CASE STUDY: HELLISHEIDI POWER PLANT, COMBINED HEAT AND POWER

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Figure 1 - Hellisheidi Plant

ABSTRACT

Hellisheidi power plant is a combined heat and power plant. Estimated capacity is 300MW of power and 400 MW thermal.

Keywords: geothermal power plant, Hellisheidi, Iceland, steam, hot water utility

INTRODUCTION

The Hellisheidi power plant is located approximately 18 kilometers outside the capital city of Iceland, Reykjavik. Construction started in 2005 and the first phase of the plant went online in 2006. When fully developed the estimated production capacity will be 300 MW of electric energy and 400 MW of thermal energy with the option to expand the plant by connecting to adjacent areas.

The plant´s purpose is to meet increasing demand for electricity in the industrial sector and for hot water for space heating in the domestic sector. The single largest energy buyer is an aluminum smelter situated close by in Hvalfjordur bay.

LOCATION

The geothermal area of the Hellisheidi plant is at Mount Hengill, which is located on an active volcanic ridge. The area is divided into the upper geothermal area above the Hellisskard pass and the lower area below the pass. However, a much larger area has been included in research to assess the available geothermal reservoir as well as the environmental impact of the plant.

The geothermal activity in the Hengill area is connected with three volcanic systems. At least three volcanic eruptions have occurred in the area in the last 11,000 years, the most recent being 2,000 years ago. The Hengill area is part of the Hengill region, which covers 112 square kilometers and is one of the most extensive geothermal areas in Iceland.

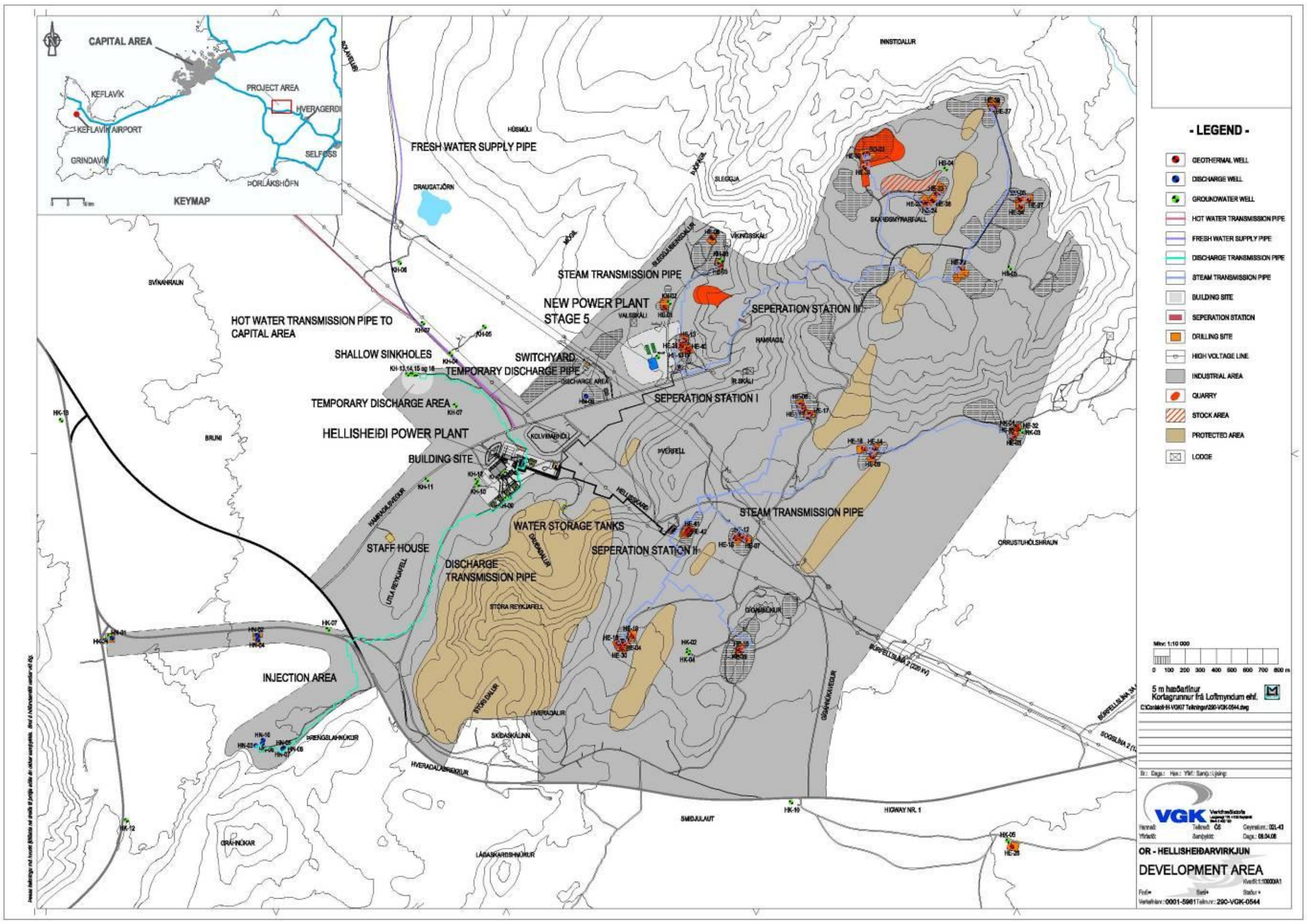

Figure 2 - The Hellisheidi power plant and surrounding area

CONSTRUCTION PHASES

Table 1 show the construction phases of the plant, starting in 2006 and ending in 2011-2012.

