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Geothermal Energy Use, Country Update for Iceland

Árni Ragnarsson

ÍSOR-Iceland GeoSurvey, Grensásvegur 9, 108 Reykjavík, Iceland

arni.ragnarsson@isor.is

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ABSTRACT

Iceland´s geological characteristics have endowed the country with an abundant supply of geothermal resources. The geothermal resources are utilized both for electricity generation and direct heat application. The share of geothermal energy in the nation´s primary energy supply is 69.2%. Space heating is the most important direct utilization of geothermal energy in Iceland, covering 90% of all houses in the country. Other sectors of direct use are swimming pools, snow melting, industry, greenhouses and fish farming. The total direct use of geothermal energy was estimated to be 25,277 TJ (7,021 GWh) in 2011. Generation of electricity by geothermal energy has been increasing during the past 15 years, mainly due to increased demand in the energy intensive industry. The total installed capacity is now 660 MWe and the annual generation in 2012 was 5,210 GWh, which is 30% of the total produced in the country.

1. INTRODUCTION

Iceland has a huge geothermal potential based on the location of the country on the Mid-Atlantic Ridge. The country is mountainous and volcanic, with much precipitation, making the hydropower resources abundant. The population of Iceland is 322,000, of which almost two third live in the capital area. During the course of the 20th century, Iceland went from what was one of Europe's poorest countries, dependent upon peat and imported coal for its energy, to a country with a high standard of living where practically all stationary energy, and roughly 87% of the primary energy comes from indigenous renewable sources (69.2% geothermal, 17.6% hydropower). The rest of Iceland´s energy sources come from imported fossil fuel used for fishing and transportation. Iceland´s energy use per capita is among the highest in the world and the proportion provided by renewable energy sources exceeds most other countries.

The geothermal resources in Iceland are used to a great extend for both electricity generation and direct uses. In the high-temperature (>200°C) fields geothermal steam is utilized for electricity generation and to an increasing extend also for hot water production in so-called co-generation plants. Thus, the energy efficiency is improved considerable. The low-temperature (<150°C) fields are used mainly to supply hot water for district heating. The current utilization of geothermal energy for heating and other direct uses is considered to be only a small fraction of what this resource can provide. A master plan assessing the economic feasibility and the environmental impact of the proposed power development projects has recently been adopted by the Icelandic Parliament.

It has been the policy of the government of Iceland to increase the utilization of renewable energy resources even further for the power intensive industry, direct use and the transport sector. A broad consensus on conservation of valuable natural areas has been influenced by increased environmental awareness. Thus, there has been opposition against large hydropower and some geothermal projects. The ownership of energy resources in Iceland is based on the ownership of land. However, exploration and utilization is subject to licensing.

2. OVERVIEW OF THE GEOHERMAL UTILIZATION

Figure 1 and Table 1 give a breakdown of the estimated utilization of geothermal energy in Iceland for 2011. Direct use of geothermal energy that year, i.e. for heating, totalled about 25,277 terajoules (TJ), which corresponds to 7,021 GWh. This is based on estimated inlet and outlet water temperature for each category (35°C outlet temperature for space heating). In addition, electricity production by geothermal amounted to 4,701 GWh in 2011. The 45% share of space heating was by far the greatest, followed by electricity production, accounting for 39%.

Table 1: Geothermal utilization in Iceland 2011

	GWh/year	TJ/year
Space heating	5,177	18,638
Greenhouses	187	673
Fish farming	507	1,826
Industry	221	796
Snow melting	491	1,768
Swimming pools	438	1,576
Direct uses total	7,021	25,277
Electricity generation	4,701	16,924
Geothermal utilization total	11,722	42,200

