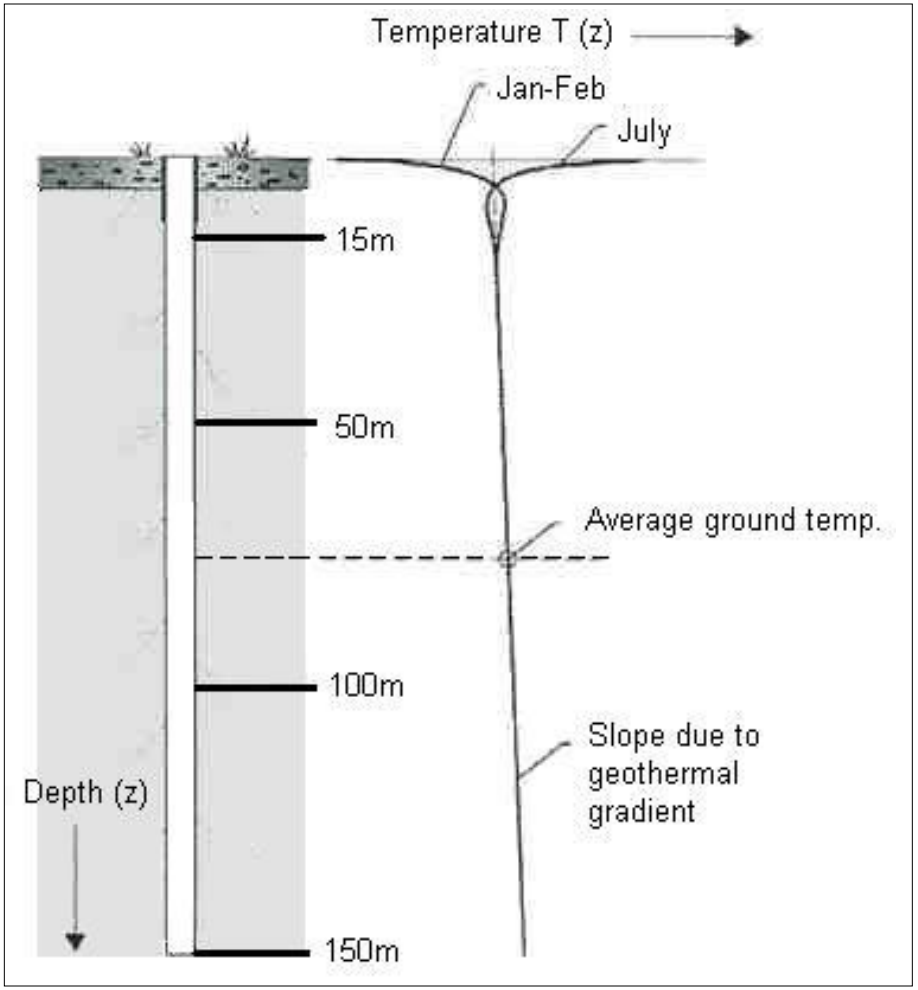
Open Loop installations actually pump water from an underground aquifer through the geothermal unit and then discharge that water to a drainage ditch or pond. Discharging water to a pond or lake is considered ideal.

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 or lake or ditch.

Closed Ground Loop



Ground temperatures

- **Depth < 15 m (*49.21 ft*): Ground temperature fluctuates according to ambient conditions.**
- **Depth ~ 15 m (*49.21 ft*): Ground temperature approximates mean annual air temperature.**
- **Depth > 15 m (*49.21 ft*): Ground temperature increases slightly with depth. This increase called the "geothermal gradient" is about 2°C per 100 m (*1°F per 100 ft*).**

