IEA GEOTHERMAL

Iceland Country Report
2012

IEA Geothermal
Implementing Agreement

National Activities

Chapter 12 of Draft 2012 GIA Annual Report

Iceland

Figure 12.1 Nesjavellir geothermal power plant.

12.0 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. 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 2012, equivalent to 175 PJ. Nowhere else does geothermal energy play a greater role in providing a nation's energy supply.

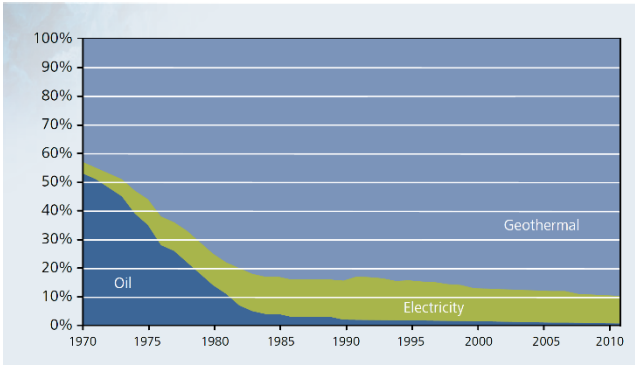

Figure 12.2 Space heating by source from 1970 (Orkustofnun, 2012)

Table 12.1 Geothermal energy use in Iceland for 2012.

Electricity	
Total Installed Capacity (MW_e)	665
Contribution to National Capacity (%)	25%
Total Generation (GWh)	5210
Contribution to National Demand (%)	30%
Direct Use	
Total Installed Direct Use (MW_{th})	na
Total Heat Used (PJ/yr) [GWh/yr]	25 [7000]
Total Installed Capacity for Heat Pumps (MW_{th})	na
Total Net Heat Pump Use (PJ/yr) [GWh/yr]	na

(na = data not available)

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 of which it is thought to be technically and economically possible to install 4,300 MW_e of geothermal power at current electricity

prices in Iceland and generate about 30 TWh of electricity without taking environmental concerns into account.

12.1 Highlights and Achievements

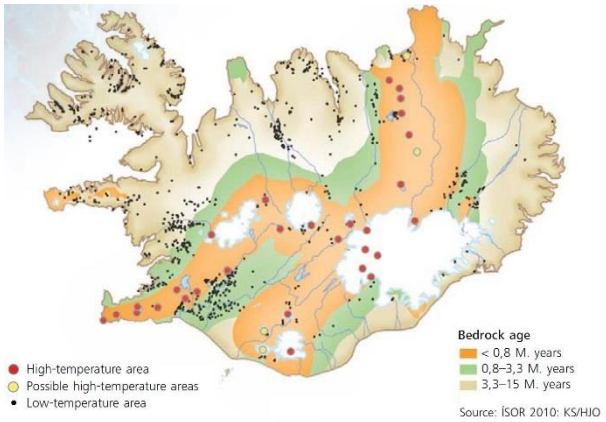

Figure 12.3 Location of high temperature geothermal fields in the volcanic zones of Iceland and clusters of low temperature springs on the flanks of the volcanic zones. Iceland is located on both a hotspot and the Mid-Atlantic Ridge, which runs right through it. This combined location means that geologically the island is extremely active (Orkustofnun, 2012).

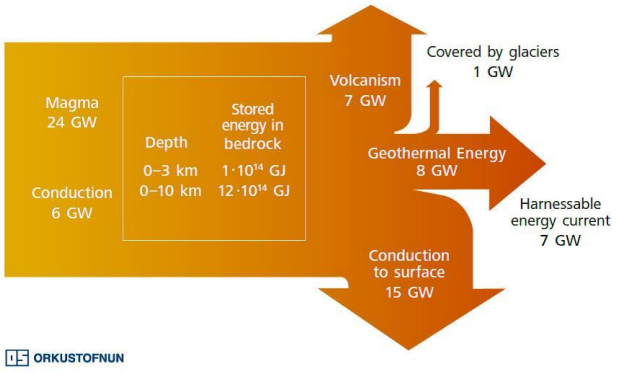

Figure 12.4 Terrestrial energy current through the crust of Iceland and stored heat (Orkustofnun, 2010).

Primary energy supply of geothermal increased from 156 PJ to 175 PJ (12% increase) mainly due to the increase in the electricity generation of geothermal power plants by 8% from 4.7 TWh to 5.2 TWh. Nine geothermal power plants of total estimated 675 MW_e installed capacity are under formal consideration of which 45–170 MW_e is predicted to be installed in year 2015–2017.

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

The focus will be on building geothermal heat plants where existing fossil fuel based district heating systems are in place in Hungary and Romania 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. As part of the Hungarian Programme eight specialists will be supported to undertake the six months UN University Geothermal Training Programme that Orkustofnun operates. In Portugal the focus of the Programme will be a predefined project for building a 2–3 MW geothermal pilot power plant on the island Terceira, which will be the first geothermal power plant on that island. Besides reducing carbon emissions by increasing the share of renewable electricity on the islands the Programme will offer specialized courses which will be held in Azores, organized by the UN University Geothermal Training Programme.