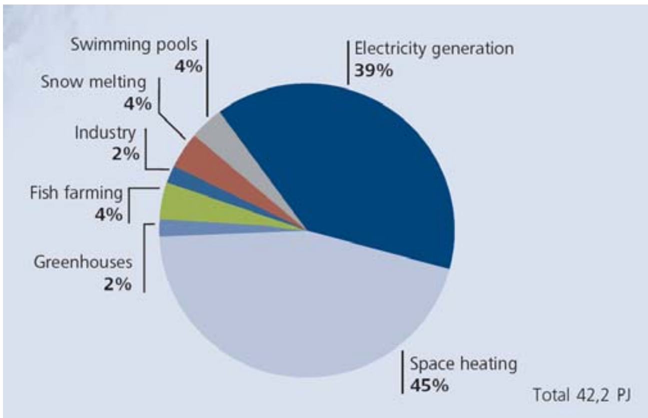

Figure 1: Sectoral share of geothermal utilization in Iceland 2011

3. GEOLOGICAL BACKGROUND

Iceland is a young country geologically. It lies astride one of the earth's major fault lines, the Mid-Atlantic Ridge. This is the boundary between the North American and Eurasian tectonic plates, one of the few places on earth where one can see an active spreading ridge on land. The two plates are moving apart at a rate of about 2 cm per year. As a result of its location, Iceland is one of the most tectonically active places on earth, resulting in a large number of volcanoes and hot springs. Earthquakes are frequent, but rarely cause serious damage. More than 200 volcanoes are located within the active volcanic zone running through the country from the southwest to the northeast, and at least 30 of them have erupted since the country was settled over 1100 years ago. In this volcanic zone there are at least 20 high-temperature areas containing steam fields with underground temperatures reaching 200°C within 1000 m depth. These areas are directly linked to the active volcanic system. About 250 separate low-temperature areas with temperatures not exceeding 150°C in the uppermost 1000 m are mostly in the areas flanking the active zone. Over 600 hot spring areas (temperature over 20°C) have been located (Fig 2).

4. SPACE HEATING

Different from most other geothermal countries, direct uses and especially space heating play a predominant role in the geothermal utilization in Iceland. Utilization of geothermal energy for space heating on a large scale began in Reykjavík in 1930. Following the oil price hikes of the 1970s, the government took the initiative in expanding district heating, with the result that the share of geothermal energy increased from 43% in 1970 to the current level of about 90%. This development is illustrated in Figure 3. About 30 separate geothermal district heating systems are operated in towns and villages in the country and additionally some 200 small systems in rural areas. This achievement has enabled Iceland to import less fossil fuel, and has resulted in a very low heating cost compared to most other countries. Using geothermal energy, which is classified as a renewable energy source, for space heating has also benefited the environment. Although most of the towns and villages in Iceland with the possibility of geothermal heating have already such a system in operation, exploration activities are ongoing with the aim to develop geothermal heating in new areas.

