U.S. Department of Energy
Energy Efficiency and Renewable Energy

GEOTHERMAL HEAT PUMPS

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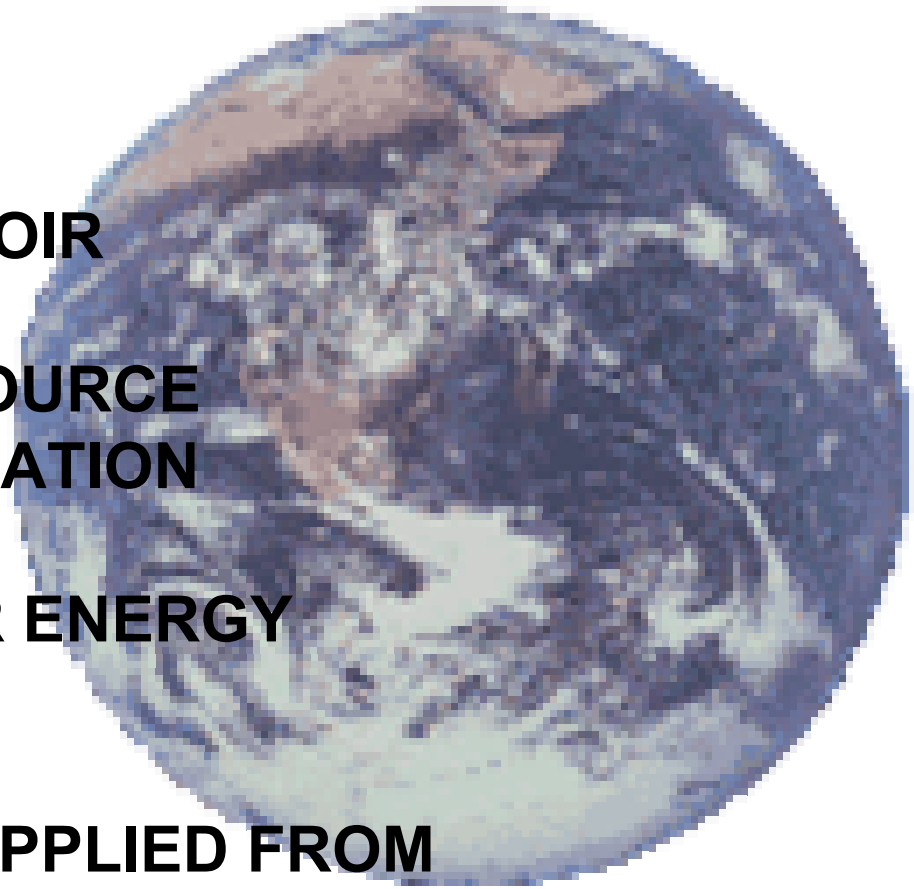
Geothermal Energy



- **GROUND: HEAT RESERVOIR**
- **RENEWABLE ENERGY SOURCE**
  FEDERAL CLASSIFICATION
- **47% OF INCIDENT SOLAR ENERGY**
  STORED IN EARTH
- **ADDITIONAL ENERGY SUPPLIED FROM**
  EARTH'S CORE

Geothermal Heat Pumps

- **LOW TEMPERATURE APPLICATION**
  GEOTHERMAL HEAT PUMP
  (GROUND SOURCE HEAT PUMP)

