

Ground Source Heat Pumps in the Central Valley

Civil Engineering

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Abstract

This project provides a review of ground source heat pump technology and location specific parameters with a goal of proposing an ideal ground source heat pump system for residential use in Central California. The project includes a review of ground source heat pump technology to include the type (open vs. closed loop), orientation (vertical vs. horizontal), fluid type, and thermal performance.

Based on the location used for this project, the application of ground source heat pumps for residential dwellings in the Central Valley would yield positive results. Benefits would be seen by individual home owners (lower energy bills), in addition to the community through lower emission releases via power plants and air conditioning units.

Introduction

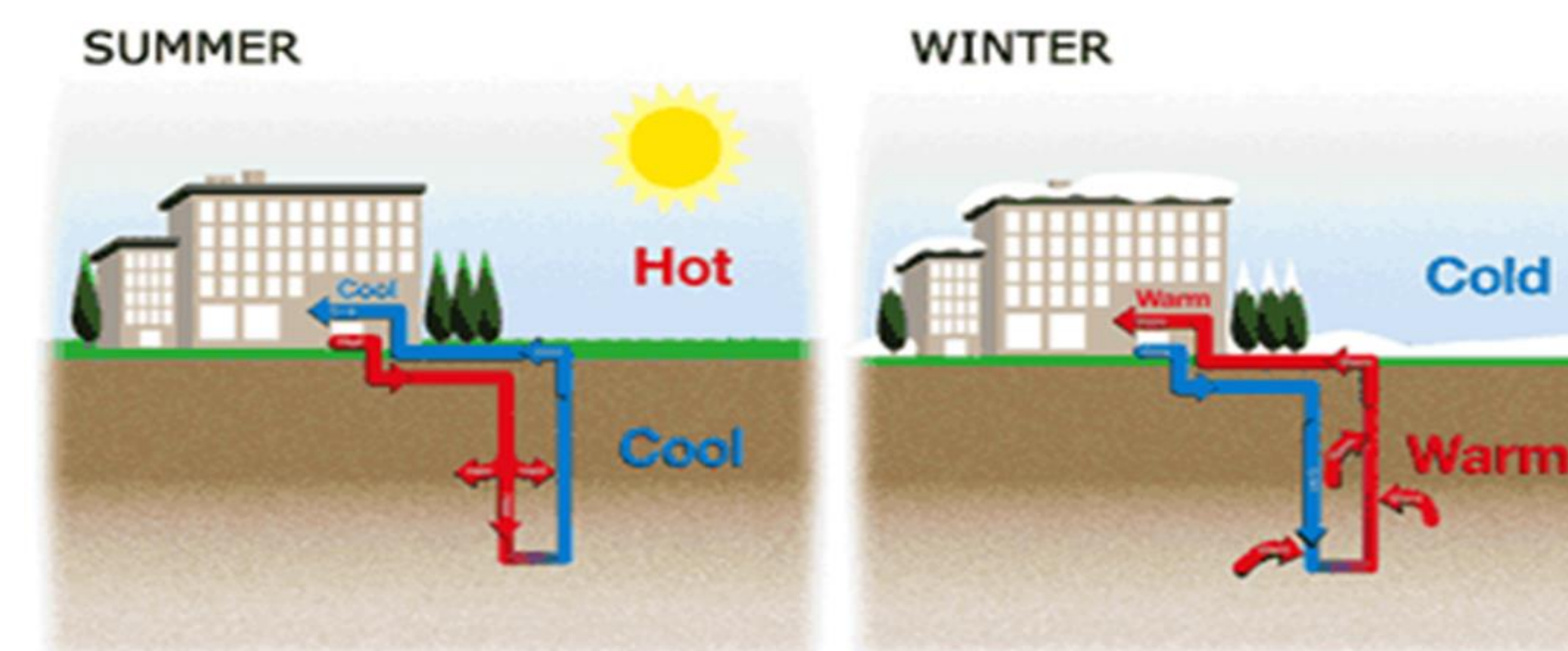


Figure 1: Basic System Operation and Layout ⁸

Utilizes constant ground temperature to heat the building in the winter and cool the building in the summer. System is 70% more efficient than common HVAC systems in place.