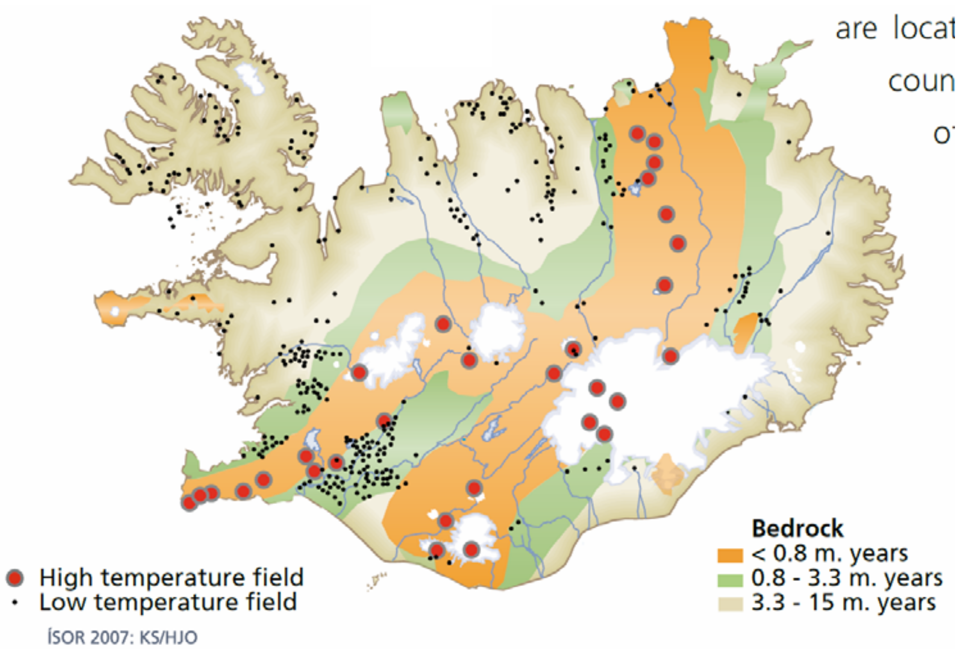

Figure 2: Volcanic zones and geothermal areas in Iceland

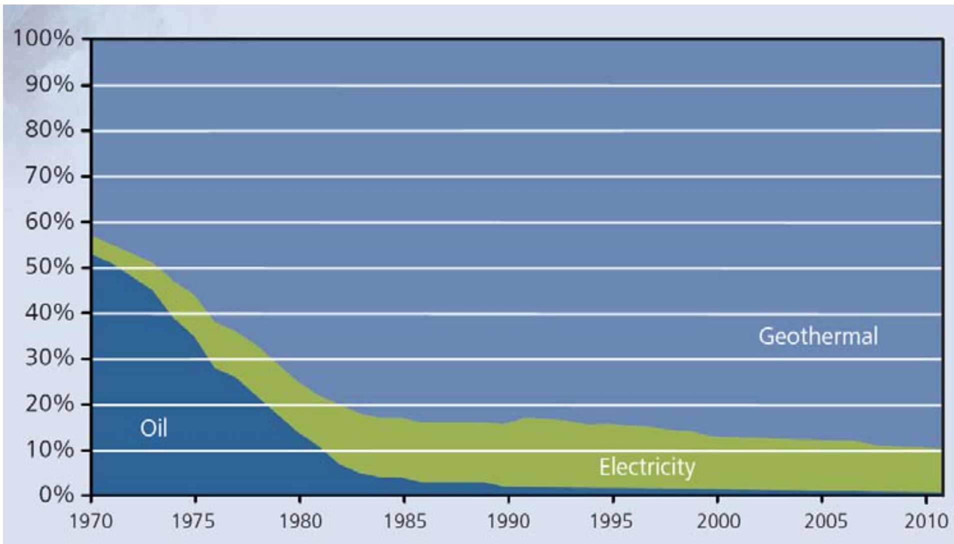

Figure 3: Energy sources used for space heating in Iceland 1970-2011

4.1 District heating in Reykjavik

Reykjavík Energy (Orkuveita Reykjavíkur) is responsible for distribution and sale of both hot water and electricity as well as the city's waterworks and sewage system. The total number of employees is about 430 and the turnover in 2012 was 37,900 million ISK (305 million US$ based on the average 2012 exchange rate). Reykjavík Energy is by far the largest geothermal district heating utility in Iceland. It serves over 200,000 people, the entire population of Reykjavik, plus neighbouring communities as well as some additional villages.

District heating in Reykjavík began in 1930 when some official buildings and about 70 private houses received hot water from geothermal wells, located close to the old thermal springs in Reykjavík. In 1943 delivery of hot water from the Reykir field, 18 km from the city, started. Today Reykjavik Energy utilizes low-temperature areas within and in the vicinity of Reykjavik as well as the high-temperature fields at Nesjavellir, about 27 km away, and since 2010 at Hellisheiði. At Nesjavellir and Hellisheiði fresh water is heated in cogeneration power plants. A few years back Reykjavik Energy took over several district heating systems in operation outside the capital area. Some are small systems in rural areas, but others are among the largest geothermal district heating systems in the country.

4.2 HS-Orka and HS-Veitur

In the beginning of 2009 the former Hitaveita Sudurnesja (Sudurnes Regional Heating), which was the second largest geothermal energy company in Iceland, was split into two companies: HS-Orka, now privately owned, which is responsible for production and sale of electricity and heat, and HS-Veitur, which takes care of the non-competitive distribution of energy. HS-Orka is the first energy company in Iceland to be privatized. Hitaveita Suðurnesja was a pioneer in building the cogeneration power plant at Svartsengi on the Reykjanes peninsula in 1977. It is located about 50 km SW of Reykjavik. The plant utilizes 240°C geothermal brine from the Svartsengi field to heat fresh water for district heating (150 MWt), and to generate electricity (74 MWe). On Reykjanes there is a plant (100 MWe) that was commissioned in 2006 for electricity generation only. HS-Veitur serves four communities on the Reykjanes peninsula with totally about 20,000 inhabitants with hot water, electricity and water. They also serve about 30,000 inhabitants in Hafnarfjordur and neighbouring communities with electricity.

