IEA GEOTHERMAL

# Iceland Country Report

## 2013

## IEA Geothermal Implementing Agreement

# National Activities

## Chapter 12 of the 2013 IEA-GIA Annual Report

# Iceland

**Figure 1** Hellisheidi geothermal power plant.

## 1 Introduction and Overview

Practically all stationary energy and 85% of primary energy in Iceland is derived from indigenous renewable sources with a carbon-free electricity generation footprint. This is the result of an effective policy in making renewable energy a long-term priority in Iceland. Geothermal primary energy use contributed 69% in year 2013, equivalent to 175 PJ. Nowhere else does geothermal energy play a greater role in providing a nation's energy supply.

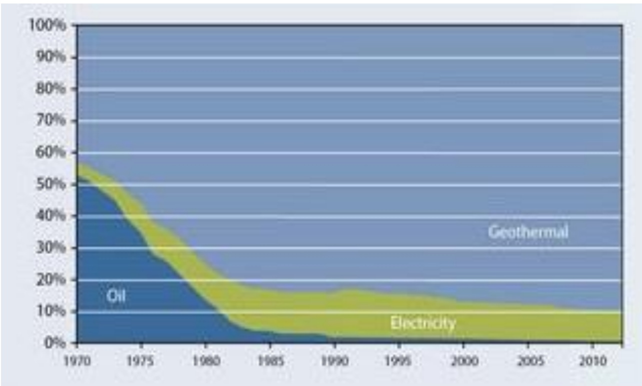


**Figure 2** Space heating by source from 1970 (Orkustofnun, 2013).

The energy current for Iceland has been estimated to be about 30 GW, of which 7 GW is estimated to be harnessable. Above 10 km depth the energy stored is estimated to be $12 \cdot 10^{14}$ GJ. It is thought to be technically and economically possible to install 4300 $MW_e$ of geothermal power at current electricity prices in Iceland and generate about 30 TWh of electricity without taking environmental concerns into account.

**Table 1** Geothermal energy use in Iceland for 2013. (na = data not available)

| Electricity | |
|---|---|
| **Total Installed Capacity ($MW_e$)** | 663 |
| **Contribution to National Capacity (%)** | 25% |
| **Total Generation (GWh)** | 5245 |
| **Contribution to National Demand (%)** | 30% |
| **Direct Use** | |
| **Total Installed Direct Use ($MW_{th}$)** | na |
| **Total Heat Used (PJ/yr) [GWh/yr]** | 27 [7113] |
| **Total Installed Capacity for Heat Pumps ($MW_{th}$)** | na |
| **Total Net Heat Pump Use (PJ/yr) [GWh/yr]** | na |