Technology

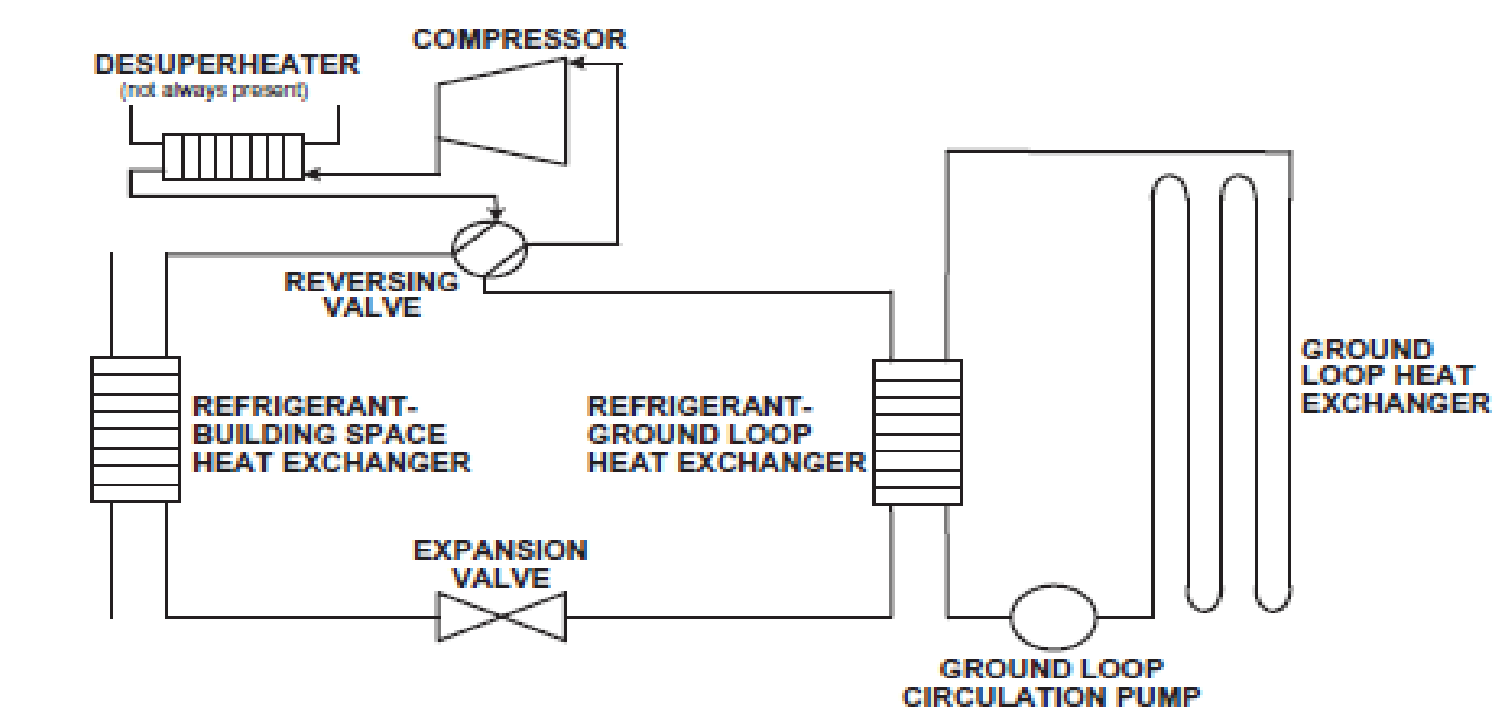


Figure 2: Diagram of Ground Source Heat Pump System ⁷

- **Circulation Pump** – Used to circulate fluid through ground for heating or cooling purposes
- **Heat Exchanger** – Permits transfer of lower fluid temperatures to air for system
- **Reversing Valve** – Allows switch from summer to winter for cooling/heating system
- **Compressor** – Increases pressure of Freon for lower output temperatures