4.3 Nordurorka - District heating in Akureyri

Akureyri is a town of 18,000 inhabitants located in the central N-Iceland. It has been heated by geothermal energy since the end of the seventies. Hot water is pumped to Akureyri from five different geothermal fields. In addition to this, two 1.9 MWt heat pumps have supplied a small part of the annual energy production most of the time since 1984, but their contribution has been insignificant the last four years. During the last few years several small district heating systems in neighbouring communities have merged with Nordurorka. Thus, the total number of people served is now about 23,000. The total installed capacity is 94 MWt and the annual hot water consumption about 7.3 million m^3.

5. OTHER DIRECT UTILIZATION

5.1 Swimming pools

For centuries mainly natural hot springs were used for bathing, but since early in the last century outdoor swimming pools as we know them today have been gaining popularity and they are today a part of the daily life of a large part of the nation. There are about 175 swimming pools in the country, 150 of which use geothermal heat. The combined surface area of the geothermally heated pools is about 34,000 m^2. Most of the swimming pools are open to the public throughout the year. They serve for recreational purposes and are also used for swimming lessons, which are compulsory in schools. Swimming is very popular in Iceland and swimming pool attendance has increased in recent years. In the greater Reykjavik area alone there are fourteen public outdoor pools and a few indoor ones. The largest of these is Laugardalslaug with 1,500 m^2 outdoor pools, 1,250 m^2 indoor pool and five hot tubs where the tub temperature ranges from 35 to 42°C. Other health uses for geothermal energy are the Blue Lagoon, the bathing facility at Bjarnarflag close to Lake Myvatn and the Health Facility in Hveragerdi, comprising geothermal clay baths and water treatments. Typically, about 220 m^3 of water or 40,000 MJ of energy is needed annually for heating one m^2 pool surface area. This means that a new, middle-sized outdoor swimming pool uses as much hot water as is needed to heat 80-100 single-family dwellings.

5.2 Snow melting

For a long time, geothermal water has been used to some extent in Iceland to heat pavements and melt snow during the winter. These uses have been gradually increasing and today almost all new buildings in areas with geothermal heating have snow melting systems. Iceland´s total area of snow melting systems is around 1,200,000 m^2, mostly in the capital area. Used water from the houses, at about 35°C, is thus used for de-icing sidewalks and parking spaces. Most of the larger systems have the possibility to mix the spent water with hot water (80°C) when the load is high. The main purpose is often to prevent icing or to make removal of the snow easier, rather than directly melt the snow. In downtown Reykjavík, a snow-melting system has been installed under most sidewalks and some streets, covering an area of 40,000 m^2. This system is designed for a heat output of 180 W/m^2 surface area and the annual energy consumption is estimated to be 430 kWh/m^2. About two thirds of that energy come from return water from the space heating systems and one third directly from hot supply water.

5.3 Industrial uses

The seaweed drying plant Thorverk, located at Reykhólar in West Iceland, uses geothermal heat directly in its production. The company harvests seaweed found in the waters of Breidafjordur in NW-Iceland using specially designed harvester crafts. Once landed, the seaweed is chopped and dried on a band dryer that uses large quantities of air heated to 85°C by geothermal water in heat exchangers. The plant has been in operation since 1975, and produces about 6,000 tonnes of rockweed and kelp meal annually using 35 l/s of 112°C water for the drying process.

Since 1986, a facility at Haedarendi in Grímsnes, South Iceland, has produced commercial liquid carbon dioxide (CO_2) derived from the geothermal fluid. The Heidarendi geothermal field has an intermedium temperature (160°C) and a very high gas content (1.4% by weight). The gas discharged by the wells is nearly pure carbon dioxide with a hydrogen sulphide concentration of only about 300 ppm. Upon flashing, the fluid from the Haedarendi well would produce large amounts of calcium carbonate scaling. Scaling in the well is avoided by a 250 long downhole heat exchanger made of two coaxial steel pipes. Cold water is pumped down through the inner pipe and back up on the outside. Through this process, the geothermal fluid is cooled and the solubility of calcium carbonate sufficiently increased to prevent scaling. The plant uses approximately 6 l/s of fluid and produces some 3,000 tonnes CO_2 annually, which is sufficient for the Icelandic market. The production is used in greenhouses, for manufacturing carbonated beverages and in other food industries.