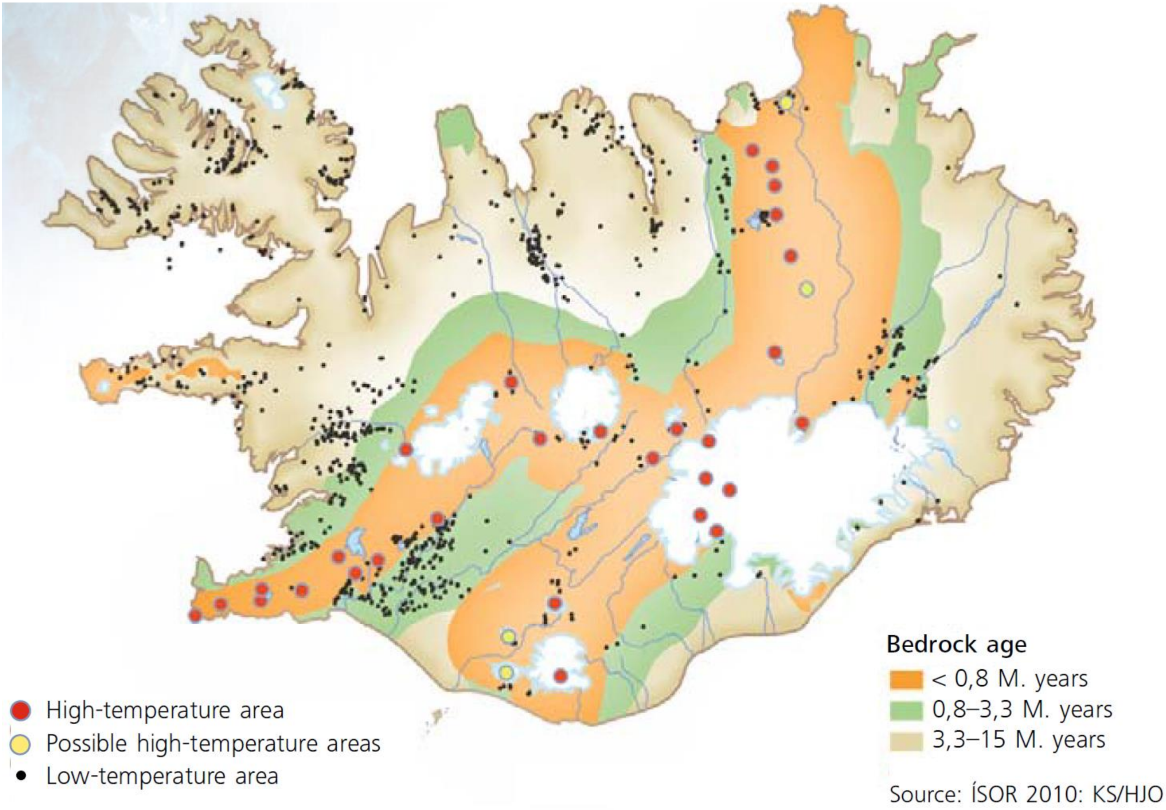


**Figure 3** Location of high temperature geothermal fields in the volcanic zones of Iceland, and clusters of low temperature springs on the flanks of the volcanic zones. Iceland is located on both a hotspot and the Mid-Atlantic Ridge, which runs right through it. This combined location means that geologically the island is extremely active (Orkustofnun, 2013).

