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ENVIRONMENTAL IMPACT ASSESSMENT OF GEOTHERMAL PROJECTS IN ICELAND

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ABSTRACT

An Environmental Impact Assessment (EIA) is always required before permits are granted for construction of a new geothermal power plant. In some areas the developer must carry out an EIA on exploratory drilling before necessary permits are granted. This paper summarizes the geothermal cases which have been subjects to EIA in Iceland. Many of the EIA cases are for one and the same geothermal development project, due to enlargement of an existing power plant or additional drilling of production wells or reinjection wells. The Hengill-Hellisheidi project is especially dealt with as well as connection of the Hverahlíd field to the Hellisheidi power plant.

1. INTRODUCTION

The use of high enthalpy geothermal resources in Iceland has increased considerably last decade. In the year 2005 the generation of electricity by the use of geothermal energy was about 200 MW_e. Today the installed capacity has increased to about 665 MW_e (Figure 1). Development and construction of a new power plant is now in progress at Theistareykir.

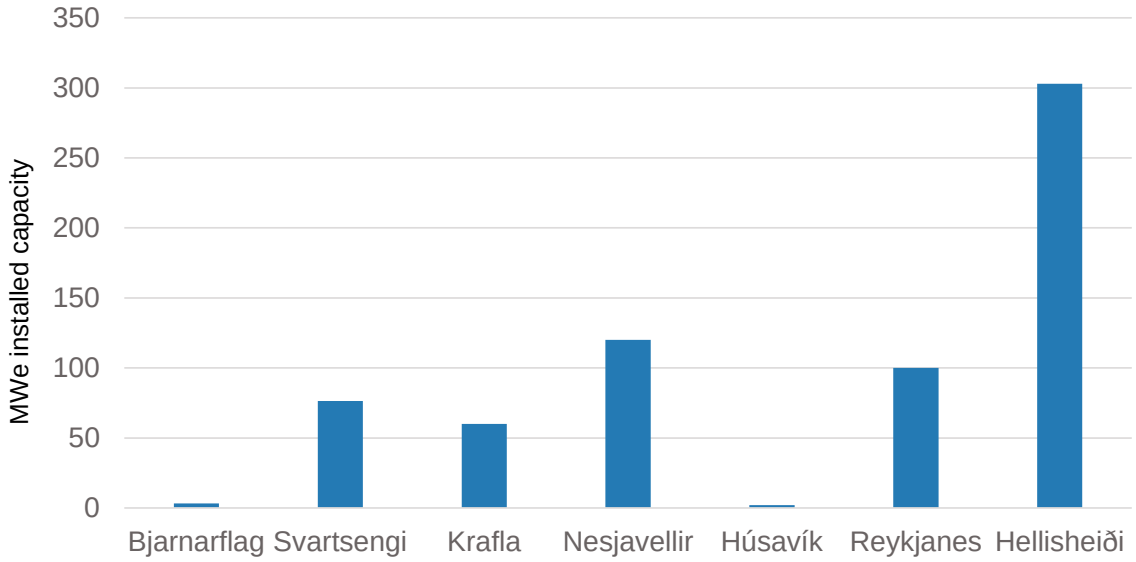

FIGURE 1: Installed capacity of geothermal power plants in Iceland (Loftsdóttir et al., 2015)

2. LAWS AND REGULATIONS REGARDING GEOTHERMAL UTILIZATION

All geothermal projects in Iceland are subject to legal and regulatory frameworks. The number of permits varies with the nature of the project, e.g. whether permits are applied for a power plant of some kind or for drilling production or exploration wells. Table 1 displays an overview of the application process for geothermal projects in Iceland, which permits are applied for and what legal body issues these permits. The process also includes changes in land use plans in the given area. The developer is responsible for applying for these permits.

TABLE 1: Permits and processes for geothermal projects in Iceland
(Modified from Albertsson et al., 2010)

	Permit/process	**Institution**	**When to apply**
Resources	Research permission	The National Energy Authority	Optional
	Utilization permission	The Ministry of industry, energy and tourism / The National Energy Authority	Optional
	Harnessing permit	The Ministry of industry, energy and tourism / The National Energy Authority	When findings on the size of the project are out in the open and decisions have been made about building the project
Land	Change in land use plan	Local authority	In the preliminary phase of the project
	Detail land use-plan	Local authority	When execution of the project is out in the open
EIA	Project subject to assessment	The National Planning Agency	When decision on project is on hand
	Scoping document	The National Planning Agency	
	Environmental impact statement	The National Planning Agency	
Development	Development consent	Local authority	Granted when planning ready and EIA is completed
	Building permit	Local authority	When building-blueprints have been approved
	Operating license	Local health committee	Apply months before operating of the project begins
	Project in areas protected as natural phenomena	The Environment Agency	If project disrupts protected natural phenomena
	Archaeological remains	Archaeological Heritage Agency	If project disrupts protected archaeological phenomena

3. ENVIRONMENTAL IMPACT ASSESSMENT

The Environmental Impact Assessment Act no. 63/1993 (EIAA) was legalized in the year 1993. In the year 2000 a new EU directive (Directive 97/11/EB) came into effect and changes in the Icelandic EIAA followed (Icelandic parliament, 2000). Further changes were made in the year 2005.