Geothermal energy has been used in Iceland for drying fish for about 30 years. The main application has been the drying of salted fish, cod heads, small fish, stockfish and other products. Until recently, cod heads were traditionally dried by hanging them on outdoor stock racks. Because of Iceland´s variable weather conditions, indoor drying is preferred. Hot air is blown over the fish in batch dryers. Today about 10 companies dry cod heads indoors and all of them use geothermal hot water. The annual export of dried cod heads is about 15,000 tonnes. The product is shipped mainly to Nigeria where it is used for human consumption.

Several other industrial processes utilizing geothermal energy have been operated in Iceland in the past. Among them are the Kisilidjan diatomite plant at Lake Myvatn, a salt production plant on the Reykjanes peninsula utilizing geothermal brine and seawater, drying of imported hardwood in Húsavík by geothermal water, retreading of car tires and wool washing in Hveragerdi, curing of cement blocks at Myvatn and steam baking of bread at several locations.

5.4 Greenhouses

Apart from space heating, heating of greenhouses is one of the oldest and most important uses of geothermal energy in Iceland. For years, naturally warm soil had been used for growing potatoes and other vegetables when geothermal heating of greenhouses started in Iceland in 1924. The majority of the greenhouses are located in the south, and most are enclosed in glass. The heating installations are by unfinned steel pipes hung on the walls and over the plants. Undertable or floor heating is also common. It is common to use inert growing media (volcanic scoria, rhyolite) on concrete floors with individual plant watering. The increasing use of electric lighting in recent years has lengthened the growing season and improved greenhouse utilization. CO_2 enrichment in greenhouses is common, primarily by using CO_2 produced in the geothermal plant at Haedarendi. Outdoor growing at several locations is enhanced by soil heating with geothermal water, especially during early spring (total 120,000 m^2).

Greenhouse production is divided between different types of vegetables (tomatoes, cucumbers, paprika etc.) and flowers for the domestic market (roses, potted plants etc.). After a steady increase in the total surface area of greenhouses for several decades (1.9% per year between 1990 and 2000) this industry has experienced considerable changes during the last decade. Increased competition on the market requires increased productivity. Artificial lighting, which also produces heat, has contributed to diminishing demand for hot water supply to greenhouses. By lengthening of the growing season the utilization of greenhouses has been improved and the need for new constructions is less than before.

The total surface area of greenhouses in Iceland was about 196,000 m^2 in 2008 including plastic tunnels for bedding- and forest plants. The surface area has most like not changed much since 2008. Of this area, 50% is used for growing vegetables and strawberries, 26% for cutflowers and potted plants and 24% are nurseries for bedding- and forest plants. A new project that is now being considered is building of greenhouses that will use effluent water from the Hellisheidi geothermal power plant to produce tomatoes for export.

5.5 Fish Farming

Fish farming has been a slowly growing sector in Iceland for a number of years. After a rapid growth from 2002 the total production reached about 10,000 tonnes in 2006, mainly salmon. The dominating species are now salmon and arctic char followed by trout and cod. There are about 50 fish farms in Iceland and the total production was almost 8,000 tonnes in 2012. Of these fish farms about 25 utilize geothermal water. Initially, Iceland´s fish farming was mainly in shore-based plants. Geothermal water, commonly 20-50°C, is used to heat fresh water in heat exchangers, typically from 5 to 12°C for juvenile production. The beginning of the 21st century saw growing interest in developing sea cage farming of salmon in the sheltered fjords on Iceland’s east cost. Two large farms were established and remained in operation for a few years, but today only two small cage farms are in operation. The main use of geothermal energy in the fish farming sector in Iceland is for juveniles production (char, salmon, cod). In land-based char production geothermal energy is also used for post-smolt rearing. Geothermal utilization in the fish farming sector is expected to increase in the coming years. An important part of that development is the ongoing establishment of a new fish farm that will use surplus hot water from the Reykjanes geothermal power plant to breed 2,000 tonne of Senegalese sole annually.

6. ELECTRICAL POWER GENERATION

Electricity generation using geothermal energy has increased significantly during the past 15 years. Figure 4 shows the development in the period 1970-2012. The total installed capacity of geothermal generating plants is now 660 MWe. The production in 2012 was 5,210 GWh, which is 30% of the total electricity production in the country.

6.1 Bjarnarflag

The oldest geothermal power plant in Iceland is in Bjarnarflag (Namafjall field) where a 3.2 MWe back pressure unit started operation in 1969. The power plant has been operated successfully ever since the beginning except for three years in 1985-1987 when the plant was closed, partly due to volcanic activity in the area.