70% OF ENERGY: SOLAR

30% OF ENERGY: ELECTRICITY

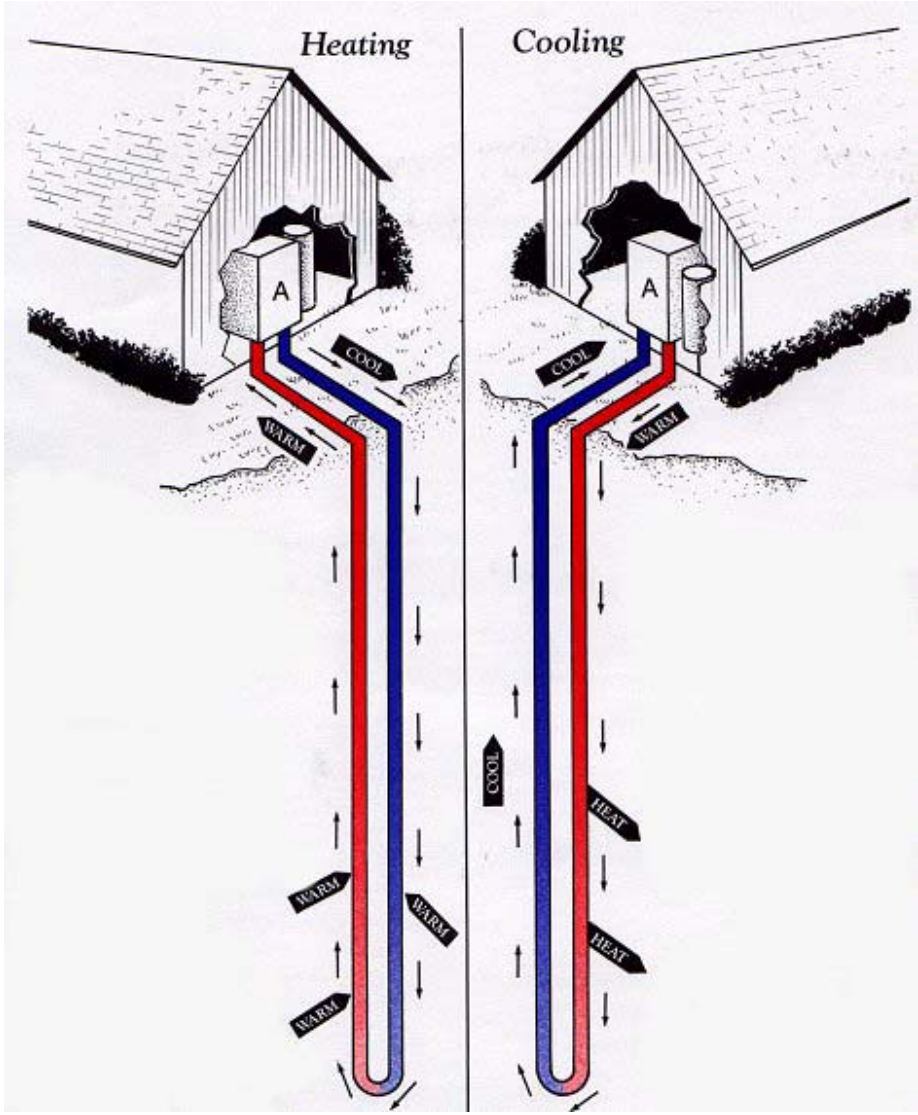
Geothermal Heat Pumps

HEATING MODE

EXTRACTS HEAT **FROM** THE GROUND

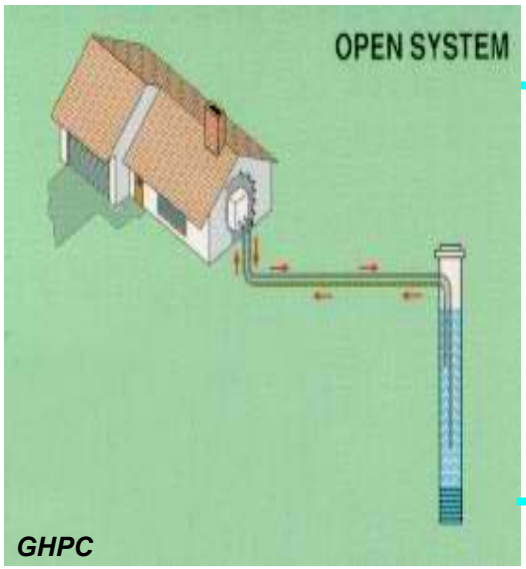
COOLING MODE

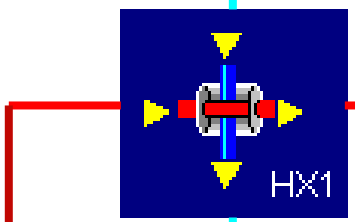
REJECTS HEAT **INTO** THE GROUND



SOURCE: EIA, 4/2000

Overall Configuration





SOURCE

BUILDING LOOP INTERFACE

DISTRIBUTION

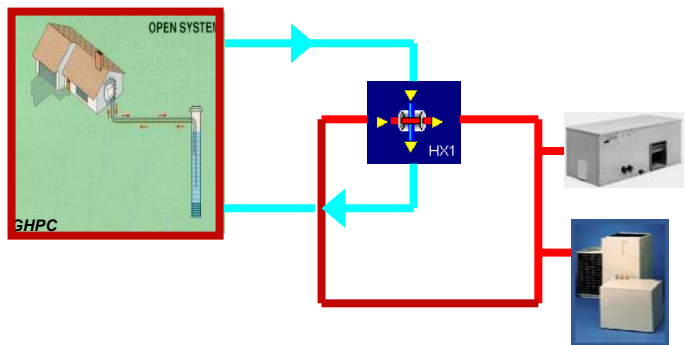
Geothermal Heat Pump Source Configurations