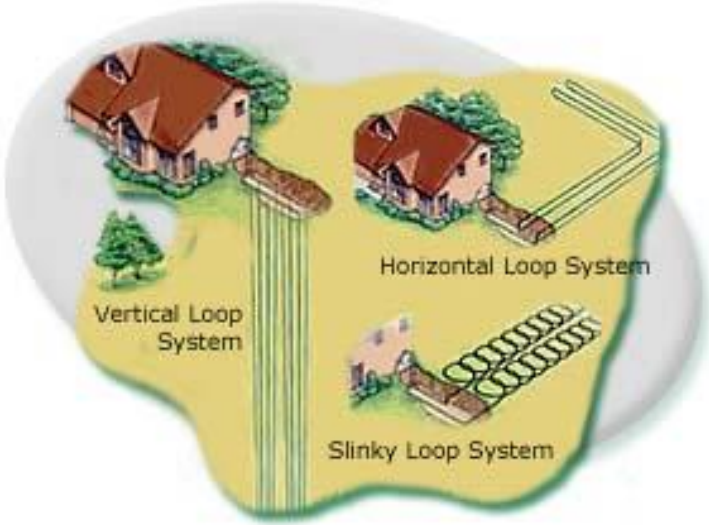
Ground Closed Loop System

Trenching

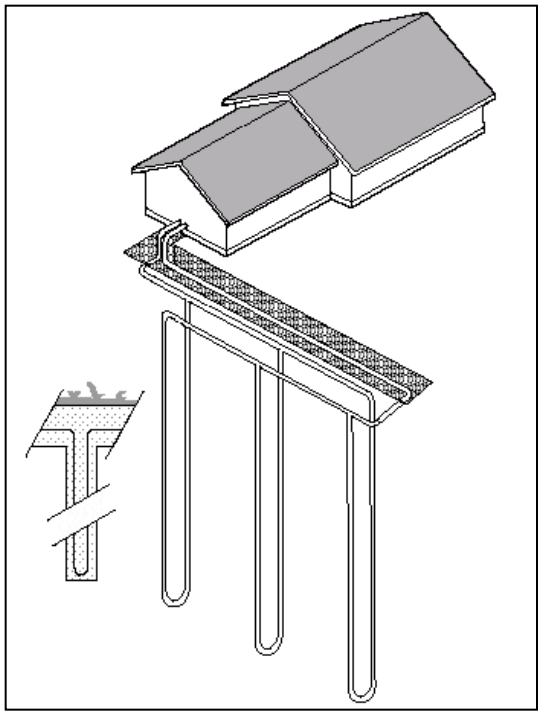
- Trenching-horizontal loops with one or more pipes in loops. 4’-5’ deep.
- Or Vertical Boring – vertical loop bore hole with one pipe down hole looping back to surface. Restricted space.
- Or Directional Boring - horizontal loop that can be under a building or parking lot.

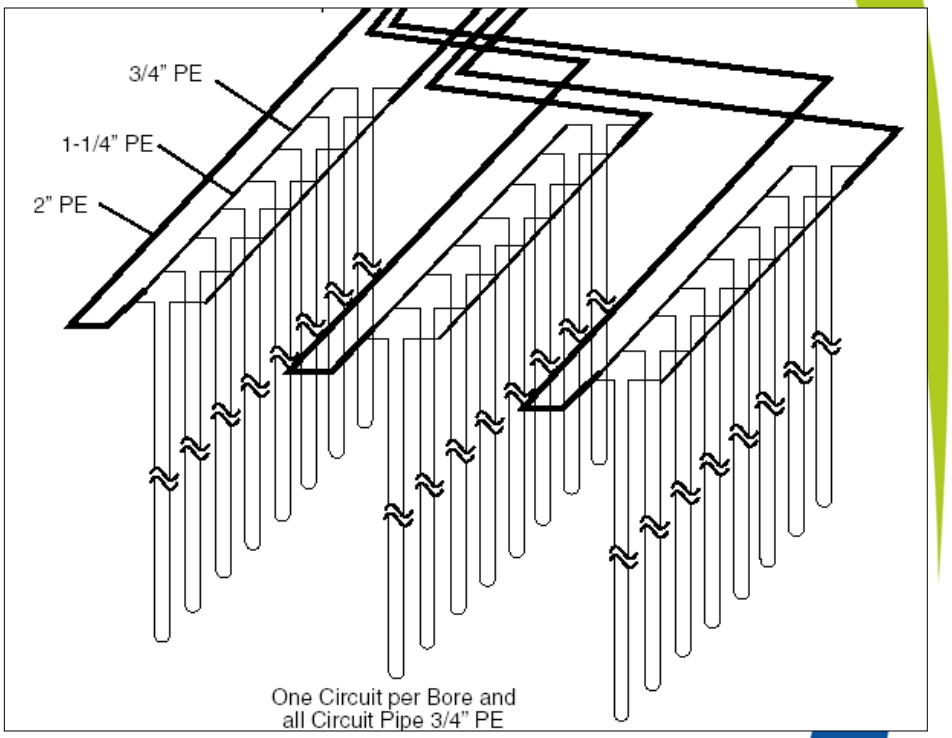
Vertical Boring

Directional Boring



Closed Ground Loop





Closed Ground Loop

Geothermal Potential in India

ADVANTAGES OF GEOTHERMAL

- WATER SAVING
- ENERGY EFFICIENT
- LONG LIFE
- NO MAINTENANCE
- EASY INSTALLATION

ADVANTAGES OF GEOTHERMAL

- **Reduces Pressure from Grid**
- **Reduces Dependence on Imported Oil**
- **Reduces Installation Size and Operating Cost of Captive Power Generator**
- **Going Geothermal adds Points towards Higher level of 'LEED' Certification with 'Indian Green Building Council'**

QUESTIONS

PLEASE ?

THANK YOU FOR YOUR TIME AND ATTENTION!