Landsvirkjun

The founding of Landsvirkjun in 1965 may be traced to the Icelandic government's interest in increasing the utilisation of energy resources by attracting foreign investors for power-intensive industry in Iceland. At this point, Landsvirkjun was established for the purpose of constructing and operating power plants which could both sell electricity to power-intensive industries and provide the general market with electricity at reasonable prices. Up to this time, the electrification of Iceland had been managed by government and municipalities around the country; however, these utilities were incapable of financing new energy projects.

Landsvirkjun has developed its power system since 1965, with installed capacity expanding from about 90 MW to over 1900 MW with the Kárahnjúkar Hydro Station. At the same time, electricity prices on the general market have declined in real terms, while electricity sales in foreign currency to power-intensive industries have increased up to about 80% of the company's electricity production. Furthermore, the quality and security of supply from Landsvirkjun's ranks among the best in the world.

Production and demand of electricity

From the time the company was first started until the end of the 1970s, the company built three power stations on the rivers Thjórsá and Tungnaá. During these early years, electricity sales were increasing to aluminium and ferrosilicon production. Towards the end of the period, weather conditions and mushrooming demand resulted in a power shortage in Iceland, making construction of the Sigalda and Hrauneyjafoss plants in the late seventies a race against time.

In 1983, Landsvirkjun became a national electricity company, whereas its operation up till then had been limited to the south and west of Iceland. The period of 1982 to 1996 was characterized by only a small increase in electricity demand and no success in attracting foreign investors to power-intensive industry projects in Iceland. It was in those years that Landsvirkjun built the Blanda Hydro Station, with many criticising the resulting surplus supply of electricity.

In 1995-96, however, circumstances became favourable for attracting foreign investors in heavy industry. Landsvirkjun negotiated contracts for increased energy purchases by the Straumsvík aluminium plant, Icelandic Alloys and a new aluminium plant, Nordurál. All those contracts were completed in just under a year. This introduced a period of intense development at Landsvirkjun, which increased its production by about 60% in five years. The power plants at Blanda, Búrfell and the geothermal plant, Krafla, initieally built by the Icelandic State, were enlarged, and new plants were constructed at Sultartangi and Vatnsfell in south Iceland.

In 2002 negotiations were concluded for electricity sales to Alcoa Fjardaál at Reydarfjördur. Construction therefore began on Kárahnjúkar Power Plant at the beginning of 2003, which resulted in another 60% increase in Landsvirkjun's electricity production.

Environment

Plentiful electricity supplies are one of the cornerstones of the living standards that a modern society requires. Iceland is more fortunate than most countries in being able to produce its electricity by harnessing hydropower and geothermal energy, renewable and non-polluting sources. It has no need to produce electricity from energy sources that cause atmospheric pollution or ecological damage, such as the burning of fossil fuels. Landsvirkjun strives to plan its development projects so as to minimize environmental impact and maintain the existing ecological balance.

Bjarnarflag – the power station as tourist attraction

Landsvirkjun has proposed building a power station with exceptionally open access for visitors at Bjarnarflag in Námaskard, near Lake Mývatn. Two access routes to the buildings are envisaged, one for electricity production and the other for tourists. Station operations would take place on one side and visitors would have access to them from a slope on the other side. The visitors' route is envisaged as a walk through the buildings to see all aspects of the electricity production process, ending with a relaxing stop at the nearby sauna and outdoors-bathing facilities using run-off water from the power plant.

At a visitor centre tourists will be able to find out about the station's activities, the environment and local history as well as volcanic eruptions (1724-1746 and 1975-1984). Geothermal fluid is procured from boreholes near the car park and the visitors' centre, then piped to a separator where the steam is separated from the water. It is then carried to steam turbines in the powerhouse after the moisture has been vaporized from it. Steam pressure is controlled by valves inside a special structure, and if the pressure becomes excessive, steam is released through a funnel.

The turbines in the powerhouse are expected to consist of either a single 40 MW unit or two 20 MW turbines. The energy released when the steam temperature drops in the turbine is converted into electricity by a generator connected to it. Steam leaves the turbines to be cooled and condensed. Water for cooling is pumped through a closed circuit process between the condenser and a cooling tower.

Key figures and specifications:

Installed capacity: 60 MW (2x30 MW)
Energy production: 480 GWh

At full capacity the station utilizes 110 kg/sec of 7.7 bar saturated high-pressure steam and 36 kg/sec of 2.2 bar saturated low-pressure steam.

Main gas compounds in geothermal steam:

Carbon dioxide (CO_2)	90-98%
Hydrogen sulphide (H_2S)	2-10%

Nearly 40 wells have been sunk at Krafla. Three of them were redrilled. In all there are 17 high-pressure wells and 5 low-pressure wells, while others are not utilized. The deepest borehole measures 2,222 metres.

Original design:
Power station: VST hf., Rafteikning hf. and Rogers Engineering Co. Inc.
Steam utility: VST hf. and Virkir hf.
Architects: Manfred Vilhjálmsson and Thorvaldur Thorvaldsson
Geophysical research and exploratory drilling:
Orkustofnun (National Energy Authority of Iceland)

Manufacturers of equipment:
Turbines, transformers and machinery:
Mitsubishi Heavy Industries, Japan
Cooling towers: Marley, USA

Main contractors 1975-77:
Groundwork and construction: Snidill hf., BSHSTh, Midfell hf.
Drilling: Icelandic State Drilling Company

Installation of turbine 2 and steam utility expansion 1996-98:
Design and project supervision: VGK and Rafteikning hf.
Main contractors:
Drilling: Icelandic Drilling Company Ltd.
Mechanical equipment: Mitsubishi Heavy Industries, Alstom

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Krafla
Geothermal Power Station

Landsvirkjun

Krafla Geothermal Power Station

Development for harnessing of geothermal steam at Krafla began with trial boreholes in 1974. Work commenced in summer 1975 on sinking of production wells and construction of the power station and a 132 kV transmission line to the town of Akureyri. The powerhouse and other buildings were designed to match two 30 MW turbine units.