- **OPEN-LOOP SYSTEMS (WATER SOURCE)**
- **CLOSED-LOOP SYSTEMS**

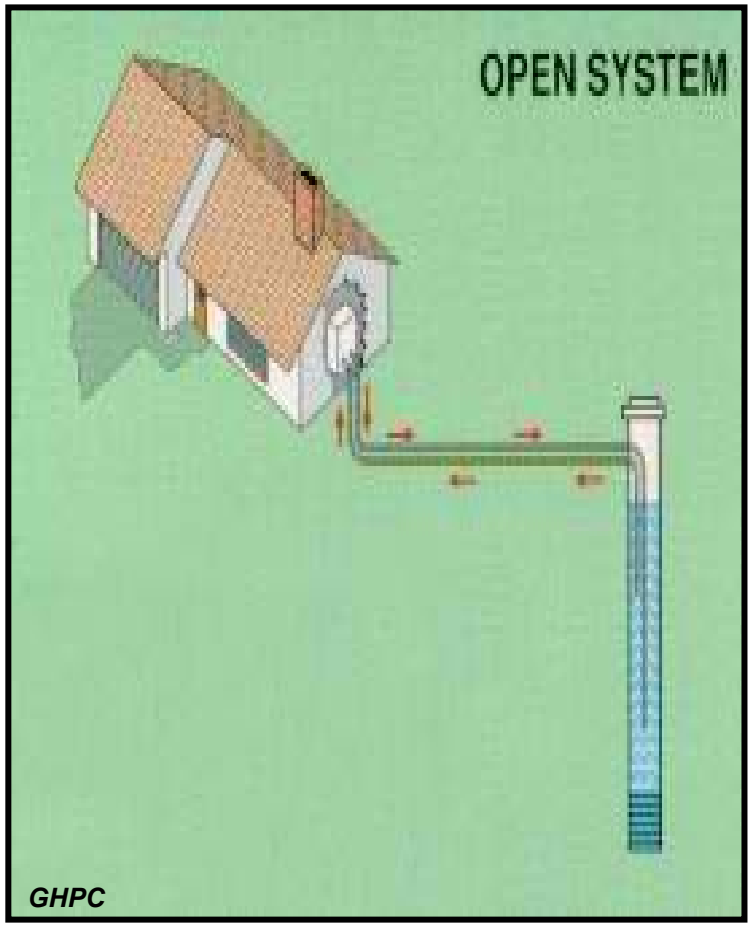
VERTICAL

HORIZONTAL

POND



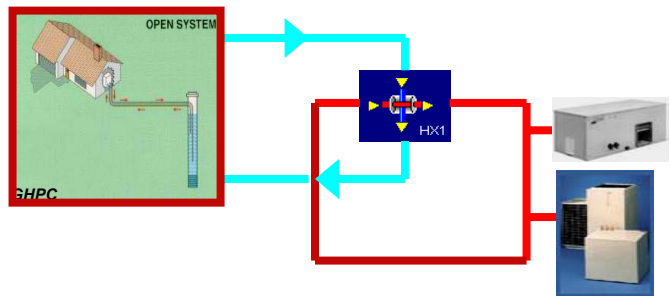
Open Loop



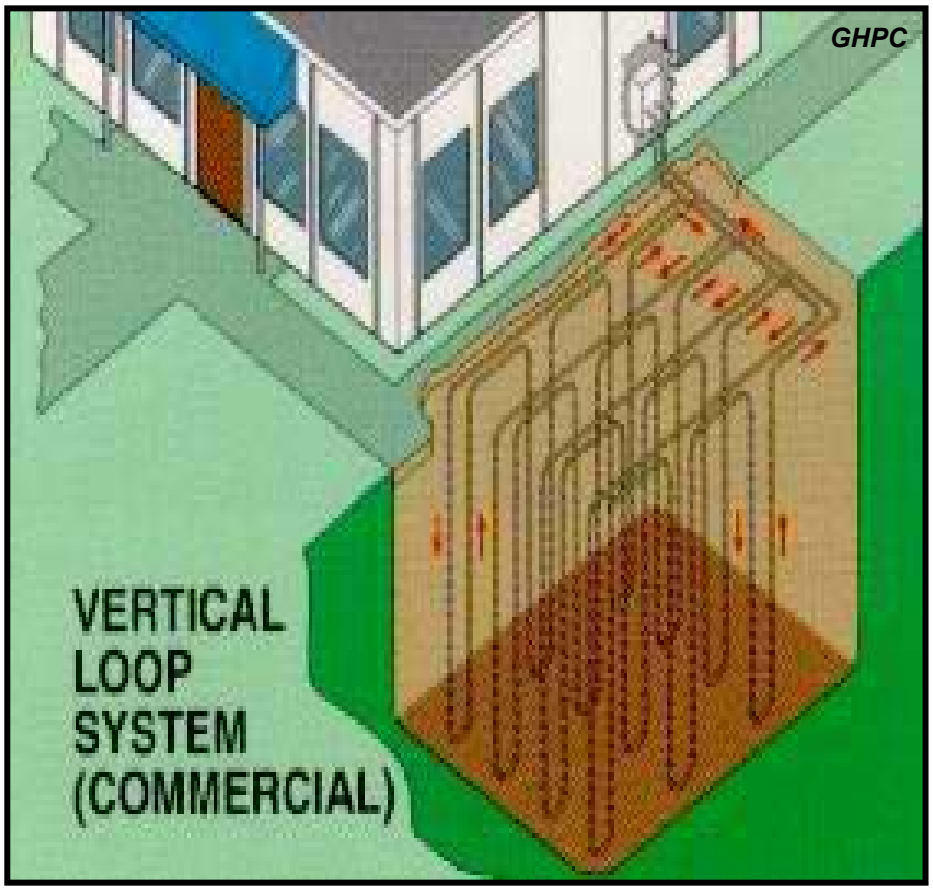
- **GROUND WATER IS HEAT DISTRIBUTION FLUID**
- **HIGH EFFICIENCY**
- **LOWER COST**
- **PRACTICALITY DEPENDS ON**