Table 1- Construction phases

	2006	2007	2008	2009	2010	>2011
Electric - MW_e	90	33	90		90	
Thermal - MW_{th}				133		267

EXPLORATION DRILLING

In 1985, a research well was made adjacent to the Kolvidarholl hill (in the same area that the plant is situated). In 1994, another well was made on the Olkelduhals ridge. Both wells offered some clues about the reservoir available, but more evidence was needed before a commercial decision regarding a construction could be made. Two wells were made in the Hellisheidi heath in 2001 and three more in 2002. The information from these holes provided the basis for the commercial decision to start full scare development of the area.

Now there are 50 production wells ranging from 1500 to 3322 meters deep, with heat ranging from 255 to 320°C in the area. Furthermore, there are eight injection wells (1500m) and six fresh water wells (60 m).

ELECTRICITY

The Hellisheidi plant is currently producing 215 MW of electricity. When fully developed in 2010 the capacity will be 300 MW.

The plant uses a double-flash process with four 45 MW high-pressure turbines (from Mitsubishi) and one 35 MW low pressure turbine (from Toshiba).

The power station is linked with the national power grid's substation, located under 220 kV transmission lines around 1 km from the plant.

HEATING

Currently the construction of a hot water pipe is underway. The capacity of the pipe will be 2.100 L/sec 83°C or 400 MW thermal. The pipe will be ready for use in the year 2009. The capacity of the pipe is estimated to be sufficient to meet future increases in demand for hot water for space heating over the next 15 years.

The plant uses fresh ground water from - the water is first heated to 50°C by using steam from the turbines. The water is then heated for a second time by heat exchange to about 83°C. An underground, pre-insulated pipe will be used for the heating utility. The water will travel 18 km to hot water tanks in Reykjavik. The heat loss is estimated to be about 1,5°C.

The hot water pipe will be the third longest in the world after the Akranes hot water utility (68 km) and Nesjavellir combined heat and power plant (27 km).

Figure 3 - The Pearl, Hot-water Tanks in Reykjavik

DRAINING SEPARATOR WATER

The initial plan was to drain the separator water 400m underground. There it would join a powerful groundwater current that runs out to sea at Selvogur Cove. However, this plan was met with strong resistance from the municipal authorities in the region as the groundwater is considered a natural resource to be retained for future use. A decision was therefore made to channel the water from the power plant down into the geothermal system itself. The most challenging problem with the on-site re-injection are silica deposits clogging both pipes and wells. Separator water from the Hellisheidi heath and the Nesjavellir fields is known to be exceptionally pure almost meets drinking water standards, although the taste leaves something to be desired.

PLANT LAYOUT

When designing the plant, flexibility was very important. The goal is to have all plant components in one central building with each production unit located around the main structure. Generator rooms for electricity production face south from the central building and the hot water plant faces north.

The plant is designed to accommodate visitors; guided tours and educational materials are readily available. About 25,000 guests visited the power plant this year.

ENVIRONMENTAL IMPACT

In accordance with laws and regulations, Reykjavik Energy carried out an extensive environmental assessment on the effects of the Hellisheidi geothermal power plant. The results indicate that the construction of the plant will not have a lasting influence on the area´s vegetation. Any impact is limited to the construction areas of boreholes, pipes, roads, mines, and buildings.

CARB FIX

The University of Iceland, Colombia University, CNRS in Toulouse and Reykjavik Energy are working on a project called CarbFix in connection with the Hellisheidi power plant. The purpose is to research the possibility to reduce industrial CO2 emissions by optimizing methods for storing CO2 in basaltic rocks.

By capturing CO2 from variable sources and injecting it into suitable deep rock formations (basaltic bedrock), the carbon released is returned back where it was extracted instead of freeing it to the atmosphere.

A mixture of water and steam is harnessed from 2000 m deep wells at Hellisheidi geothermal power plant. The steam contains geothermal gases, i.e. CO2. It is planned to dissolve the CO2 from the plant in water at elevated pressure and then inject it through wells down to 400-800 m, just outside the boundary of the geothermal system. The liquid will react with calcium from the basalt and form calcite. This process occurs naturally and the mineral calcite is stable for thousands of years in geothermal systems. The project will aim at accelerating these natural processes.