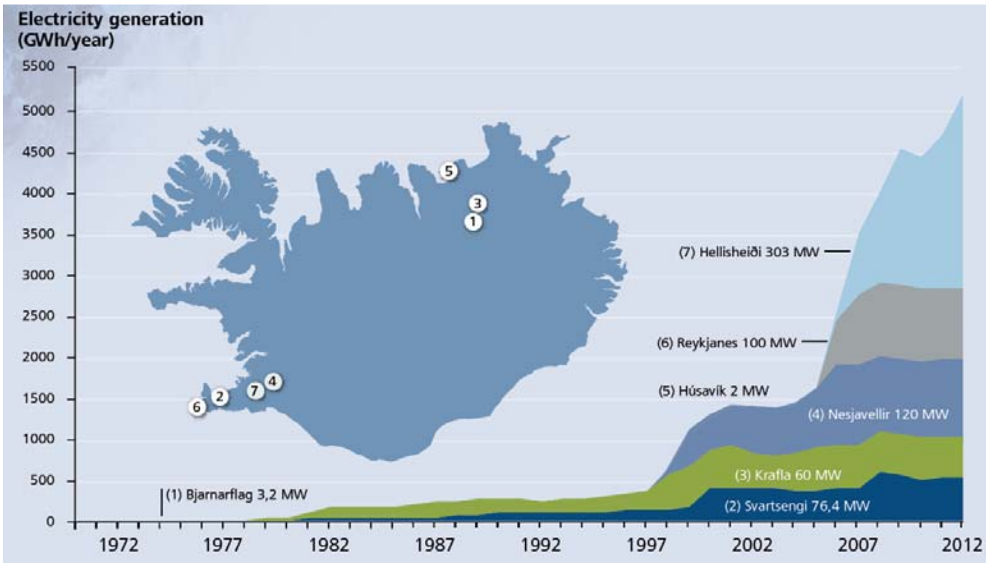

Figure 4: Electricity generation by geothermal energy in Iceland 1970-2012

6.2 Krafla

The Krafla power plant in north Iceland has been in operation since 1977. Two 30 MWe double flash condensing turbine units were purchased, but due to unexpected difficulties with steam supply the plant was run with only one installed turbine for the first 20 years. The shortfall of steam was due to volcanic activity that injected volcanic gases into the most productive part of the geothermal reservoir. Initially the power generation was 8 MWe, but reached 30 MWe in 1982. The capacity of the Krafla power plant was expanded in 1997 from 30 to 60 MWe.

6.3 Svartsengi and Reykjanes

The Svartsengi co-generation power plant of HS-Orka has been producing both hot water and electricity since it started operation in 1977. It is located on the Reykjanes peninsula, about 40 km from Reykjavik, and serves about 20,000 people. The reservoir fluid is a brine at 240°C and with a salinity of about two thirds of sea water. The total production from the reservoir is about 400 kg/s. Of that between 50 and 75% is reinjected. Geothermal heat is transferred to freshwater in several heat exchangers. After expanding the plant in several steps the total installed capacity in Svartsengi is now 150 MWt for hot water production and 72 MWe for electricity generation. Of that 8.4 MWe come from Ormat binary units using low-pressure waste steam. A part of the effluent brine from Svartsengi (40 l/s) goes to a 5,000 m^2 surface pond called the Blue Lagoon. It is getting increasing popularity by tourists with 585,000 visitors in 2012, making it one of Iceland’s most popular tourist attractions. There is also a psoriasis clinic that takes advantage of the therapeutic effects of the geothermal brine. The Blue Lagoon company offers a line of skin care products that contain unique natural ingredients, silica, minerals and algae.

HS-Orka started operation of a new 100 MWe geothermal power plant at Reykjanes in May 2006 (two 50 MWe twin steam turbines with sea cooled condensers). An expansion of the plant has been under preparation for some time, totally by 80 MWe of which 30 MWe are planned to be produced by using brine from high pressure separators. These plans are now being reconsidered.