<u>WATER QUALITY</u>

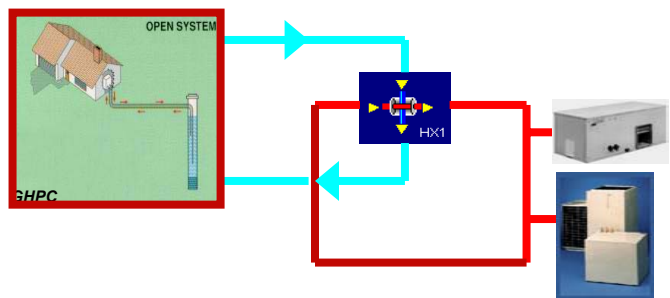
<u>WATER AVAILABILITY</u>



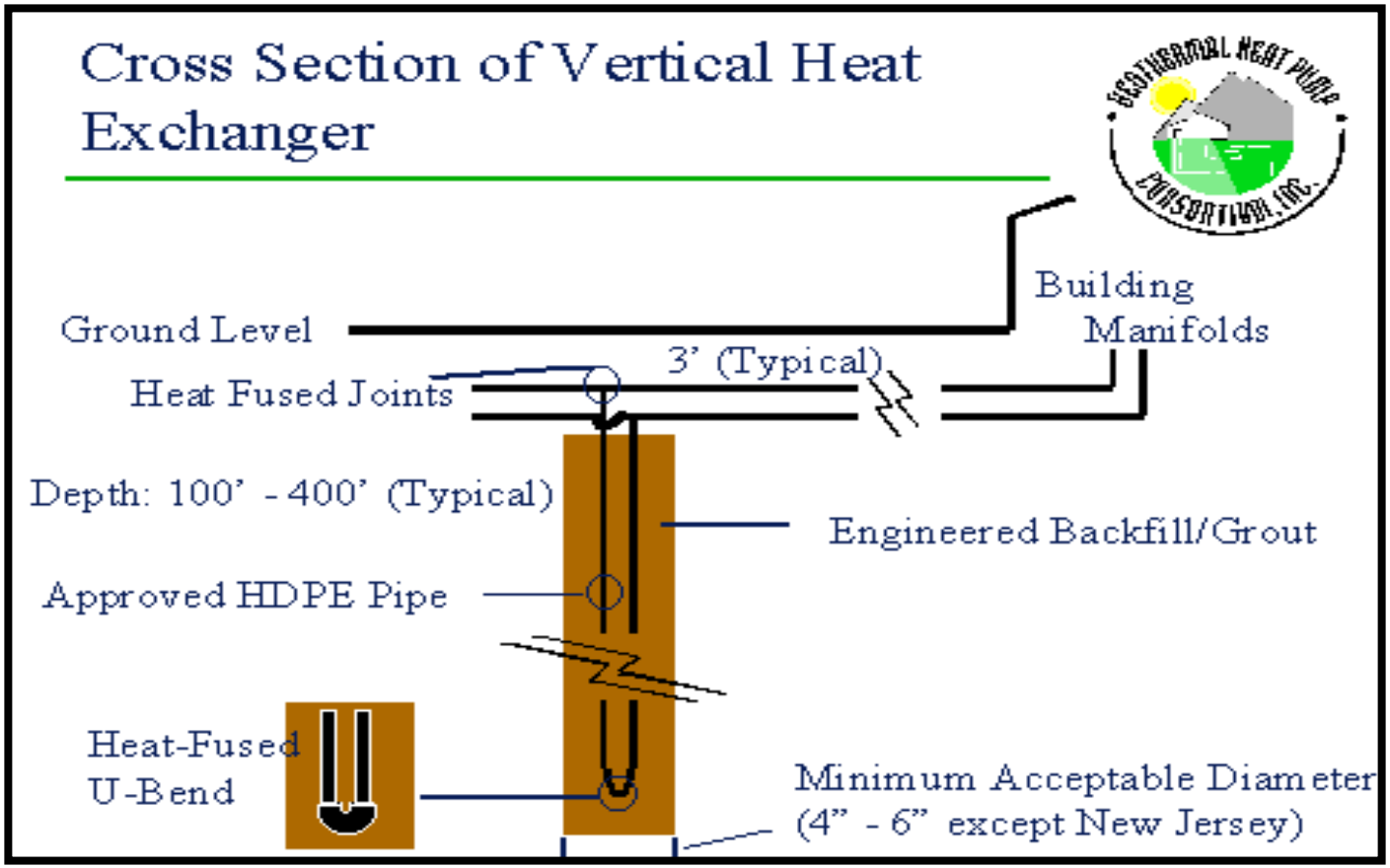
Closed-Loop System:Vertical

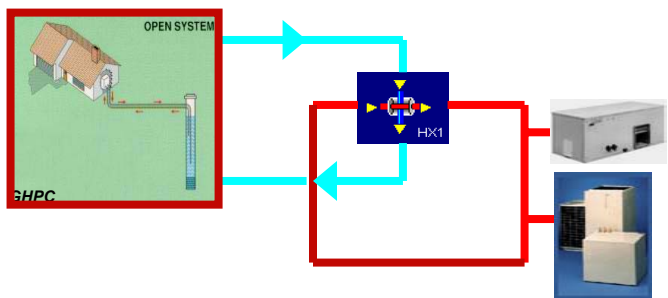


- **BORE HOLE 150-500 FT DEEP**
- **100-150 FEET OF HOLE PER TON**
- **UP TO 100 TONS PER ACRE**
- **BORE HOLES: 3 TO 8 INCHES IN DIAMETER**