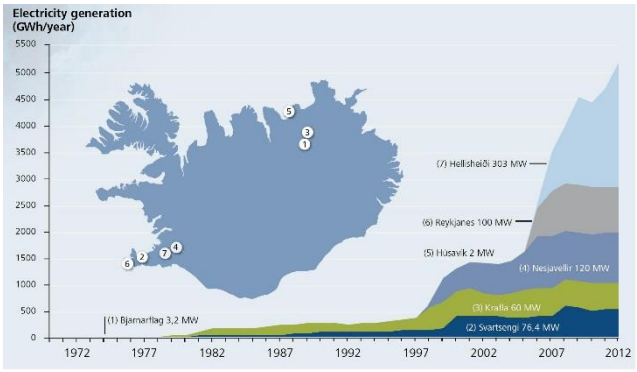

Figure 12.5 Electricity generation by geothermal power plants in Iceland 1969–2012 (Orkustofnun, 2012).

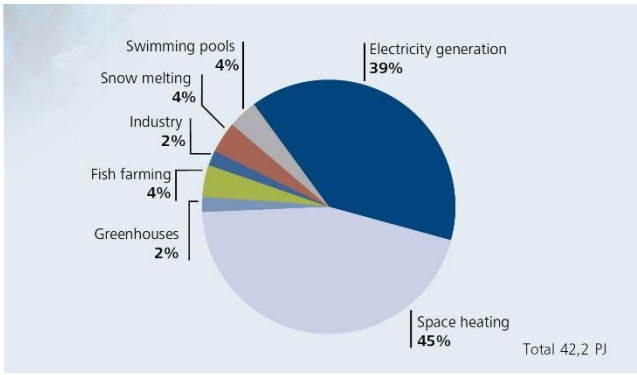

Figure 12.6 Direct use of geothermal energy and electricity generation (Orkustofnun, 2012).

12.2 National Programme

It is the policy of the Government of Iceland to increase the utilization of the renewable energy resources further for the power intensive industry, direct use and transport sector 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 year 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.

Two major amendments were made in year 2012 to the energy legal framework in Iceland that effect geothermal exploration and utilization:

(1) Grants to new geothermal heat utilities was increased from being the equivalent of the accumulation of space heating subsidization with oil or electricity of 8 years to 12 years. In addition if the project receives other grants it will not effect in any way this lump sum payment (Act No. 78/2002).

(2) Promotion of the use of energy from renewable sources was further stipulated by changing law no. 30/2008 taking into consideration Directive 2009/28/EC.

12.3 Industry Status & Market Development

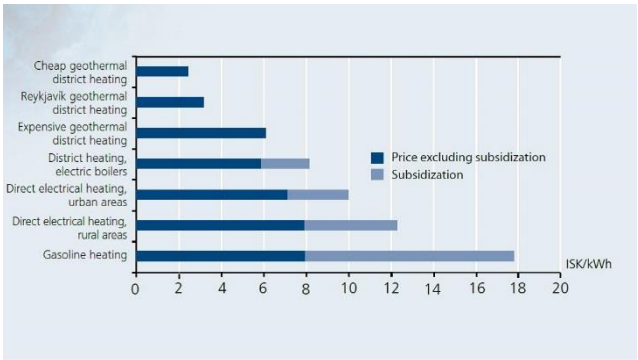

Figure 12.7 Comparison of energy prices for residential heating in mid year 2011 (Orkustofnun, 2012) in kr/kWh (10 kr/kWh is equivalent to 80 USD mills/kWh).

Development constraints are mostly due to environmental issues and low electricity prices in Iceland, though 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 search for geothermal resources.

12.4 Research, Development & Demonstration

The geothermal research cluster GEORG initiated the project Deep Roots of Geothermal Systems (DRG-project) which aims at 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 $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 surveying, resistance measurements 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 of IDDP-2 in Reykjanes.

12.5 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. A MSc programme was started in 2000 in cooperation with the University of Iceland. UNU-GTP receives its funding from the government of Iceland, 5 M US$/a. Since 1979 515 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 have been 97 women (19%).

Figure 12.8 Fellows of the UNU Geothermal Training Programme in Iceland 1979–2012 (Orkustofnun).

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

12.6 Future Outlook

A parliamentary resolution was passed which categorizes geothermal and hydro resources to be exploited, protected

or further research in accordance with Act No. 48/2011 for the utilization and protection of energy resources which sets up the legal framework for the Master Plan.

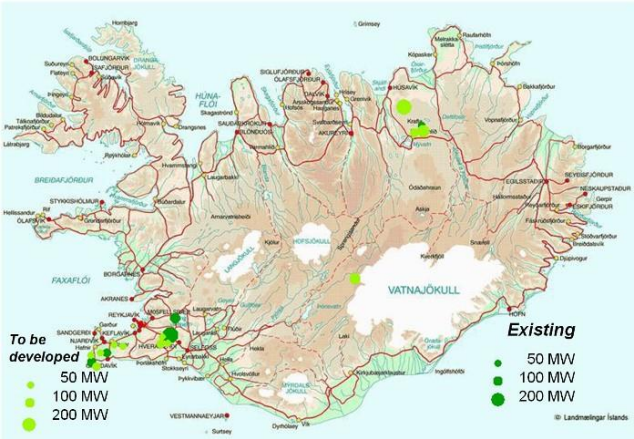

Figure 12.9 Geothermal power plants to be developed according to the Master Plan.

Table 12.2 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)	Geothermal (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**	

12.7 Publications and Websites

Orkustofnun (2012). Energy Statistics 2012 (Accessible on the website: www.os.is)

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

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Figure 12.10 The Blue Lagoon.

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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