6.4 Nesjavellir and Hellisheiði

Reykjavik Energy has been operating a co-generation power plant at Nesjavellir high temperature field north of the Hengill volcano since 1990. The primary purpose of the plant is to provide hot water for the Reykjavik area, 27 km away. Freshwater is heated by geothermal steam and hot water in heat exchangers. The capacity for hot water production is 300 MWt (1640 l/s of 83°C water). The power plant started generating electricity in 1998 with two 30 MWe steam turbines. In 2001, a third turbine was installed and the plant enlarged to 90 MWe and to 120 MWe in 2005.

Reykjavik Energy started operation of a new 90 MWe geothermal power plant at Hellisheidi in the southern part of the Hengill area in October 2006. It was expanded by a 33 MWe low pressure unit in 2007 and further by installing two 45 MWe units in late 2008 and additionally two 45 MWe units in 2011, increasing the total installed capacity of the plant to 303 MWe. Hot water production for district heating in Reykjavik started at Hellisheidi in 2010.

6.5 Húsavík

At Húsavík, in Northeast Iceland, the generation of electricity using geothermal energy began in 2000 when a Kalina binary-fluid 2 MWe generator was put into service. It was one of the first of its kind in the world. The plant utilizes 120°C water as an energy source to heat a mixture of water and ammonia, which in closes circuit acts as a working fluid for heat exchangers and a turbine. Part of the hot water leaving the generating plant at 80°C is used for the town´s district heating, as well as the local swimming pool. Due to operational problems the plant has not been running for several years but work on making it operational again is ongoing.

7. CONCLUSIONS

During the last century Iceland has developed the indigenous energy resources, hydropower and geothermal energy, to increase the standard of living and make the country less dependent upon imported fossil fuel. There is a large potential for increased utilization of geothermal energy. Geothermal electricity generation is expected to increase in the coming years, but direct uses will most likely only grow at a moderate rate.

The Icelandic energy companies have plans for expansion in the geothermal electricity generation. However, new developments have slowed down considerably since the financial crisis a few years back and new developments have been delayed. The project that is closest to being implemented is a new geothermal power plant in North Iceland. It will be 45 MWe in the first stage and located either in the Bjarnarflag og Theistareykir geothermal field.

As a result of these delayed projects there has been a drastic reduction in the geothermal drilling activity from a high of 28 high-temperature wells drilled in 2008 to only 2 wells drilled in 2012. As a consequence of this most of the larger Icelandic drill rigs are temporarily in operation overseas. The first well drilled as a part of the IDDP project (Iceland Deep Drilling Project) in 2009 hit magma at a depth of 2,100 m. Research is now ongoing with the aim of finding if the well can be used somehow in the future.

The Geothermal Training Programme of the United Nations University (UNU) has operated in Iceland since 1979 with six months annual courses for increasing number of professionals from developing countries. In 2012 a total number of 33 fellows attend the training course. Specialized training is offered in different geothermal disciplines. Most of the candidates receive scholarships financed by the Government of Iceland and the UNU. A MSc. programme was started in 2000 and a PhD programme in 2008 in cooperation with the University of Iceland. Also, annual workshops/short courses are held in Africa, Central America, and Asia. From the beginning a total number of 515 scientists and engineers from 53 countries have completed the six month courses, 35 have completed the MSc. programme and the first fellow defended his PhD degree in yearly 2013.

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Tables A-G

Table A: Present and planned geothermal power plants, total numbers

	Geothermal Power Plants		Total Electric Power in the country		Share of geothermal in total	
	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (%)	Production (%)
In operation end of 2012	660	5,210	2,659	17,550	24.8	29.7
Under construction end of 2012	0	0	95	585	0	0
Total projected by 2015	830	6,570	2,924	19,495	28.4	32.9

Table B: Existing geothermal power plants, individual sites

Locality	Plant Name	Year commiss.	No of units	Status	Type	Total inst. Capacity (MW_e)	Total running cap. (MW_e)	2012 product. (GWh_e/y)
Bjarnarflag	Bjarnarflag	1969	1	O	1F	3.2	3.2	17.5
Krafla	Krafla	1978/97	2	O	2F	60	60	472
Svartsengi	Svartsengi	1977/07	10	O	1F/B/D	72	72	507
Nesjavellir	Nesjavellir	1998/05	4	O	1F	120	120	1,011
Húsavík	Húsavík	2000	1	N	B	2	0	0
Hellisheiði	Hellisheiði	2006/11	7	O	1F	303	303	2,414
Reykjanes	Reykjanes	2006	2	O	1F	100	100	789
Total			**26**			**660**	**658**	**5,210**