4. EXPERIENCE OF THE PERMIT PROCESSES

Geothermal projects differ from most other projects which has thus great influence on the EIA process. Most projects are well defined, i.e. the design, size and magnitude of the project is known

when assessing the impact of the project. The utilization of geothermal energy is however dynamic in nature, where the information is being gathered and processed continuously during the time of utilization. The characteristics of geothermal utilization is therefore very different from other projects. This mean that geothermal projects have to be addressed to the EIA process many time as the knowledge of the nature of the resource increases.

From 2000 to 2015 46 geothermal development projects were assessed case-by-case whether they were subject to an EIA (Figure 2). Majority of these projects (30) dealt with drilling projects. From 2008 to 2015 eight drilling projects went through screening process decision and IEA was net needed. From 2000 to 2015 ten development projects were subject to an EIA. The projects are all situated in high temperature areas, on the southwest coast, Reykjanesskagi and Hellisheidi, and on the northeast coast, Krafla and Theistareykir. Only one project was situated in low temperature area.

Many of the EIA cases are for one and the same geothermal development project, due to enlargement of an existing power plant or additional drilling of production wells or reinjection wells.

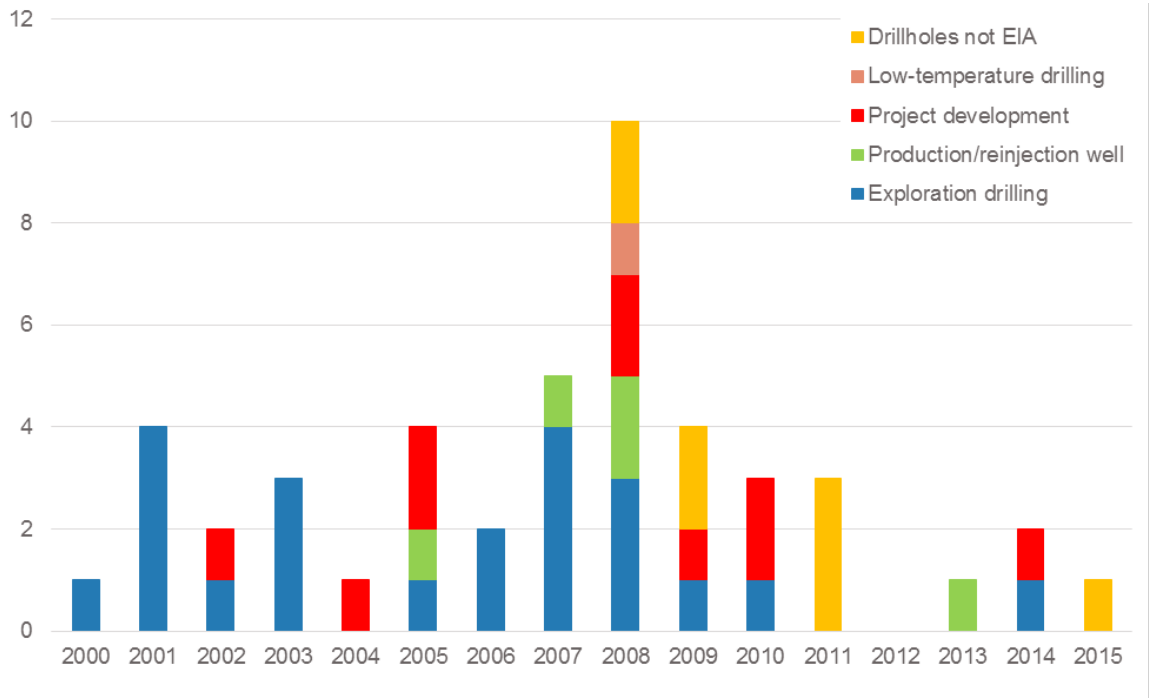

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FIGURE 2: Number of geothermal development projects in Iceland assessed case-by-case whether they were subject to EIA.

During exploration phase information are gathered that have significant effect on the location, size and overall design of the project. The geothermal projects are dynamic not static as most other EIA projects such as hydropower projects, roads and aluminium smelters. This is mainly due to the nature of the geothermal resource. The outcome of the different surveys undertaken at a very early stage of the project and which is the basic data for the EIA is just indicative for the real, short and long term impact the project imposes on the environment. Commonly it takes 10 to 13 years to develop a geothermal green field project in Iceland and therefore different phases of the development have to be screened by the EIA process.