Vertical Closed Loop

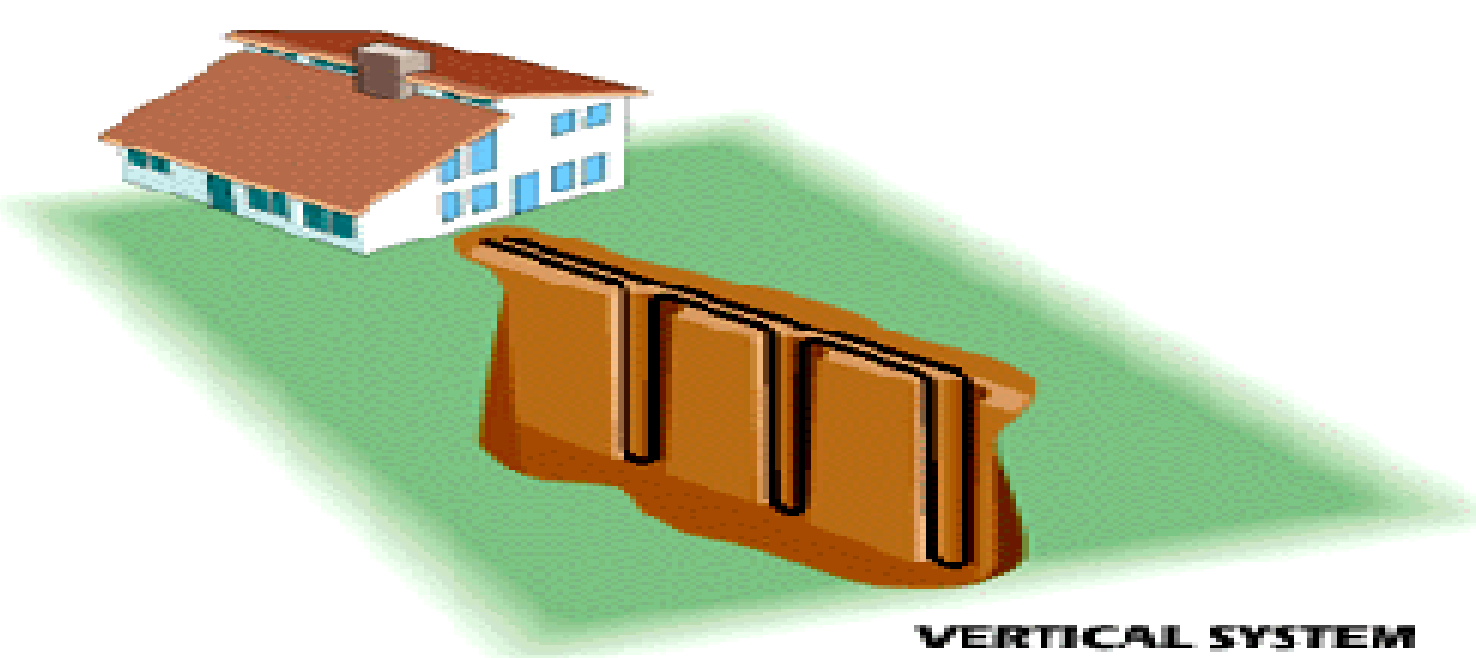


Figure 3: Image of Vertical Looped System ²

Pros

- Longer project design life
- Less surface area required
- Cooler temperatures can be achieved

Cons

- Greater initial capital required
- Challenging for residential application
- Efficiency is lowered

