GEOTHERMAL POWER PLANTS

In harmony with nature and the ecosystem

The Hengill area is one of the largest geothermal areas in Iceland and the geothermal field is linked to three volcanic systems in the area. The geothermal energy in Reykjadalur and Hveragerði comes from the oldest of the three volcanoes; from the Grensdals system. To the north of this area is another volcano associated with Hrómundartindur which last erupted about 10 thousand years ago. This particular volcano is the source of the geothermal energy found in Ölkelduháls. The westernmost and youngest system is the Hengill system and the Nesjavellir and Hellisheiði Power Plants are within that particular system.

The Hengill system has erupted several times since the Ice Age. About two thousand years ago, the Nesjahraun lava flowed from the Kýrdalssprungu crevice alongside Nesjavellir. In this area, it is common to feel the volcanic activity beneath your feet. Over 80,000 small tremors were detected in the Hengill area in the period between 1994 and 1998.

The two geothermal power plants in Hengill; Nesjavellir and Hellisheiði have long since been seen as symbols of the knowledge and tools that have been built up in the field of geothermal energy in Iceland. Both play the same role in producing hot water for district heating and electricity in the capital, for power intensive industries and the wider market.

It was in the middle of the last century when employees at Reykjavík District Heating began focussing on the potential of the Hengill area. The land Kolviðarhóll stood where Hellisheiði power plant stands today and was purchased in 1955 followed by the Nesjavellir land, ten years later.

Nesjavellir

In the early 20th century, the idea that the power of the Hengill area could be utilised for domestic heating purposes in Reykjavík was introduced, but the decision to go ahead with the Nesjavellir Power Plant was not taken until the 1990's.

In 1965, exploratory drilling began at Nesjavellir and continued with some interruption, until 1986. The largest geothermal energy source on the surface of the area is to the south of Nesjavellir and was the focus for exploration at that time. The distribution of geothermal energy at a depth of one to two kilometres to the east, west and north was investigated and detailed surface studies were conducted, including the geology, geochemistry and geophysics of the area.

The Power Plant

The construction of Nesjavellir Power Plant began in 1987. The plant was officially opened in September, 1990. Nesjavellir was the largest geothermal power plant in Iceland at that time and is now the second largest, after the Hellisheiði Power Plant.

Its annual output is 120 MW of electricity and 1640 l / s of 85 ° C of hot water; equivalent to 300 MW of thermal energy.

The production cycle

The production process at the power plant can be divided into three stages: the collection and processing of steam from boreholes, the collection and heating of cold water and finally, electricity production. Cold water is taken from the six boreholes in Grámel, by the Þingvellir Lake and pumped into the water tanks by the power plant. From there it goes to the condenser, the water separator and to the heat exchanger, which raises the temperature to 85-90 ° C.
At Nesjavellir, 24 holes have been drilled at a depth of between 1.000 to 2.200, reaching a temperature of 380 °.

Water mixed steam is led to the separation station, via a collection pipeline, where the water is separated from the steam. The steam and water are then transported via separate pipelines to the power plant. The steam is led to the steam turbines where electricity is made.

Separated water passes through the heat exchanger where the final heating of the water takes place. After this process the water is then boiled under pressure in a gas extractor to remove oxygen from the water, in order to prevent corrosion in pipes.

The powerhouse at Nesjavellir stands at a height of 177 meters above sea level. Hot water is pumped via a powerful pumping system into the tank in Háhrygg by Hengill. The water runs with the help of gravity and reaches the hot water utility tanks at Reynisvatnsheiði. The hot water pipeline to the capital is about 27 km long and the heat loss along the way is less than 2 ° C.

Hellisheiði

The geothermal area supplying the Hellisheiði Power Plant is located to the south of Hengill. The geothermal production line is divided into two main areas: the upper power plants site, above the Hellisfjörður mountain pass and the lower power plant site below the mountain pass and the Skarðsmýri Mountain. The research that has been conducted on the environmental impact of the power plant covers a much larger area than the two sites; in particular, the groundwater studies.

The power plant

The construction of the power plant began in late 2004. In autumn 2006, the first turbine units were put into operation and the production of electricity began. The annual output increased steadily in the coming years when more turbines were introduced. At the end of 2010, the thermal station began operations and in October, 2011 the final phase of electricity production started.

The installed capacity of the Hellisheiði Power Plant is 303 MW of electricity and 133 MW of thermal power, but if the plant was to be expanded and used to full capacity, then the figure could reach 400 MW in the future. This would occur in two or three stages dependent upon the need for hot water in the metropolitan area.

The processing cycle

The Hellisheiði Power Plant process can also be divided into three categories: the collection and processing of steam from boreholes, the collection and heating of cold water and finally, electricity production. 57 boreholes have been drilled at Hellisheiði and approximately 40 wells are in operation. The depth of the boreholes is often about 2.000 meters and their length up to 3.000 meters. Boreholes are drilled at a curve to minimise the surface effects (this is also the case at Nesjavellir). Collection pipes carry the mixture of steam and water from the boreholes to three separation stations. Separated water and steam are transported via pipeline to the plant. Collection pipes and pipelines are above ground, are insulated and lined with aluminium.