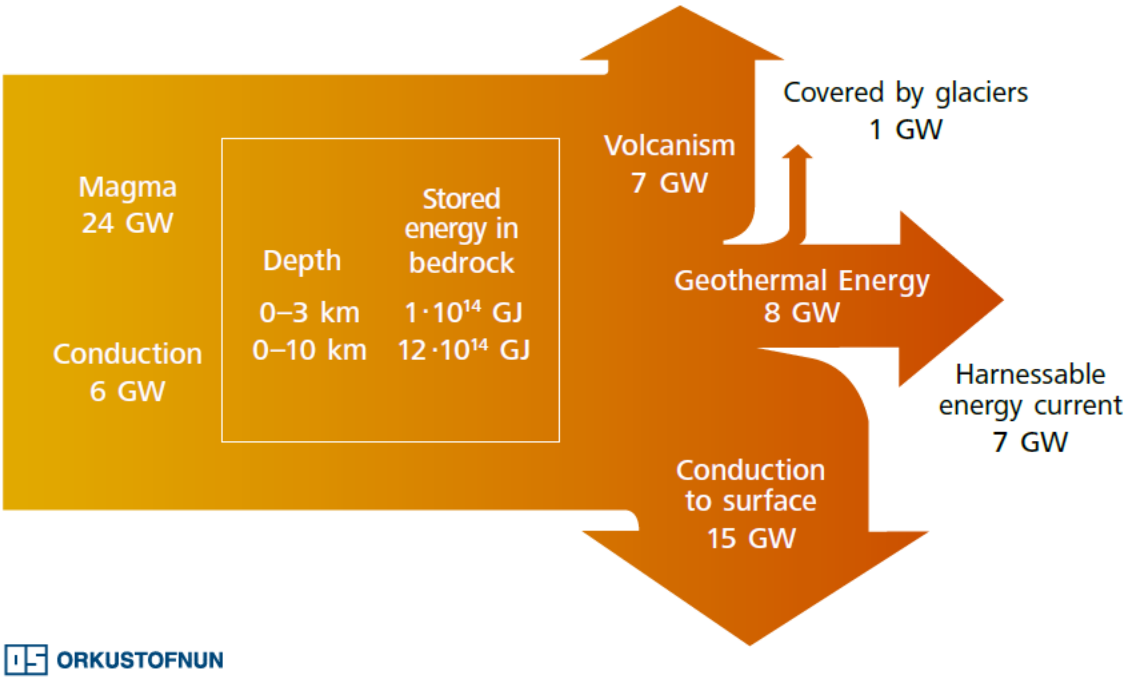


**Figure 4** Terrestrial energy current through the crust of Iceland and stored heat (Orkustofnun, 2010).

## 2 Highlights and Achievements

Nine geothermal power plants with a total estimated 675 MWe installed capacity are under formal consideration. Of these 45–170 MWe is predicted to be installed in 2016–2017.

Orkustofnun has the role of a Donor Programme Partner (DPP) for three Renewable Energy Programmes for European Economic Area grants, with a total available budget of about €28M for the period 2013–2016. These are available in Hungary (€9M), Portugal (€5M) and Romania (€14M) for the development, execution and supervision of projects supported by programmes in the field of renewable energy.

The focus in Hungary and Romania will be on building geothermal heat plants where existing fossil fuel based district heating systems are in place, as well as raising awareness on sustainable use of renewable energy in Hungary and supporting higher education in renewable energy in the donor states for Hungarians. In Portugal, the focus of the Programme is a predefined project for building a 2–3 MW geothermal pilot power plant on the island Terceira, which is the first geothermal power plant on that island. The Energy Strategic Plan presented by the government of the Azores has as a main goal to increase its share of renewable energy to 65% of total electricity production by 2018. Besides reducing carbon emissions by increasing the share of renewable electricity on the islands, the Programme has offered specialized courses which will be held in the Azores, organized by the UN University Geothermal Training Programme.


**Figure 5** Electricity generation by geothermal power plants in Iceland 1969–2013 (Orkustofnun, 2013).

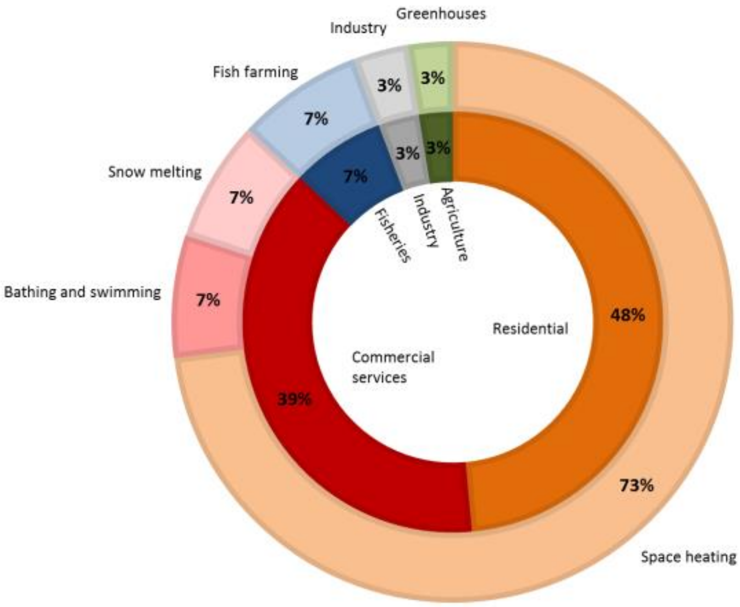


**Figure 6** Geothermal utilization in 2013 with IGA categories (outer ring) and IEA categories (inner ring). In total 27 PJ.

