

Summary and Conclusion

XVI. The Big Picture: Electricity Production and its Consequences

Despite improvements in coal, natural gas, and oil power plant technology, fossil fuel combustion continues to produce more air pollution than any other single source.¹³² Power plants contribute close to 60 percent of U.S. water pollution.¹³³

The EPA, in its discussion of power plant impacts, notes that “fossil fuel-fired power plants are responsible for 67 percent of the nation's sulfur dioxide emissions, 23 percent of nitrogen oxide emissions, and 40 percent of man-made carbon dioxide emissions.”¹³⁴

These pollutants have been widely documented to cause a host of environmental and health problems, including smog formation, respiratory attacks in children and seniors, acid rain that damages water bodies and forests, nitrogen emissions that lead to dead zones of aquatic life, mercury contamination of lakes and streams that has led 40 states to issue fish mercury advisories, and carbon dioxide-driven climate change that results in destructive floods, droughts, heat waves, intense storms, and climate-related infectious disease.¹³⁵

The EPA highlights the increasingly important role of green power in contributing to the clean air goals of the U.S. According to a number of EPA studies, if all states were to implement “cost-effective energy efficiency and clean energy policies, the expected growth in demand for electricity could be cut in half by 2025, providing billions of dollars in customer savings, contributing to lower prices for natural gas, and substantially reducing greenhouse gas emissions.”¹³⁶

Although green power pollutes significantly less than fossil fuel sources, it is important to note that all power generation impacts the environment, regardless of whether electricity is derived from the combustion of fossil fuel or renewable sources. Impacts such as land use, for example, cannot be avoided no matter what level of mitigation is employed. The

¹³² U.S. EPA (2004). *How Does Energy Use Affect the Environment?* Retrieved September 29, 2004, from <http://www.epa.gov/cleanenergy/impacts.htm>

¹³³ National Aerodynamics and Space Administration [NASA] Glenn Research Center. *Pollution*. Retrieved December 1, 2004, from <http://www.grc.nasa.gov/WWW/K-12/fenlewis/Pollution.html>

¹³⁴ U.S. EPA (2004). *How Does Energy Use Affect the Environment?* Retrieved September 29, 2004, from <http://www.epa.gov/cleanenergy/impacts.htm>

¹³⁵ Hawkins, David G., Director, Air & Energy Programs., Natural Resources Defense Council [NRDC]. (March 21, 2001). “*Harmonizing the Clean Air Act with Our Nation’s Energy Policy*.” U.S. Senate Hearing Testimony before the Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety, Committee on Environment and Public Works Retrieved November 11, 2004, from http://epw.senate.gov/107th/haw_0321.htm.

¹³⁶ U.S. EPA. NREL (2004). *EPA-State Energy Efficiency and Renewable Energy Projects*. Retrieved March 8, 2005, from http://www.epa.gov/cleanenergy/pdf/eere_factsheet.pdf.

goal, instead of eliminating all impacts, should be to minimize impacts. Because we cannot feasibly shut down all electricity producers, we must look to alternative sources such as geothermal energy.

XVII. Summarized Environmental Benefits of Geothermal Energy

In light of the inevitable impact and use of energy, specifically electricity, in the United States, it is important to consider the environmental benefits of geothermal energy, especially when compared to more common energy sources such as fossil fuels. Although geothermal provides environmentally sound electricity to millions of Americans, it supplies only a small percentage of total domestic electricity. In highlighting some of the most important environmental benefits of geothermal energy, the bullets below support the expanded development of geothermal power production.

- *Geothermal energy is reliable.* Because geothermal resources are available 24 hours a day regardless of changing weather, geothermal energy is as reliable as any fossil fuel facility. Geothermal is a renewable energy technology that can offer baseload or intermediate power, is dispatchable, and can achieve high capacity factors. Geothermal represents a plentiful resource that has not been utilized to its full potential. As an additional bonus, geothermal energy does not rely upon energy imports. Geothermal is an indigenous source of energy.
- *Geothermal energy is renewable.* Geothermal resources are sustainable because of the heat from the earth and water injection, and thus will not diminish like fossil fuel reserves. As time progresses and technology improves, our ability to extract geothermal resources with ease will increase, not decrease.
- *Geothermal energy produces minimal air emissions and offsets the high air emissions of fossil fuel-fired power plants.* Emissions of nitrous oxide, hydrogen sulfide, sulfur dioxide, particulate matter, and carbon dioxide are extremely low, especially when compared to fossil fuel emissions. The binary geothermal plant, which currently represents around 15 percent of all geothermal plant capacity, along with the flash/binary plant, produce nearly zero air emissions. Lake County, California, downwind of The Geysers, has met all federal and state ambient air quality standards for seventeen years. At The Geysers, air quality has even improved as a result of geothermal development because hydrogen sulfide, which would ordinarily be released naturally into the atmosphere by hot springs and fumaroles, instead now passes through an abatement system that reduces hydrogen sulfide emissions by 99.9 percent.
- *Geothermal energy can offset other environmental impacts.* Wastewater that would otherwise damage surface waters is being used to recharge The Geysers geothermal system and irrigate local land. In addition, electricity generation from geothermal resources eliminates the mining, processing and transporting required

for electricity generation from fossil fuel resources. Finally, research into the extraction of minerals from geothermal fluids is showing great promise. Use of extraction technology would allow for the production of minerals without the environmental impacts of mining.