Six high pressure steam turbines are used to utilise the steam pressure, each producing up to 45 MW. There is also a low pressure steam turbine that can produce up to 33 MW. All engines are equipped with steam condensers, which maximise the utilisation of the steam. The steam condensers are also used for preheating the cold fresh water for district heating purposes.

Hellisheidi Thermal Station went into operation in November, 2010. The station has two heat exchanger substations, each with two serially configured heat exchangers. The installed capacity of the thermal station is 133 MW or 650 l/s of 85 ° C of water. Heated fresh water is used for district heating. The fresh water supply was investigated by drilling 23 exploration holes into the ground water west of Hellisheidi. It is thought that the water source at Engidalskvísl, to the west of Húsmúla will be enough to supply water for heating purposes for the years to come.

The water catchment area in Engidalskvísl was first utilised in 2005. Six boreholes are connected to the system and the area capacity is approximately 1.100 l/s. If and when the thermal plant is expanded, it is clear that the water extraction from Engidalskvísl will need to be increased. Today, the daily use of cold water is between 600 to 700 l/s.

Transferring power from the plant

The hot water pipeline from Hellisheiði is roughly 20 km in length. Its diameter begins at 1.000 mm and decreases to 900 mm. The pipeline runs from the hot water tank by the Hellisheiði Power Plant and connects with the control centre at Reynisvatnsheiði where the water mixes with the Nesjavellir water. Presently, the production rate is 650 l / s and it takes the water around 6 hours to reach Reykjavík. The pipeline is designed for a thermal station capable of producing 1600 l/s, which would reduce the transport time dramatically to 2.5 hours.

Environmental impact

It could be said that the production of energy in the Hengill area has had an impact on the environment. The main effects have been in connection with the disruptive nature of construction work, the disposal of run-off water and pollution caused by the emissions of hydrogen sulphide. Reykjavík Energy has been monitoring the impact and will continue to find ways to resolve these issues. The high-temperature region is closely monitored to assess the effects of utilisation and how these figures compare with the various calculations that have made with regard to the matter.

Nesjavellir Power Plant

Nesjavellir Power Plant began operations in 1990 as a district heating utility for the capital. In 1998, the production of electricity began at the plant and the discharge of water increased significantly. The effluent water from the plant is separated water, condensed water and heated groundwater that is not utilised for heating. Much of the effluent water is disposed of at the surface by the Nesjavellir Power Plant. The highest level of effluent water tends to be disposed of during the summer months and is mostly heated fresh groundwater, as there is less need for hot water and central heating than in the winter. More than a dozen boreholes have been drilled on site to investigate the effects on groundwater. The results show that the water from the springs in the lake has become warmer and action is being taken to resolve the matter.

Hellisheiði Power Plant

The Hellisheiði Power Plant began operations in 2006. The history of the endeavour is therefore brief and the project has been completed within a short timeframe. The effluent water from the plant has been pumped back into the geothermal system to ensure the sustainable status of the project and to protect the groundwater. The groundwater is monitored in over 40 boreholes, to measure the effects of the power plant on the environment. No significant increase in chemicals in the boreholes has been recorded. Procedures for pumping water back into the system have been reviewed and revised following earthquakes that occurred when pumping began in a new area by Húsmúla in late 2011. The regularity of the tremors has gradually been reduced. Construction of the power plant has mostly been completed and the focus has shifted to the restoration of the surroundings and of the local vegetation.

The increased development of geothermal energy production in the Hengill area has resulted in an increase in gas emissions in the immediate vicinity of urban areas. Reykjavík Energy has in recent years worked hard to find a solution to deal with geothermal greenhouse gases such as carbon dioxide (CO_2), which traps heat and hydrogen sulphide (H_2S), which causes pollution. Work is in progress to reduce emissions of hydrogen sulphide (SulFix project) and carbon dioxide (CarbFix project) by delivering the geothermal gases back deep into the rock layers. This project is an attempt to mimic the natural process that is already taking place in geothermal areas and should therefore prove to be a satisfactory mitigation measure.

In the spring of 2012, Reykjavík Energy, Landsvirkjun and HS Orka began working together to find environmentally friendly and cost-effective solutions to reduce the concentration of hydrogen sulphide in the air. The companies also support research at the University of Iceland in order to shed light on the possible health-related effects of hydrogen sulphide.

Reykjavík Energy wants to reduce the emission of hydrogen sulphide as much as possible and contributes to research and development in the field, in close cooperation with its stakeholders.

Timeline

1946
Initial drilling begins in the Hengill area

1964
Reykjavík District Heating buys Nesjavellir

1965
The first exploratory drilling begins in Nesjavellir

1987
Construction begins at Nesjavellir

1990
Nesjavellir officially comes online

1998
The first steam turbine for generating electricity turned on at Nesjavellir

2004
Construction begins on Hellisheiði

2006
First turbine units in Hellisheiði begin operation

2007
Low pressure unit at Hellisheiði begins operation

2010
Thermal Station at Hellisheiði begins operation

2011
Construction of Hellisheiði power plant officially completed

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