

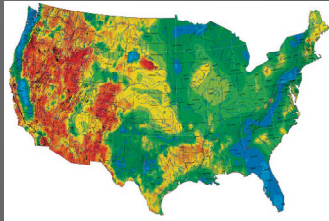


# Feasibility of Geothermal Power Production in the United States

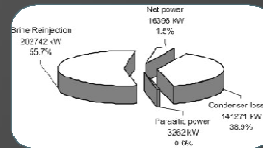
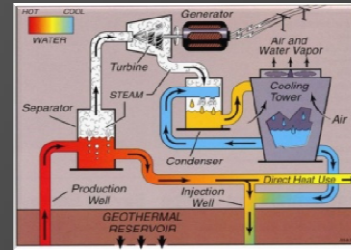
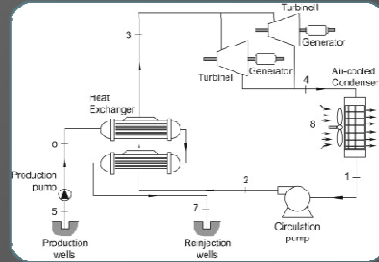
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## Abstract

Large-scale geothermal electricity production is one of the few renewable energy resources that are able to replace base load power plants. What this project aimed to accomplish was to demonstrate how geothermal electricity production is a more feasible alternative to the current sources of energy available for large-scale power generation. To understand how geothermal energy has manifested, a brief overview of the history has been analyzed, and a summary of current policies have been included in this study. The technology behind the industry was also one of the key aspects of geothermal energy, as well as its environmental impacts and economic viability. Other sources of energy such as nuclear, coal, solar, and wind, have also been compared to geothermal energy as well, so as to give an understanding of the benefits of increasing the number of geothermal power plants in the US.



Heat Flow:  
25-150 mW/M<sup>2</sup>



## Average Power Plants

### Approx. MW

- ❖ Nuclear = 800 MW
- ❖ Solar = 400 MW
- ❖ Wind = 500 MW
- ❖ Geothermal = 50 MW
- ❖ Coal = 1 GW

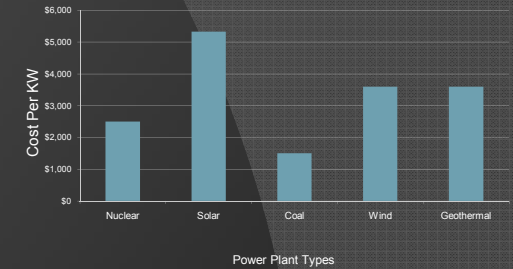
### Approx. Cost

- ❖ Nuclear = \$2 Billion
- ❖ Solar = \$1.6 Billion
- ❖ Wind = \$1.8 Billion
- ❖ Geothermal = \$180 Million
- ❖ Coal = \$1.5 Billion

### Approx. Time

- ❖ Nuclear = 20 years
- ❖ Solar = 4 years
- ❖ Wind = 16 months
- ❖ Geothermal = 16 months
- ❖ Coal = 3 years

## Construction Costs Per Kilowatt



## Historical Overview

### California

- State with the most Geothermal Resources

### Geysers Power Plant

- First in Nation, developed in the 70's, still running today

### Imperial Valley

- Home of the largest Geothermal Resource in the state

## Policies

### Advanced Geothermal Energy Research and Development Act of 2007

- Gives instructions to the Sec. Of Energy to support the advancements of geothermal systems

### Carbon Tax

- A proposition to place a tax on energy sources that give off CO<sub>2</sub>, so to make geothermal more competitive

### Energy Policy Act of 2005

- Gave legislation to help the government and other companies a way to lease and buy land that was known to be a KGRA



## Geothermal Technology

- Geothermal reservoirs found with several techniques
- Drilling similar to oil and gas except high temperature and low pressure
- 3 main types of plants
  - Dry steam
- High temperature vapor-dominated reservoirs (>170° C)
  - Very rare
  - Flash steam
- High temperature water-dominated reservoirs (>170° C)
  - Runs hot water through a flash tank to generate steam
  - Binary cycle
- Low temperature reservoirs (120-170° C)
  - Geothermal water heats a working fluid that runs the turbine
  - Sources below 120° C used for direct heat applications
- Enhanced geothermal system (EGS) have the potential to greatly increase available resources
- Create fractures in hot dry rock that a fluid can be pumped through to run a turbine

## Conclusion

Much of the technology used for geothermal power generation already exists or can be adapted from other sources. The efficiency of a geothermal system is only 20%, but that is common among power generation facilities. The environmental impacts of geothermal Energy facilities are less than the other current energy sources. Gas emissions from geothermal plants are small to zero in comparison to coal and oil plants, and leaks and earthquakes are unlikely. The problem of intruding into wildlife habitats still remains, but Acts for the conservation of wildlife should be carefully considered. Finally, geothermal energy is very practical from an economic standpoint, since geothermal energy is cheap, and is also a base load generator. The biggest downside, though, is that geothermal power plants are not as cheap as coal or even nuclear power plants. In light of these facts, this group decided that increasing the focus of energy production to geothermal energy away from other forms of energy that are either more costly or more dangerous would be a prudent energy strategy for the US government.

## Gaseous emissions (Air)

- NCG's such as CO<sub>2</sub> and H<sub>2</sub>S (Carbon Dioxide and Hydrogen Sulfide) as well as small amounts of methane and ammonia.
- Emitted into the air through steam release.
- Systems injects NCG's gases back underground

## Leaks (Land)

- Fluid leaking toxic chemicals (such as Boron Mercury) into the surrounding soil
- Reinforced well pipes prevent leaks
- Seismicity- earthquake activity- is also possible from reinjection of fluids.
- Unavoidable due to hot spots tendency to locate near fault lines, where earthquakes are most likely. However, this has not been a major problem.

## Discharge (Water)

- Water contaminated with toxic elements from underground leaking into rivers or ponds.
- This contamination disrupts the ecosystem of the body of water, either by toxic contaminants or temperature increase.
- To avoid this, binary systems use separate liquid to turn the turbines that does not come in contact with the toxic fluid from the subsurface.

## Emissions Comparison of Different Power Plants