The station was designed and built for the Icelandic State and its operation was originally managed by a State appointed committee. It was taken over by the State Electric Power Works from January 1, 1977 until the end of 1985, when Landsvirkjun purchased the Krafla station from the State and took over its ownership and operation.

The first turbine started up in August 1977, but electricity production did not begin until February 1978 due to inadequate steam supply. Initially the station operated under capacity on a single turbine, but in recent years it has been running at its installed capacity.

Various initial difficulties were encountered in prospecting and drilling for steam, largely due to seismic activity which caused corrosive magma vapours to enter the geothermal system, destroying the borehole linings. A series of nine volcanic eruptions began near the station on December 20, 1975 and lasted until September 1984. Since then, seismic and volcanic impacts on operations have greatly diminished.

In 1996, Landsvirkjun decided to install the second turbine unit and prospect for more steam. Drilling began immediately using improved technology, including diagonal drilling, which proved highly successful both for developing new boreholes and upgrading existing ones. The results were so good, in fact, that there is now ample steam to expand the Krafla station beyond the 60 MW capacity originally envisaged for it.

Electricity production using the second turbine unit began in November 1997 and Krafla Station has been operating at its full installed capacity of 60 MW since 1999.

How is the electricity produced?

Drilling a borehole at a site as rich in energy as the Krafla geothermal field releases steam under enormous pressure, containing thermal energy. Steam pressure varies from one borehole to the next, depending upon how deep they have been drilled.

A steam generation plant harnesses thermal energy by using the steam to drive a turbine wheel, after all the moisture has been vaporized from it. Steam is piped to the turbine at different pressures: low-pressure steam is used to drive its larger wheels and high-pressure steam the smaller ones. The steam condenses as it supercools under the turbine, causing a drop in pressure and the resulting suction draws the steam down from above, increasing the rotary force of the wheel.

The turbine wheel drives a magnetized rotor inside the generator. Surrounding the rotor is a copper coil in which an electrical current is induced by the motion of the magnet. This electrical current is then carried along high-voltage transmission lines to the transmission system.

Geology of the Krafla geothermal field

Iceland is part of the ocean floor which has been forced up above sea level by special geological conditions. The "hot spot" located beneath Iceland has played a major role in this process, and one of the places it breaks forth is the Krafla geothermal field, where it is accessible for energy production. Nature's forces are still locked in battle and their conflicts take various forms: Steam from seething hot springs, volcanic craters of all shapes and sizes, large and small and rough and smooth stretches of lava, the land split into fault blocks.

This area is a central volcano. Primeval forces tug the Earth's crust apart and split it with fissures that can be seen on the surface. Roughly 100 km long, this fissure zone runs almost due north to Öxarfjördur fjord and south to Mt. Bláfjall. The land to the west and east of the fissures is continuously spreading apart in its respective directions, by an average of 2 cm a year. Stóragjá chasm is a clear example of such tectonic plate drift. Some fissures have slipped to create a fault landscape; Mt. Dalfjall, for example, was formed in this way.

Volcanic eruptions are characteristic of such fissures. They create either crater series such as Threngslaborgir, or flow lavas of which Eldá is a fine example. Fissures emit either flows of relatively smooth pahoehoe lava such as we see at Reykjahlídarhraun, or rough lava which is difficult to cross, like Nýjahraun.

More than ten thousand years ago, this area was covered by an ice-age glacier. The ice hindered the lava from flowing away from the eruption fissure, and it piled up instead into tuff ridges such as Mt. Skógarmannafjöll. Mt. Búrfell, on the other hand, is a table mountain formed when the eruption managed to force its way through the surface of the glacier and fill the hole with lava. In some cases, basic lava has formed under the glacier and been transformed into shiny obsidian. Hrafntinnuhryggur ("Obsidian ridge") is an example of such a phenomenon.

Almost all the hot pools that bubble way near Krafla are solfataras like Hveraröndd. Hot streams do not flow from them, except underground – the bathing cave Grjótagjá is a famous instance. At Leirbotnar, powerful columns of steam can be seen rising from springs. Sometimes the underground steam becomes so intense that it explodes the surface to leave mud pools, as in Hveragil. Víti ("Hell") is a large explosion crater created by such an eruption and Mt. Hverfjall (Hverfell) was piled up by numerous explosions of this kind.

One of the most typical features of a central volcano is a bowl-shaped caldera which generally occurs in their centre. More than a hundred thousand years ago, the centre of the volcano around Leirhnjúkur sank or collapsed by several hundred metres in what must have been a spectacular eruption, to form a caldera some 8-10 km in diameter. Over the long period since then it has gradually filled up with pyroclastic material, lava and ash, which means that it has virtually vanished and can only be seen on careful examination.

At a depth of 3-8 km beneath Leirhnjúkur is a magma chamber, full of molten lava (magma). At intervals of several centuries the lava forces its way out into the fissures or up to the surface in a fissure eruption, and the land spreads by several metres. Such activity can last for a long time, even as much as a decade, as happened in the eruption series of 1975-1984.

Sightseeing around Krafla

In the immediate vicinity of Krafla Station are several of the most beautiful and distinctive places in the Lake Mývatn area. The car park just above the station is the starting point for walks out to Mt. Leirhnjúkur and across Nýjahraun. Landsvirkjun has set up a detailed information sign there, along with sanitary facilities. A little farther beyond is Víti, the crater formed in a tremendous volcanic explosion in the early hours of May 17, 1724.