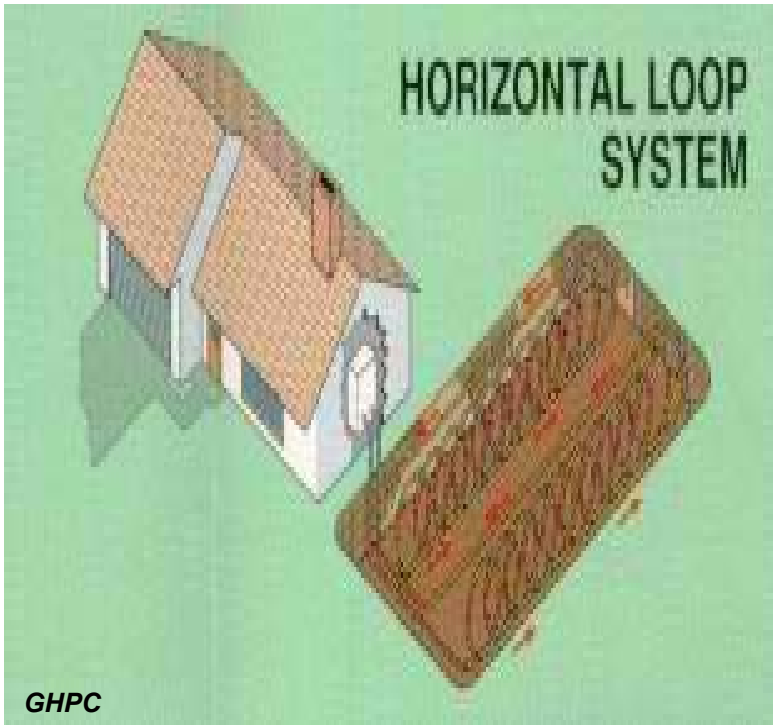


Closed-Loop System: Vertical

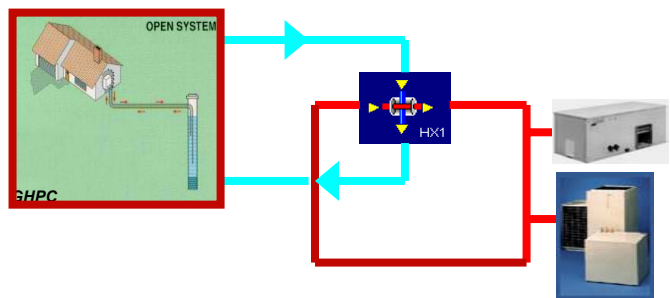




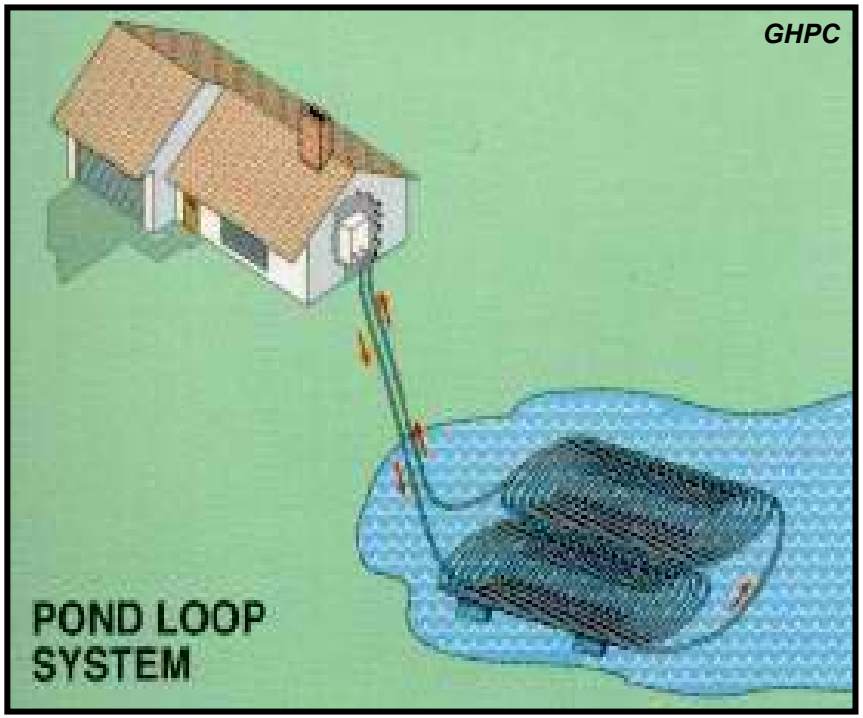
Closed-Loop System: Horizontal



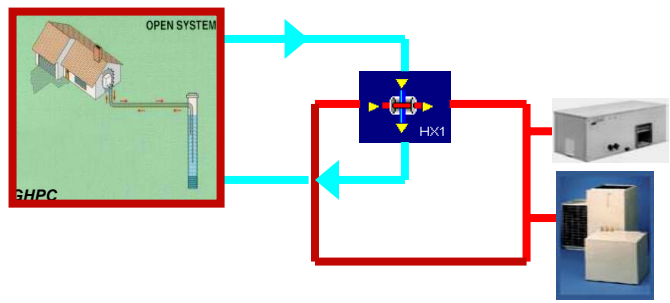
- **TRENCHES 4 TO 6 FEET DEEP**
- **COILS 100-400 FEET LONG**
- **AVOIDS WELL DRILLING COSTS**
- **APPROXIMATELY 20 TONS PER ACRE**



Closed-Loop System: Pond



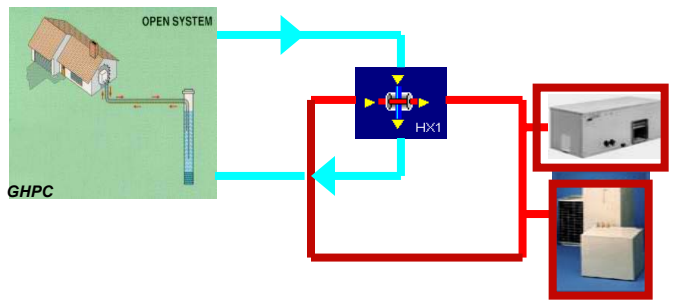
- **15 TONS PER ACRE**
- **ANCHORED TO BOTTOM**
- **6 FEET MINIMUM DEPTH**