Key for status:		Key for type:			
O	Operating	D	Dry Steam	B-ORC	Binary (ORC)
N	Not operating (temporarily)	1F	Single Flash	B-Kal	Binary (Kalina)
R	Retired	2F	Double Flash	O	Other

Table C: Present and planned geothermal district heating (DH) plants and other direct uses, total numbers

	Geothermal DH Plants		Geothermal heat in agriculture and industry		Geothermal heat in balneology and other	
	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)
In operation end of 2012	1,725	6,342	120	410	310	1,483
Under construction end of 2012						
Total projected by 2015	1,810	6,660	122	417	340	1,622

Table D: Existing geothermal district heating (DH) plants, individual sites

Locality	Plant Name	Year com miss.	Is the heat from geo-thermal CHP?	Is cooling provided from geo-thermal?	Installed geotherm. capacity (MW_{th})	Total installed capacity (MW_{th})	2012 geo-thermal heat prod. (GWh_{th}/y)	Geother. share in total prod. (%)
Reykjavík	Orkuveita	1930	Yes, partly	No	1000	1000	4,050	100
Seltjarnarnes		1971	No	No	35	35	96	100
Mosfellsbær		1929	No	No	29	29	134	100
Sudurnes	HS-veitur	1976	Yes	No	136	136	655	100
Akranes and Borgarfj.		1981	No	No	7	7	20	100
Akranes		1980	No	No	33	33	100	100
Borgarnes		1980	No	No	10	10	42	100
Stykkishólmur		1998	No	No	8	8	30	100
Dalabyggð		1999	No	No	3	3	13	100
Reykhólar		1954	No	No	4	4	7	100
Sudureyri		1977	No	No	3	3	12	100
Drangsnes		1999	No	No	1	1	2	100
Hvammstangi		1972	No	No	5	5	18	100
Blönduós		1977	No	No	7	7	27	100
Skagafjördur		1953	No	No	27	27	123	100
Siglufjördur		1975	No	No	7	7	24	100

Table D: Existing geothermal district heating (DH) plants, individual sites (continued)

Locality	Plant Name	Year com miss.	Is the heat from geo-thermal CHP?	Is cooling provided from geo-thermal?	Installed geotherm. capacity (MW_{th})	Total installed capacity (MW_{th})	2012 geo-thermal heat prod. (GWh_{th}/y)	Geother. share in total prod. (%)
Ólafsfjordur		1944	No	No	10	10	39	100
Dalvik		1969	No	No	16	16	46	100
Hrísey		1973	No	No	4	4	12	100
Akureyri	Nordurorka	1977	No	No	94	94	284	100
Húsavík		1970	No	No	26	26	92	100
Reykjahlíd		1971	No	No	7	7	25	100
Eskifjordur		2005	No	No	8	8	16	100
Egilsstadir		1979	No	No	15	15	40	100
Rangæinga		1982	No	No	16	16	48	100
Flúdir		1929	No	No	38	38	92	100
Blaskogabyggd		1923	No	No	33	33	155	100
Selfoss		1948	No	No	60	60	155	100
Hveragerdi		1947	No	No	71	71	108	100
Thorlakshöfn		1979	No	No	12	12	55	100

Table E: Shallow geothermal energy, ground source heat pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New GSHP in 2012		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2012	10	2	1			
Projected by 2015						

Table F: Investment and Employment in geothermal energy

	in 2012		Expected in 2015	
	Investment (million €)	Personnel (number)	Investment (million €)	Personnel (number)
Geothermal electric power	18	130	50	130
Geothermal direct uses	5	70	5	70
Shallow geothermal	0	0	0	0
total	**23**	**200**	**55**	**200**

Table G: Incentives, Information, Education

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D			
Financial Incentives – Investment		RC	RC
Financial Incentives – Operation/Production		DIS	DIS
Information activities – promotion for the public	No	No	No
Information activities – geological information	Yes	Yes	Yes
Education/Training – Academic	Yes	Yes	Yes
Education/Training – Vocational	Yes	Yes	No

Key for financial incentives:

DIS	Direct investment support	RC	Risc coverage	FIP	Feed-in premium
LIL	Low-interest loans	FIT	Feed-in tariff	REQ	Renewable Energy Quota