

The *Lotus Live* Guide to **Geothermal**

(Draft Copy as of 11/19/07)

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Geothermal Fundamentals

Origin of Geothermal Energy

- Geothermal energy is heat from the 7000°C core of the earth, 6500 km underground. Much of this heat is left over from the formation of the Earth from stellar gas and dust 4.6 billion years ago, but radioactive decay from metals in the earth's core also contributes to it.¹

Energy in Steam

- Coming soon.

Geothermal History

- **The Last 10,000 Years:** Geothermal springs have been used for warmth, cooking, and bathing.
- **1830:** In Hot Springs, Arkansas, Asa Thompson charges a dollar for a bath in geothermal spring water - the first known commercial use of geothermal energy.
- **1847:** William Bell Elliot discovers steaming valley north of San Francisco, which he calls the Geysers. He believes he has found the gates of Hell.
- **1904:** First geothermal power plant is built in Tuscany, where steam is erupting from the earth.

Types of Geothermal Power Plants

- **Dry Steam Plants:** steam from underground is used to directly drive steam turbines to generate electricity.
- **Flash Steam Plants:** high pressure hot water is converted to steam to drive steam turbines to generate electricity. When it condenses, it is injected back into the ground to be recycled. Most geothermal is flash geothermal.
- **Binary Plants:** heat from geothermal water is transferred to a separate working fluid, which evaporates, and drives a steam turbine to generate electricity.
- **Hot Dry Rock:** theoretically, water could be injected into hot dry rock to extract the heat. This requires deep drilling, and is still being developed.

¹ (Breeze 2005, 170)

Resource Potential

How Much Heat Is There?

- 32 TW_{th} of geothermal heat reach the earth's surface every year² - more than twice what we use for all purposes.³ This heat is extremely diffuse, however, with a mean geothermal flux of 0.06 W/m² across the earth's surface, so we cannot tap all of this energy.⁴ The use that we get out of geothermal comes mostly from areas of concentrated heat, where magma is close to the surface, and heats up rocks that we have access to through drilling.

Renewability

Is Geothermal Power "Renewable"?

- Coming soon.

Economics

Capital Costs

- Coming soon.

² (Boyle 2004, 12) - converted from 1008 EJ/yr conduction in rocks, 9.36 EJ/yr convection in volcanos and springs

³ 14 TW (SOURCE)

⁴ Earth has a surface area of 510,065,600,000,000 m².

United States Geothermal

Installed Geothermal Electric Capacity

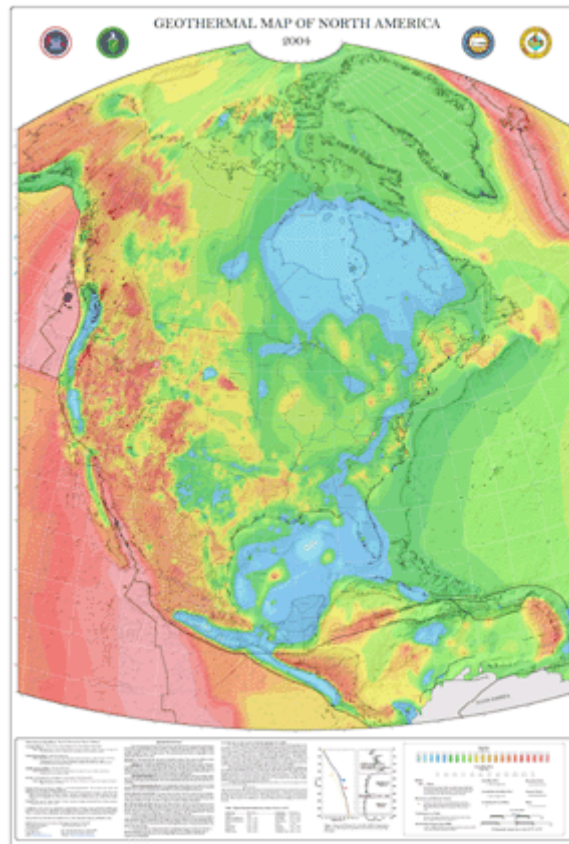
- In 2005, the U.S. had 2544 MW_e of geothermal electricity capacity installed. The U.S. is the world geo-electricity leader, in terms of installed capacity with 28% of the world capacity. (Updated data available from: [International Geothermal Association](#))