Distribution System

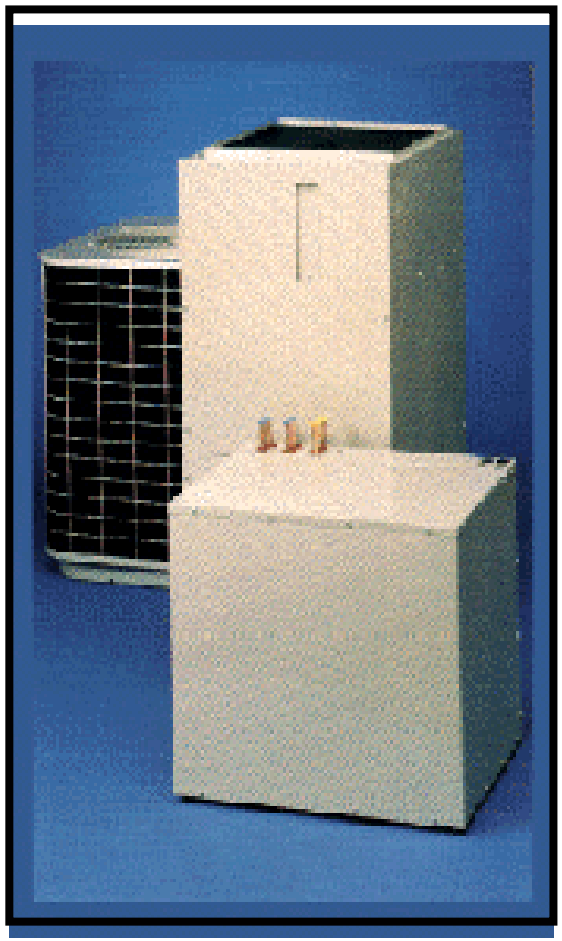
- **WATER TO WATER HEAT PUMP**

- **RADIANT SURFACES**
- **VALENCE UNITS**
- **AIR HANDLING UNITS**

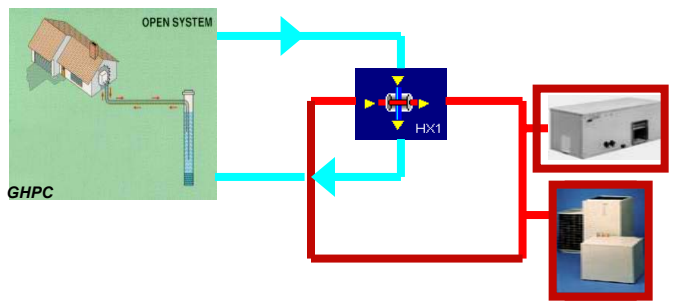


Distribution System

- **WATER TO AIR HEAT PUMP**



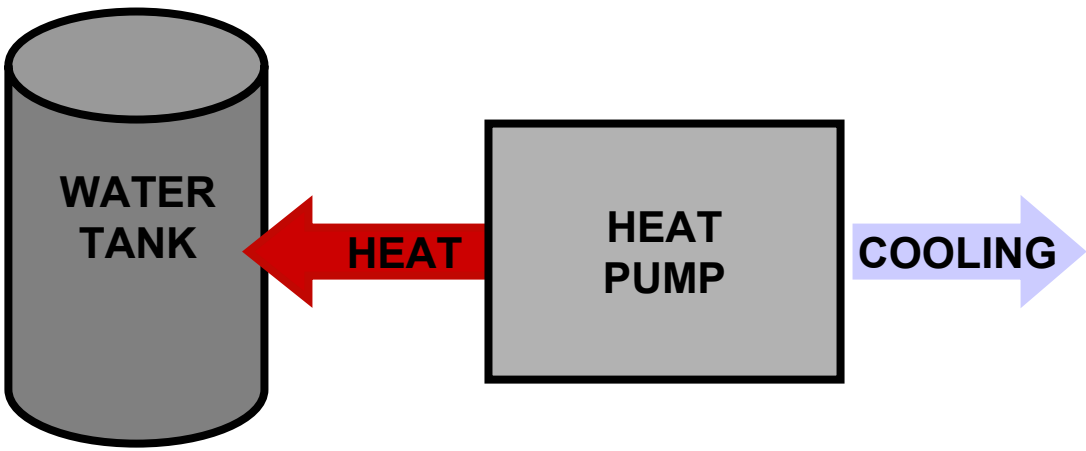
- **DUCTED DISTRIBUTION**
- **VAV SYSTEMS**