- *Geothermal energy is combustion free.* Unlike fossil fuel power plants, no smoke is emitted from geothermal power plants, because no burning takes place: only steam is emitted from geothermal facilities.
- *Geothermal energy minimally impacts land.* According to the U.S. Department of Energy, geothermal energy uses less land than other energy sources, both fossil fuel and renewable. No transportation of geothermal resources is necessary, because the resource is tapped directly at its source.
- *Geothermal energy is competitive with other energy technologies when environmental costs are considered.* A 1995 study estimates that costs of power generation would increase 17 percent for natural gas and 25 percent for coal if environmental costs were included.¹³⁷ These costs include land degradation, potentially toxic emissions, forced extinction and destruction of animals and plants, and health impacts to humans.

XVIII. Conclusion

Abundant geothermal resources throughout the nation can provide an environmentally friendly source of energy. Data compiled from a variety of sources point to geothermal energy as an environmental option for new power generation that is far better than other energy sources such as fossil fuels. In addition, geothermal remains as environmentally friendly as most other renewable sources, while simultaneously offering reliability and a source of baseload power that is unique among most other renewable options available. The Department of Energy, along with several scientific laboratories, conducts research on a regular basis to improve the already minimal environmental impacts of geothermal energy and to decrease the associated costs.

While currently used at only a fraction of its potential, geothermal energy can substantially contribute to the energy needs of the twenty-first century. With increased federal research and development funding in conjunction with supportive renewable energy policies, the Union of Concerned Scientists (UCS) estimates that renewable sources of energy could meet 20 percent of the nation's electricity needs by 2020, with geothermal contributing 19 percent of the overall renewable contribution (just under 4 percent of total domestic electricity needs).¹³⁸ If this UCS geothermal projection can be

¹³⁷ Haberle and Flynn (1995). *Comparative Economics and Benefits of Electricity Produced from Geothermal Resources in the State of Nevada*. Univ. of Nevada, Las Vegas.

¹³⁸ UCS (October 2001). *Clean Energy Blueprint*. Retrieved October 18, 2004, from <http://www.ucsusa.org/documents/blueprint.pdf>.

achieved, geothermal development—in the United States alone—will increase by almost thirteen times its current use. As geothermal energy production is refined and expanded, the benefits continue to grow.

With continued technological development, geothermal can be expanded from the western states to all of the United States, and the already negligible environmental geothermal impacts can be reduced to nearly zero. Geothermal energy can provide the clean, reliable, and plentiful renewable energy resource for our nation and for the world.

Glossary¹³⁹

Acid Rain: Also called acid precipitation or acid deposition, acid rain is precipitation containing harmful amounts of nitric and sulfuric acids formed primarily by nitrogen oxides and sulfur oxides released into the atmosphere when fossil fuels are burned. It can be wet precipitation (rain, snow, or fog) or dry precipitation (absorbed gaseous and particulate matter, aerosol particles or dust). Acid rain has a pH below 5.6. Normal rain has a pH of about 5.6, which is slightly acidic. The term pH is a measure of acidity or alkalinity and ranges from 0 to 14. A pH measurement of 7 is regarded as neutral. Measurements below 7 indicate increased acidity, while those above indicate increased alkalinity.

Air Pollution: Unwanted particles, mist or gases put into the atmosphere as a result of motor vehicle exhaust, the operation of industrial facilities or other human activity.

Ambient: Natural condition of the environment at any given time.

Anthropogenic:¹⁴⁰ Caused by human action, such as changes in vegetation, an ecosystem, or an entire landscape.

Aquaculture:¹⁴¹ farming of organisms that live in water, such as fish, shellfish, and algae.

Baseload: The lowest level of power production needs during a season or year.

Baseload Plants: Electricity-generating units that are operated to meet the constant or minimum load on the system. The cost of energy from such units is usually the lowest available to the system.

Binary-Cycle Plant: A geothermal electricity generating plant employing a closed-loop heat exchange system in which the heat of the geothermal fluid (the "primary fluid") is transferred to a lower-boiling-point fluid (the "secondary" or "working" fluid), which is thereby vaporized and used to drive a turbine/generator set.

Biomass: Energy resources derived from organic matter. These include wood, agricultural waste and other living-cell material that can be burned to produce heat energy. They also include algae, sewage and other organic substances that may be used to make energy through chemical processes.

Bituminous Coal: A dense coal, usually black, sometimes dark brown, often with well-defined bands of bright and dull material, used primarily as fuel in steam-electric power generation, with substantial quantities also used for heat and power applications in manufacturing and to make coke. Bituminous coal is the most abundant coal in active U.S. mining regions. Its moisture

¹³⁹ All terms from Energy Information Administration [EIA] (2002). *Glossary of Electricity Terms*. Retrieved December 13, 2004, from <http://www.eia.doe.gov/cneaf/electricity/epav1/glossary.html>, California Energy Commission [CEC] (2004). Retrieved December 13, 2004, from <http://www.energy.ca.gov/glossary/>. *Glossary of Energy Terms*. Retrieved January 7, 2005, or U.S. DOE Energy Efficiency and Renewable Energy Geothermal Technologies Program. *Geothermal Glossary*. Retrieved April 14, 2005, from <http://www.eere.energy.gov/geothermal/glossary.html>, unless otherwise noted.

¹⁴⁰ Source: USGS

¹⁴¹ Ibid.