



GEA Issue Brief

Geothermal Energy's Future Potential

The heat of the Earth is considered limitless; its use is only limited by technology and the associated costs. There have been several recent reports examining the amount of energy production the US could achieve from geothermal resources in the future.

2006 NREL Workshop Report

In 2006 the National Renewable Energy Laboratory (NREL) released a report, *Geothermal—The Energy Under Our Feet*, which estimates domestic geothermal resources. The report estimates that 26,000 MW of geothermal power could be developed by 2015, with direct use and heat pumps contributing another 20,000 MW of thermal energy. The report suggests that by 2025 more than 100,000 MW of geothermal power could be in production, with direct use and heat pumps adding another 70,000 MW of thermal energy.⁽⁴⁾

As the report concludes, “these estimates show the enormous potential of the U.S. geothermal resource.” For power production, the report includes specific estimates of the potential for identified resources, deep geothermal co-produced fluids and geopressured resources, and EGS. In addition, the report examines the potential for geothermal direct use and geothermal heat pumps.

The report does not include hidden or undiscovered geothermal systems, which the USGS report estimates have substantial energy potential. Nor does the report specifically examine small power systems (distributed generation). For more information on the NREL report, please visit <http://www1.eere.energy.gov/geothermal/pdfs/40665.pdf>.

2008 USGS Western States Power Assessment

In 2008, the US Geologic Survey issued the first part of their on-going assessment of US geothermal resource potential. The report focuses on only the 13 western states and examines only medium and low temperature resource potential for electric power production from conventional hydrothermal resources, undiscovered hydrothermal resources and enhanced geothermal systems. The USGS geothermal estimate into three categories:

- **Identified Geothermal Systems:** The resource is either liquid or vapor dominated and has moderate to high temperature. The resource is either producing (the reservoir is currently generating electric power), confirmed (the reservoir has been evaluated with a successful commercial flow test of a production well), or potential (there are reliable estimates of temperature and volume for the reservoir but no successful well tests to date).

- **Undiscovered Geothermal Resources:** Geothermal resources were assessed for the same 13 states in which the identified resources are located. The assessment was based on mapping potential via regression analysis.
- **Enhanced Geothermal Systems (EGS):** Resource probability in regions characterized by high temperatures but low permeability and lack of water in rock formations.

The assessment estimates power generation potential as follows:

- **Identified Geothermal Systems:** 3,675 MWe (95% probability) to 16,457 MWe (5% probability)
- **Undiscovered Geothermal Systems:** 7,917 MWe (95% probability) to 73,286 MWe (5% probability)
- **EGS:** 345,100 MWe (95% probability) to 727,900 MWe (5% probability).

The USGS assessment evaluates geothermal resources in the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. The assessment identified 241 moderate-temperature (90 to 150°C; 194 to 302°F) and high-temperature (greater than 150°C) geothermal systems located on private and public lands in these states. Geothermal systems located on public lands closed to development, such as national parks, were not included in the assessment. Electric-power generation potential was also determined for several low-temperature (less than 90°C) systems in Alaska for which local conditions make electric power generation feasible.

Although the assessment only accounted for large-scale geothermal power production, the USGS is in the process of updating information about direct use, small power, oil and gas co-production and geopressed resources and the potential energy contribution of those portions of the geothermal resource base are not included in the estimates above.

The USGS assessment is the first new national geothermal resource assessment since 1979, when USGS released its last geothermal resource estimate, Circular 790. A new component of the 2008 assessment is the inclusion of production potential of EGS techniques. For more information on the USGS assessment, please visit http://www.usgs.gov/newsroom/article.asp?ID=2027&from=rss_home.

2006 MIT Report

In 2006, Massachusetts Institute of Technology (MIT) prepared an analysis of the future geothermal potential in the U.S. The report estimated that geothermal systems could produce 100 GWe in the next 50 years with a reasonable investment in R&D. The report, *The Future of Geothermal Energy*, is available at: http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf
http://www1.eere.energy.gov/geothermal/future_geothermal.html

International Estimates

There has not been a significant new analysis of international geothermal potential comparable to either the USGS report or the NREL report discussed above. A 1999 study that used fairly conservative assumptions about the resource base and technology concluded that geothermal resources using existing technology have the potential to support between 35,448 and 72,392 MW of worldwide electrical generation capacity. (Geothermal Energy: *The Potential for Clean Power from the Earth*, available at: <http://www.geo-energy.org/publications/reports.asp>.) Using enhanced technology (defined as the technology expected to be available by 2009), the geothermal resources could support between 65,576 and 138,131 MW of electrical generation capacity. Assuming a 90% availability factor, which is well within the range experienced by geothermal power plants, this electric capacity could produce as much as 1,089 billion kWh of electricity annually. The estimates produced for world energy potential by this study did not assess the limits of geothermal resource base, nor the potential for new development with significantly different technologies, such as engineered geothermal systems.

An estimate of world geothermal resources made by the Energy and Geoscience Institute for the President's Council of Advisors on Science and Technology stated the following for different geologic regimes.

World Continental Geothermal Resources:

Geologic Regime: Joules (J) bbl oil equivalent
Magmatic Systems 15×10^{24} J $2,400,000 \times 10^9$ bbl
Crustal Heat 490×10^{24} J $79,000,000 \times 10^9$ bbl
Thermal Aquifers 810×10^{18} J 130×10^9 bbl
Geopressured Basins 2.5×10^{24} J $410,000 \times 10^9$ bbl
Total Oil Reserves (for comparison) $5,300 \times 10^9$ bbl*

*National Academy of Sciences, 1990: includes crude oil, heavy oil, tar sands, and oil shale

Suggested Additional Reading (available at: <http://www.geo-energy.org/>):

- Geothermal 101: Basics of Geothermal Energy Production and Use. This 53-page booklet covers the basics of geothermal energy, from the types of power plants in use to common myths with numerous charts, graphs and pictures.

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