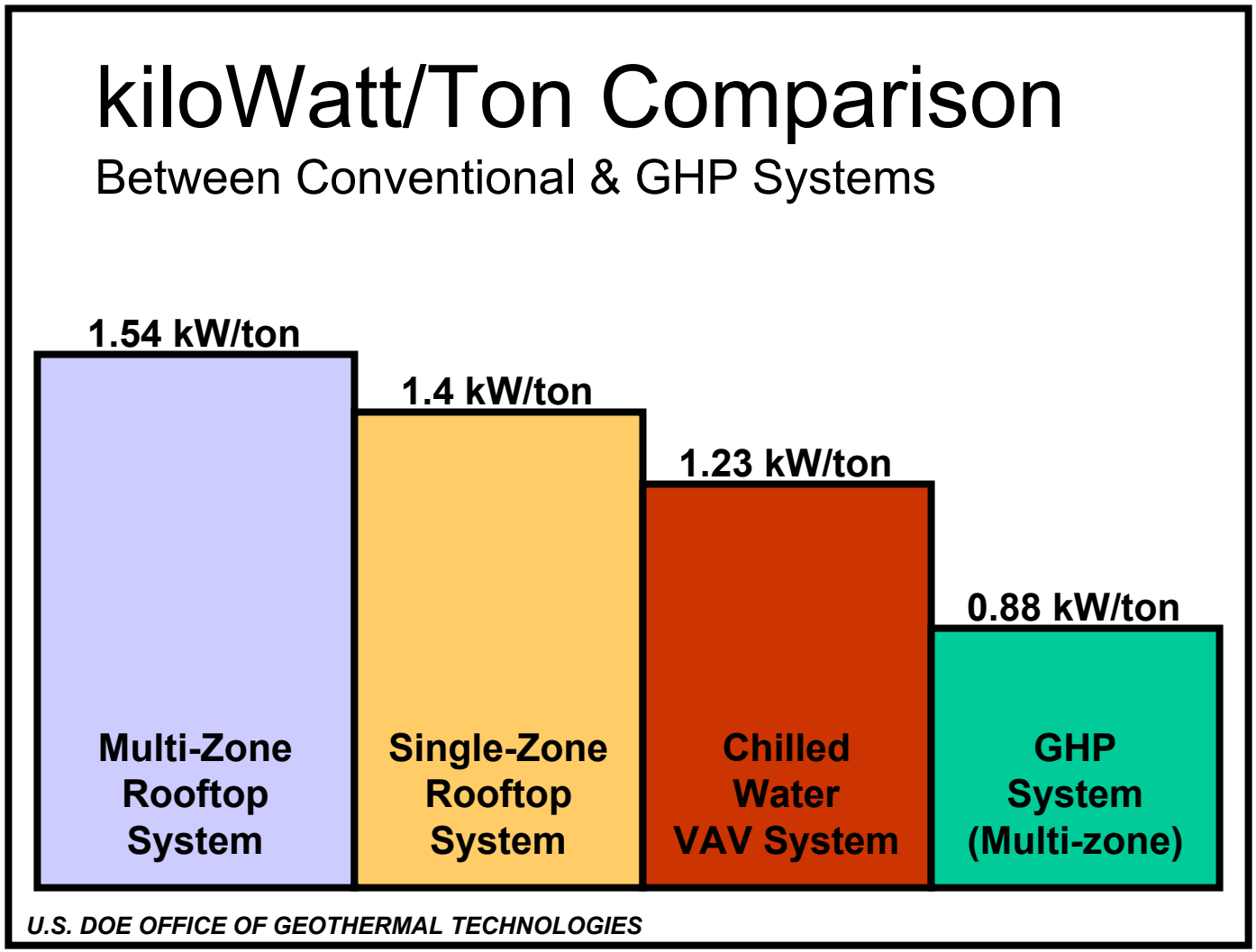
SERVICE HOT WATER

DIRECT: WATER-TO-WATER HEAT PUMP

INDIRECT: DESUPERHEATER



Energy Savings



Energy Savings

- **GEOTHERMAL HEAT PUMPS**

  SEER: 12.0 TO 22.0
  COP: 2.8 TO 4.9

- **AIR TO AIR HEAT PUMPS**

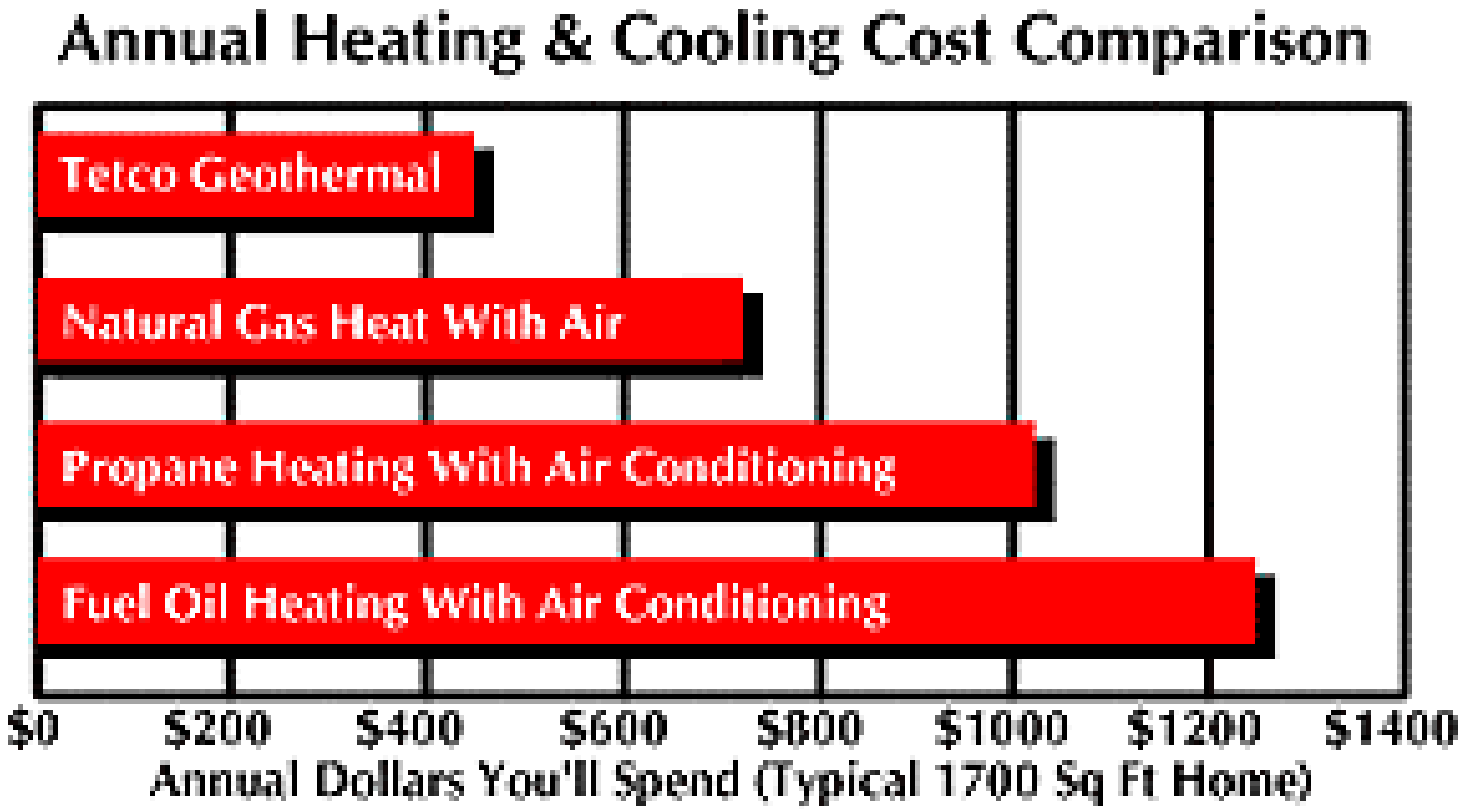
  SEER: 12.0 TO 16.0
  HSPF: 6.8 TO 8.9

- **48% MORE EFFICIENT THAN BEST GAS FURNACE**

- **50% MORE EFFICIENT THAN BEST AIR TO AIR HEAT PUMP**

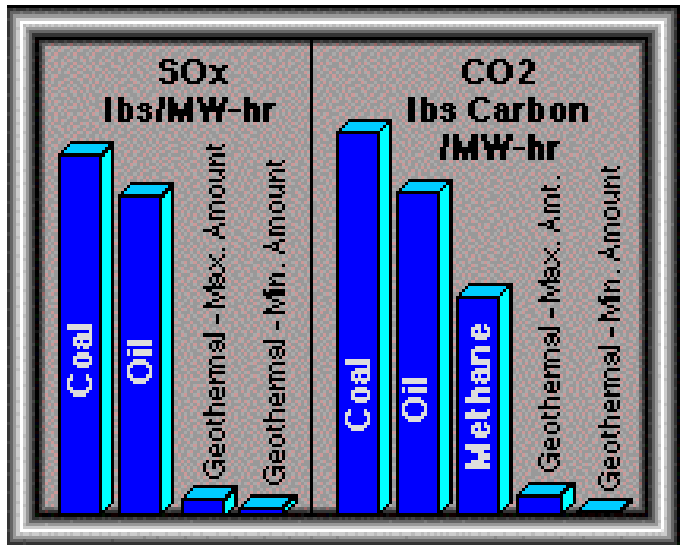
- **75% MORE EFFICIENT THAN OIL FURNACE**

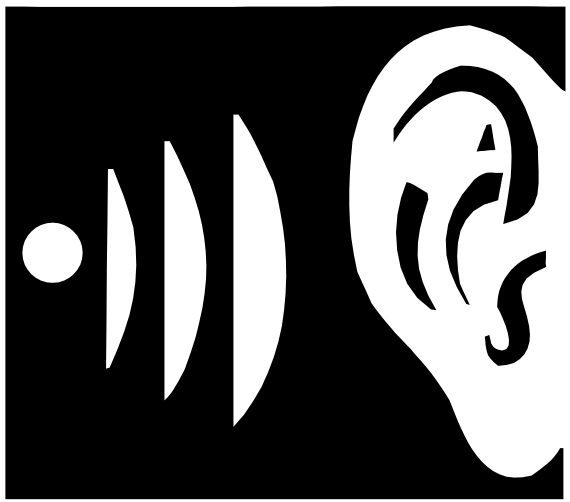
Energy Cost Savings



Environmental Benefits

- **REDUCED EMISSIONS**





- **REDUCED NOISE**

- **FACTORY-SEALED REFRIGERANT SYSTEM**

Other Benefits

- **LOWER MAINTENANCE COSTS**
  - **10-22 CENTS / FT² / YR vs.**
  - **38-50 CENTS / FT² / YR**
- **GREATER COMFORT**
  - **WARMER SUPPLY AIR TEMP.**
  - **BETTER DEHUMIDIFICATION**
- **LOWER AIR FLOW RATES**
  - **SMALLER DUCTWORK**

Other Benefits

- **NO ROOF PENETRATIONS**
- **NO OUTDOOR EQUIPMENT**
