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## Geothermal's potential

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SUBJECT: Prospects for geothermal energy.

**SIGNIFICANCE:** With fossil fuel prices well above historical average, geothermal energy investments are increasing worldwide. As geothermal technology improves, its weight in the energy mix is likely to increase substantially.

**ANALYSIS:** Geothermal energy can be used to produce electricity, to provide heat and hot water for direct applications and indirectly by using geothermal heat pumps. Unlike wind and solar photovoltaic, geothermal electricity is base load – i.e., it is available 24 hours a day, 365 days a year with capacity factors often above 90 per cent. This attribute makes geothermal a desirable part of a sustainable energy mix that includes intermittent sources. Geothermal power plants generally have a smaller environmental footprint than other renewable energy sources, because much of the infrastructure is hidden underground in geothermal wells.

**Potential.** The world geothermal potential from conventional geothermal sources has been estimated at 70 gigawatts. If engineered geothermal systems technology becomes technically viable – a process where water is pumped to extreme depths to produce steam – geothermal energy potential could double to 140 GW. A recent Massachusetts Institute of Technology study suggests an even higher world EGS potential. It found that EGS could supply the United States alone with 100 GW of electricity within 50 years.

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**Current production.** Currently, geothermal energy is utilized in over 70 countries, 24 of which produce electricity with geothermal. Worldwide geothermal electric capacity was about 9 GW in 2004 and direct use capacity including heat pumps totalled about 28 GW. As with all renewable energy sources, interest in geothermal development has increased with rising fossil fuel prices and global warming concerns. For example, the US Geothermal Energy Association reports that current US geothermal development projects are scheduled to more than double US geothermal electricity capacity in the next few years. In Germany over 100 areas are being explored for their geothermal potential.

Other countries are also increasing their geothermal capacity. Although China's increasing coal capacity has received much attention, China is currently the largest user of geothermal direct and its capacity is expanding. In Xianyang, Shaanxi province, a Chinese and Icelandic partnership is replacing coal fired heating with a geothermal district heating system, which has the potential to become the biggest such system in the world.

**Economics.** The economics of geothermal projects are site dependent. However, in many cases geothermal proves to be very competitive with other sources of energy, especially if renewable energy incentives are available:

Recent cost experience has shown that costs for geothermal electricity production typically range from 4.5 to 7.3 cents per kilowatt-hour (kWh).

An important cost factor in geothermal development is drilling costs.

High fuel prices have increased interest in oil and gas exploration as well as geothermal exploration.

As both industries use drilling rigs, the cost of drilling has risen dramatically and the availability of rigs can become a bottleneck in geothermal development.

**Policy.** Policy drivers have been an important part in increasing geothermal capacity development in recent years. Successful policy drivers of geothermal development include but are not limited to renewable energy standards, production tax credits, government loan programs and 'feed-in' tariffs. In Germany, feed-in tariffs of 0.15 euro cents per kWh and renewable energy targets have sparked a boom in geothermal development. Renewable Portfolio Standards are in place in over 30 states in the United States and have significantly affected the demand for geothermal energy in Western states where conventional geothermal resources are available for electricity production. Federal production tax credits for geothermal have also been in place in the United States for several years and have facilitated many projects. However, they are set to expire after 2008.

**Geology.** Another important policy consideration is the availability of pre-competitive geologic data:

For instance, the Icelandic government has for decades maintained a strong geothermal surveying program that has significantly contributed to Icelandic geothermal energy development. Today,

geothermal provides 89 per cent of the country's space heating needs and over 20 per cent of its electricity.

Other countries have also seen the importance of publicly available geologic data. In Australia, where geothermal is still a nascent industry, state governments are actively planning and implementing programs to supply potential geothermal developers with such geological information.

However, in other countries, such as the United States, federal efforts on geothermal surveying have been less consistent and have acted as a barrier to geothermal development. The last U.S. geothermal resource assessment was published in the late 1970s and it was not until the Energy Policy Act of 2005 that the U.S. Congress ordered a geothermal resource update.

**Development.** A general lack of understanding of what geothermal energy is and how it is harnessed has also affected geothermal development. Geothermal developers and researchers frequently find themselves in the position of having to explain to the public, government officials, and investors the basics of geothermal production. This requires both time and resources that otherwise could be spent on project development. An example of efforts to overcome this barrier is the 'Geopowering the West' initiative in the United States, which aims to broaden and better coordinate outreach, partnering, and geothermal education programs to engage all stakeholders needed for geothermal development.

Currently, geothermal development is restricted to areas where natural hydrothermal systems are available for utilization. Such systems are mainly located along the Pacific Ring of Fire, along the Atlantic Ridge, in the African Rift Valley and in isolated places of high heat flows. Advances in technology in recent decades have enabled the production of electricity with lower temperature resources using binary technology. This has increased the feasible area for conventional geothermal energy production in countries such as Germany that before were not viable for geothermal electricity production but are now building geothermal plants.

**EGS.** EGS is receiving increased attention on the global stage. If EGS becomes technically viable, geothermal energy could be harnessed everywhere in the world and no longer be limited to a few selected areas. The main technical barriers to EGS are increasing flow rates and sustaining high heat flows within the engineered reservoir for sustained periods of time. Work to overcome these barriers is being conducted in both Europe and the United States. Australia is at the forefront of these efforts with multiple private firms with millions invested in EGS development.

**CONCLUSION:** Geothermal energy is gaining momentum from high fuel prices and increased awareness of adverse effects of greenhouse gas emissions. Conventional geothermal systems are utilized worldwide but rising drilling costs are affecting geothermal economic viability. For EGS development, the next few years will be critical in deciding whether the added influx of interest and investment will be enough to prove the EGS concept, lower costs and thus make geothermal electricity available worldwide.

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