## 3 National Programme

It is the policy of the Government of Iceland to further increase the utilization of renewable energy resources for the power intensive industry, direct use and transport sectors in harmony with the environment. A broad consensus on conservation of valuable natural areas has been influenced by social opposition, increasing over the last decade, against large hydropower and some geothermal projects. There has as well been a governmental effort to search for geothermal resources in areas where geothermal energy has not yet been found. The Icelandic National Renewable Energy Action Plan (NREAP) was published in 2012 in accordance with Directive 2009/28/EC, which outlines the strategy for 2020 especially in terms of increasing the share of renewable energy in transport.

## 4 Industry Status & Market Development

Development constraints are mostly due to environmental issues and low electricity prices in Iceland, although geothermal energy was looked upon more positively than hydropower in a recent national review. Local issues do place constraints on drilling sites and access to them. As well, the visual impact of geothermal power plants is becoming increasingly important. Another development constraint is the governmental subsidies to communities where there is no access to geothermal energy for space heating. The subsidies, although effective for regional development, can decrease interest in searching for geothermal resources.

## 5 Research, Development & Demonstration

The geothermal research cluster GEORG initiated the project Deep Roots of Geothermal Systems (DRG-project) which aims to understand the relationship of water and magma in the roots of volcanoes and how heat is transferred into geothermal systems to maintain their energy. Furthermore, the design of wells and well heads for high temperatures will be a focus of the project, as will methods for utilizing superheated steam from greater depths. The US$1M project is financially supported by GEORG, Orkustofnun, Reykjavik Energy, HS Orka, Landsvirkjun and the Iceland Deep Drilling Project (IDDP). The research will be performed by three groups made up of representatives from universities, research institutes, engineering companies and energy companies. The latest technology will be applied in the areas of surveying, resistivity and seismic measurements, petrology and geochemistry. In addition, new simulation models will be developed. These models will be used to simulate heat transfer and operation of geothermal boreholes for high temperature steam. Training young scientists to work in this field will be an area of heavy focus for this project. This project is to strengthen the ongoing preparation for IDDP-2 in Reykjanes.


**Figure 7** Comparison of energy prices for residential heating in midyear 2013 (Orkustofnun, 2013) in kr/kWh (10 kr/kWh is equivalent to 0,08 USD/kWh).

## 6 Geothermal Education

The United Nations University - Geothermal Training Programme (UNU-GTP) has been operating in Iceland since 1979, with the aim to assist developing countries with significant geothermal potential to establish groups of specialists in geothermal exploration and development. An MSc programme was started in 2000 in cooperation with the University of Iceland. UNU-GTP receives its funding from the government of Iceland, US$5M per annum. Since 1979, 554 scientists have graduated from 53 countries. They have come from countries in Asia (40%), Africa (32%), Latin America (16%), and Central and Eastern Europe (12%). Amongst these, 107 have been women (19.5%).

The Iceland School of Energy at Reykjavik University offers postgraduate courses in the field of renewable energy. The University of Iceland also offers specialized post graduate studies in renewable energy focusing on geothermal energy.