Horizontal Closed Loop

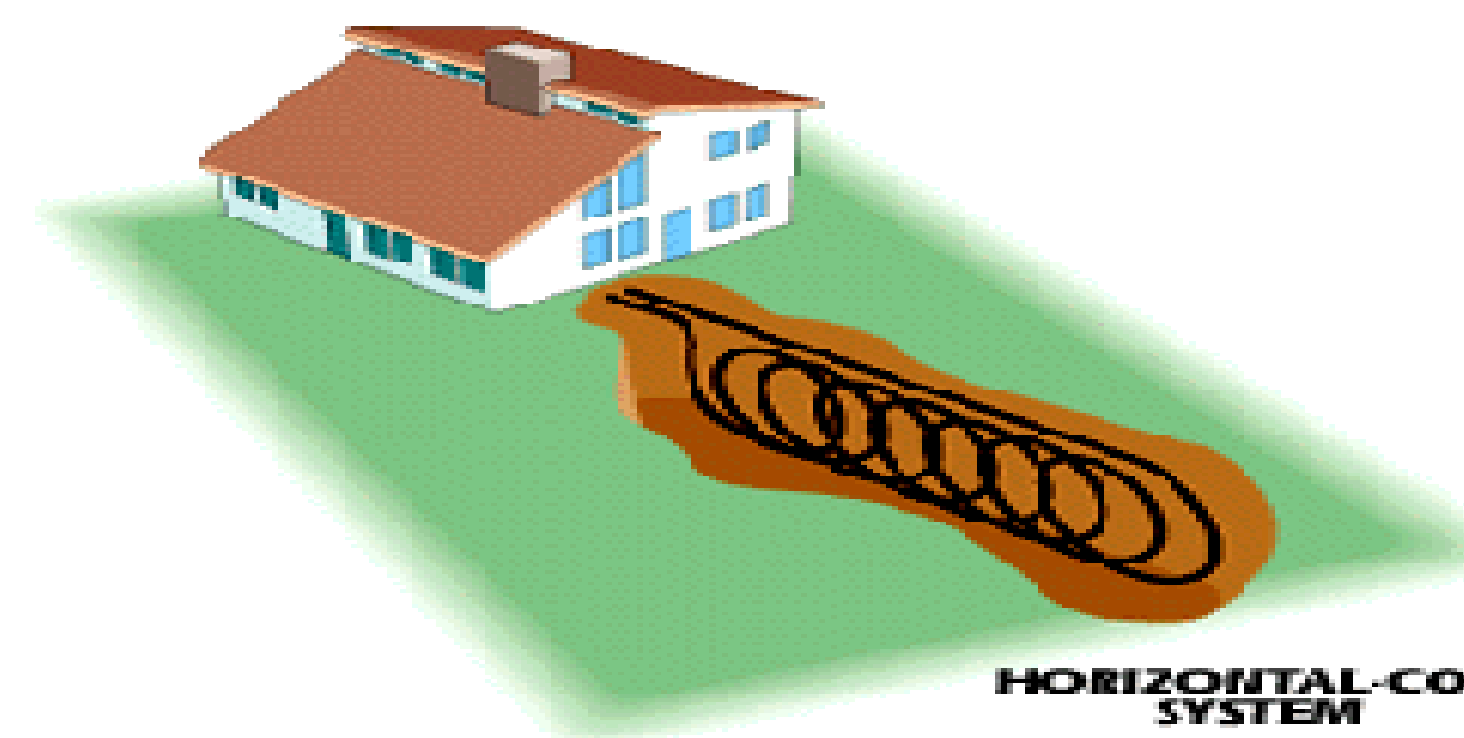


Figure 4: Image of Horizontal Looped System ²

Pros

- Lower initial capital required
- Simple installation process
- Maintenance for system is relatively easy

Cons

- Shorter project design life
- Greater surface area required

Environmental Considerations

- Sustainable energy source
- Close to a 70% reduction in energy use compared to traditional electric heating and cooling equipment
- Reduce greenhouse gas emissions (CO₂, NO_x and SO₂)
- Sealed systems minimize risk to ozone layer
- Heat is transferred in underground loops with no external venting or air pollution
- Reduces peak electrical grid demand
- A typical 3 ton system is equivalent to planting 1 acre of trees or removing 2 cars from the road

Analysis

- Geothermal Heating has a higher upfront cost than traditional HVAC
- Best used for new construction or replacement of broken system
- Annual cost savings in Fresno ~ \$1100.00
- Payoff period is 5-8 years depending on the size of the system
- System life is ~ 25 years
- 30% tax credit thru Dec 2016

Conclusion

The project has determined the following outcomes:

- The Central Valley is a prime location for ground source heat pumps
- Horizontal closed loop system would be the best for residential purposes
- Ground source heat pumps would be a cost effective way to reduce household energy bills and reduce carbon emissions

Further study is required for the effects on ground quality where ground source heat pumps have been installed

References

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