- **20% - 50% LESS SPACE IN MECHANICAL ROOMS**
- **LONGER SYSTEM LIFE**

Geothermal Heat Pump Disadvantages

- **INITIAL COST**

  $13 - $15 PER SQUARE FOOT (CLOSED LOOP)

  $13 - $15 PER SQUARE FOOT (VAV SYSTEM)

  $11 PER SQUARE FOOT (BOILER / CHILLER)

- **SPACE AVAILABILITY**

Further Information

1. **EPA: ENERGY STAR PRODUCTS**
   WWW.ENERGYSTAR.GOV

2. **GEOTHERMAL HEAT PUMP CONSORTIUM**
   GEOEXCHANGE: 1-800-255-4436
   WWW.GHPC.ORG
   WWW.GEOEXCHANGE.ORG

3. **GEO-HEAT CENTER**
   1-541-885-1750
   WWW.GEOHEAT.OIT.EDU/INDEX.HTM

4. **INTERNATIONAL GROUND SOURCE HEAT PUMP ASSOCIATION (IGSHPA): 1-800-626-4747**
   WWW.IGSHPA.OKSTATE.EDU

Further Information

6. **US DEPARTMENT OF ENERGY**
   GEOTHERMAL DIVISION: 1-202-586-5340
   WWW.EREN.DOE.GOV/RE/GEOTHERMAL.HTML

5. **NATIONAL GROUND WATER ASSOCIATION**
   1-800-551-7379
   WWW.NGWA.ORG

7. **USGA GROUNDWATER ATLAS OF THE US**
   HTTP://CAPP.WATER.USGS.GOV/GWA/INDEX.HTML
   USGS INTERACTIVE MAP
   HTTP://SEARCH.USGS.GOV
   AMERICAN ASSOCIATION OF STATE GEOLOGISTS
   WWW.STATEGEOLOGISTS.ORG