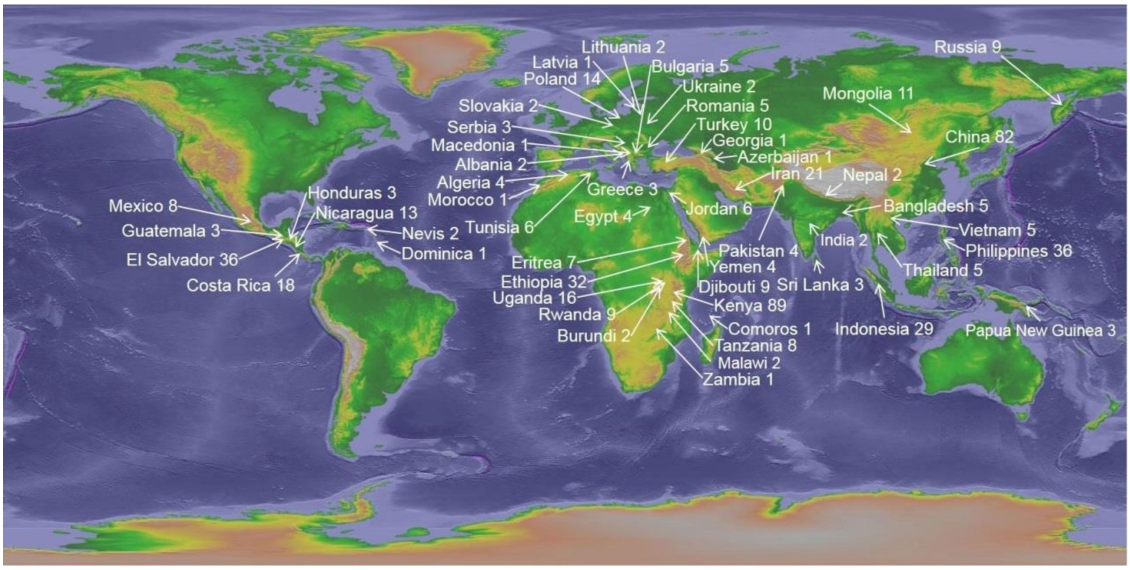


**Figure 8** Home countries of Fellows of the UNU Geothermal Training Programme in Iceland 1979–2013 (Orkustofnun).

## 7 Future Outlook

A parliamentary resolution was passed which categorizes geothermal and hydro resources to be exploited, protected or subject to further research in accordance with Act No. 48/2011. This Act is for the utilization and protection of energy resources and sets up the legal framework for the Master Plan.

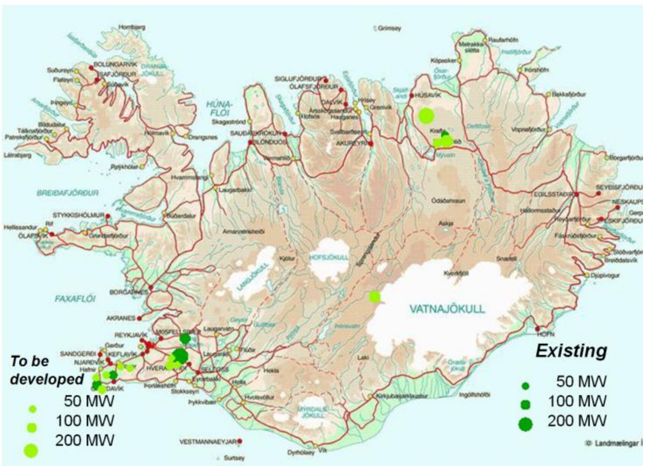


**Figure 9** Geothermal power plants to be developed according to the Master Plan.

**Table 2** Projects in the Master Plan for hydro and geothermal energy resources have been evaluated on the basis of the environmental, social and economic impact the projects will have and thus categorized to be developed, protected or to be further considered.

| Potential Power | Hydro TWh/a | Geoth. TWh/a | |
|---|---|---|---|
| Existing | 13 | 5 | 26% |
| To be developed | 3 | 10 | 20% |
| To be protected | 8 | 18 | 39% |
| To be considered | 6 | 3 | 14% |
| **Total** | **31** | **35** | |

## 8 Publications and Websites

Orkustofnun, Energy Statistics 2013 (Accessable on the website www.os.is)

Sveinbjörn Björnsson, Inga Dóra Guðmundsdóttir and Jonas Ketilsson. Geothermal Development and Research in Iceland. Orkustofnun. 2010. (Accessable on the website www.os.is)

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# *To Find Out More*

**If you are interested in learning more about the IEA Geothermal Programme, or you wish to join the GIA:**

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## *Visit the IEA-GIA Website*

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**Cover Photo:** Courtesy of Orkustofnun.

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