



## Geothermal energy

### Geothermal energy explained

Geothermal energy is thermal energy generated from the Earth's crust. There are two types of uses of geothermal energy: electricity production and direct use for heat.

### How it works

In the first case, geothermal energy drives a heat engine to produce electricity. Alternatively, the Earth's heat can be applied directly to provide heat for spaces and/or for industrial and agricultural processes. A geothermal heat pump (GHP), for instance, uses the moderate temperature difference in the ground to increase the efficiency of heating and cooling in buildings. Harnessing the Earth's thermal energy is easiest along the edges of tectonic plates where the crust naturally vents heat out through volcanic activity. However, new technology known as enhanced geothermal systems (EGS) is expanding the potential to use geothermal energy in other areas. EGS technology is capable of drilling and releasing geothermal energy from less permeable areas of the Earth's crust, also called the "hard rock".

### Opportunities in Asia and the Pacific

- **Large potential along Ring of Fire islands:** The Earth's volcanic activity along the Ring of Fire island nations provides fertile ground for geothermal energy production in much of the region. A 1999 Geothermal Energy Association report listed 39 countries around the world that could be powered solely from geothermal energy, including seven countries in the region: Fiji, Indonesia, Papua New Guinea, Philippines, Solomon Islands, Tonga and Vanuatu.<sup>1</sup>
- **Broader capabilities in the region with the development of enhanced geothermal systems:** Further development of EGS technology could increase the potential for electricity production in the region greatly by making electricity production from geothermal plants more feasible and cost-effective outside of the Ring of Fire nations.<sup>2</sup>

### Trends in development

**The Asia-Pacific region accounts for a third of the world's geothermal electricity generation:** Electricity production from geothermal only occurs in 24 countries worldwide, six of which are in Asia.<sup>3</sup> Across Asia, installed power capacity for geothermal energy reached 3,743 MW between 2008 and 2009.<sup>4</sup> These countries produced around 30 per cent of the world's geothermal electricity in 2009.<sup>5</sup>

**Philippines is a regional and world leader in geothermal electricity:** Philippines has the second-largest most installed geothermal capacity in the world, after the United States of America. In 2010, the 1,904 MW of installed

<sup>1</sup> Alison Holm and others, *Geothermal Energy: International Market Update* (Washington D.C., Geothermal Energy Association, 2010).

<sup>2</sup> *ibid.*

<sup>3</sup> It includes Philippines (1,904 MW), Indonesia (1,197 MW), Japan (536 MW), Russia (82 MW), China (24 MW) and Thailand (0.3 MW).

<sup>4</sup> Alison Holm and others, *Geothermal Energy: International Market Update* (Washington D.C., Geothermal Energy Association, 2010).

<sup>5</sup> International Energy Agency, *Statistics and Balances* (Paris, 2009). Available from [www.iea.org/stats/index.asp](http://www.iea.org/stats/index.asp) (accessed 15 February 2012).

capacity on the islands was enough to supply around 17 per cent of the country's electricity needs in 2009, which was equivalent to 10,324 GWh.<sup>6</sup>

**China leads in direct use applications:** China is the world leader in direct use of geothermal energy, with 12,605 GWh in 2005.<sup>7</sup>

### Strengths with geothermal energy

- **Steady supply:** Unlike wind and solar, electricity generated from geothermal is not intermittent, and it can be used to provide reliable base load power.
- **Scalability:** Geothermal can be used for various purposes at various scales, ranging from heating for individual households to powering an entire city.
- **Low operation costs of geothermal power:** Once constructed, geothermal power generation can be operated cost-effectively.

### Challenges to using geothermal energy

- **High upfront capital and exploration costs:** Unfortunately, the high up-front costs of geothermal power due to the initial explorative drilling have slowed down the development of this highly reliable, long-term energy resource in Asia and the Pacific.<sup>8</sup> Despite having tapped less than half of the viable geothermal resources in the Philippines, for instance, geothermal electricity production in the Philippines has not significantly increased since the mid-1990s.
- **Limited areas for resource extraction without enhanced geothermal systems:** Geographical limitations to where geothermal energy can be harvested in a cost-efficient manner for electricity production will continue to limit development outside of the Ring of Fire countries.

### Implementing strategies

**Strengthen geothermal systems to extend capacity:** Further development of EGS technology is supported by a number of OECD countries. Technology transfer, cooperation and financial incentives for domestic and international private investment will be important to ensure the development of geothermal energy production plants to meet the region's potential beyond the Ring of Fire.

<sup>6</sup> International Energy Agency website, "Electricity/Heat in Philippines in 2009". Available from [www.iea.org/stats/electricitydata.asp?COUNTRY\\_CODE=PH](http://www.iea.org/stats/electricitydata.asp?COUNTRY_CODE=PH) (accessed 16 February 2012).

<sup>7</sup> R. Bertani, "Long-term projections of geothermal-electric development in the world", presented at the GeoTHERM Congress, Offenburg, Germany, 5-6 March, 2009. Available from [www.iea-gia.org/documents/LongTermGeothermElecDevelopWorldBertanioffenburg23Feb09.pdf](http://www.iea-gia.org/documents/LongTermGeothermElecDevelopWorldBertanioffenburg23Feb09.pdf) (accessed 26 September 2011).

<sup>8</sup> Z. Sarmiento and B. Steingrímsson, "Review on estimated power potential and realistic development of geothermal resources in leading geothermal countries", presented at the Short Course on Geothermal Development in Central America UNU-GTP, San Salvador, El Salvador, 25 November - 1 December, 2007. Available from [www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-04-02.pdf](http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-04-02.pdf) (accessed 26 September 2011).