Installed Geothermal Direct Use Capacity

- In 2000, the U.S. had 3766 MW_{th} of geothermal direct use heating installed. The U.S. is the world geothermal direct use leader, in terms of installed capacity with 25% of the world capacity. (Updated data available from: [International Geothermal Association](#))

Map of Geothermal Flux

Below is a thumbnail of the high quality *Geothermal Map of North America, 2004* from the [American Assoc. of Petroleum Geologists](#). ([High quality version](#) with [legend](#))

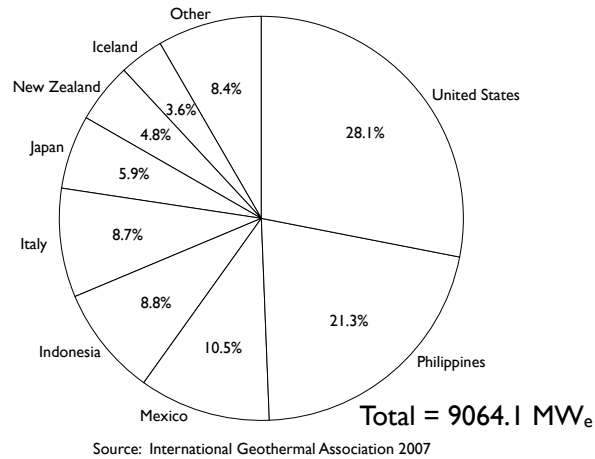


World Geothermal

Installed Geothermal Electric Capacity

- In 2005, there was 9064.1 MW_e installed capacity for electricity. The United States and Philippines lead the world in geo-electricity, together accounting for almost half the capacity. (Updated data available from: [International Geothermal Association](#))

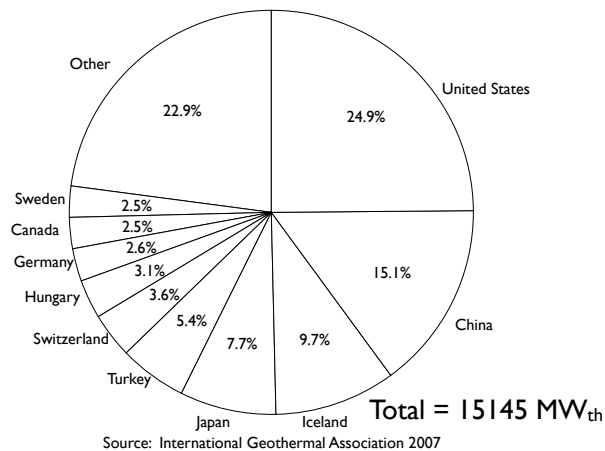
Installed Geothermal Electricity Worldwide (2005)



Installed Geothermal Direct Use Capacity

- In 2000, there was 15145 MW_{th} installed capacity for direct use. The United States, China, and Iceland lead the world in direct use, together accounting for almost half the capacity. (Updated data available from: [International Geothermal Association](#))

Installed Geothermal Direct Use Worldwide (2000)



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If you have any ideas, suggestions, or corrections you would like to contribute to this guide on Geothermal Power, please send us an email at [energy@lotuslive.org](mailto:energy@lotuslive.org).

Feel free to make use of any of the information in this guide for any purpose--we simply ask that you credit us and our predecessors, and link to us.

**Citation:** Enge, N. (2007). The lotus live guide to geothermal power. *Lotus Live*, from <http://lotuslive.org/energy/files/LLGeothermal.pdf>.

## **Bibliography**

- Boyle, G. (Ed.), (2004). *Renewable Energy: Power for a Sustainable Future (2nd Ed.)*. The Open University, UK.
- [International Geothermal Association](#).