4.1 Experience from Hellisheidi

The Hengill geothermal system lies in the middle of the western volcanic zone in Iceland, on the plate boundary between North America and the European crustal plates. The Hellisheidi power plant is located on the southern side of the Hengill Mountain about 20 km from Reykjavík. The plant is a

cogeneration plant of heat and power and is built up in modular units. The drilling of several research wells was assessed in the screening process but did not lead to a full EIA. Research drilling started in 2001 by drilling 2 wells.

Environmental impact assessment for the power plant project was carried out in two steps. First for a 120 MW_e power production and a 400 MW_{th} thermal production. That was finalized in 2003. By extending the field towards the Hengill Mountain the size of the development area had almost doubled. Then the second stage of environmental impact assessment was undertaken. This part was finalized in late 2005. The construction started in early 2005. The low pressure turbine, 30 MW_e, was not subject to an EIA nor the increased production of 30 MW_e which resulted from increased performance of the turbines. Table 2 shows how the sequence of events for Hellisheidi power plant progressed through the EIA process under the EIA law in Iceland. Figure 3 shows the number of phases of the project which were assessed case-by-case whether they were subject to an EIA for Henill-Hellisheidi. The installed power at the Hellisheidi power plant is now 303 MW_e and 133 MW_{th}. The thermal plant can be extended to 400 MW.

TABLE 2: EIA decisions and events regarding the Hengill-Hellisheidi geothermal project

No.	Time	Activity	EIA status
1	Jan. 2001	1st Phase – Drilling of 2 exploration wells at Hellisheidi	Screening decision
2	Sep. 2001	2nd Phase – Drilling of 3 exploration wells at Hellisheidi	Screening decision
3	Apr. 2003	Scoping decision on Hellisheidi PP 120 MWe and 400 MWth	Scoping decision
4	Feb. 2003	3rd Phase – Drilling of 3 exploration wells at Hellisheidi	Screening decision
5	Feb. 2004	Decision in Hellisheidi PP 120 MWe and 400 MWth	NPA opinion
6	Jan. 2005	Drilling of a total of 7 exploration wells in 4 areas in Hellisheidi region	Screening decision
7	Jun. 2005	Scoping decision on 120 MWe enlargement of Hellisheidi PP	Scoping decision
8	Dec. 2005	Changes in location of reinjection area for Hellisheidi PP	Screening decision
9	Mar. 2006	Decision on the 120 MWe enlargement of Hellisheidi PP	NPA opinion
10	Apr. 2006	Drilling of 2 exploration wells at Ölkelduháls in the eastern part of the Hellisheidi region	Screening decision
11	Apr. 2006	Drilling of 2 exploration wells at Hverahlíd in the southern part of the Hellisheidi region	Screeing decision
12	Dec. 2006	Scoping decision on Bitruvirkjun PP 135 MWe in the east Hellisheidi region	Scoping decision
13	Dec. 2006	Scoping decision on Hverahlíd PP 90 MWe in the south Hellisheidi region	Scoping decision
14	Apr. 2007	Changes in the location or reinjection area for Hellisheidi PP	Screening decision
15	Nov. 2007	Drilling of 2 exploration wells at Litli-Meitill to the south of the Hellisheidi region	Screening decision
16	Nov. 2007	Drilling of 1 exploration well at Gráuhnúkar in the southern Hellisheidi region	Screening decision
17	May 2008	NPA opinion on the Hverahlíd PP 90 MWe in the southern Hellisheidi region	NPA opinion
18	May 2008	NPA opinion on the Bitruvirkjun PP 135 MWe in the east Hellisheidi region	NPA opinion
19	Jul 2008	Additional power plant building for the Hellisheidi PP	Screening decision
20	Jul. 2008	Changes in the location of reinjection area for Hellisheidi PP	Screening decision
21	May 2009	Scoping decision on geothermal exploitation at Gráuhnúkar in the southern Helllisheidi region	Scoping decision
22	Sep. 2013	Changes in reinjection for SulFix II at Hellisheidi PP	Screening decision
23	May 2014	Steam gathering system from Hverahlíd to Hellisheidi PP	Screening decision

The development of two power plants in the Hengill area at Bitra and Hverahlíd also progressed through the EIA process. The drill field at Hvarahlíd has now been connected to the Hellisheidi power plant to compensate for reduction and drawdown at the Hellisheidi drill field.

The EIA has been effective since 1994 in Iceland. The first project was drill hole in a new field (Bitra) in the Hengill area and building a road to the field. At that time the process was relatively simple and

everyone was learning on the new process. No scoping document was submitted just environmental impact statement describing the environmental impact. After asking for further information and public consultancy the NPA approved the project. The total process was 123 days. After revision of the process the estimated minimum time for the EIA process according to laws is about 50 weeks (Gunnlaugsson, 2007).

Four project development in the Hengill-Hellisheidi area have been progressed though the EIA process from 2003 to 2008. The first phase for 120 MW_e power plant at Hellisheidi was completed in 688 days (98 weeks), 120 MW_e enlargement of that power plant in 300 days (43 weeks). The Bitra and the Hverahlíd projects were processed simultaneously and both completed in 517 days (74 weeks).

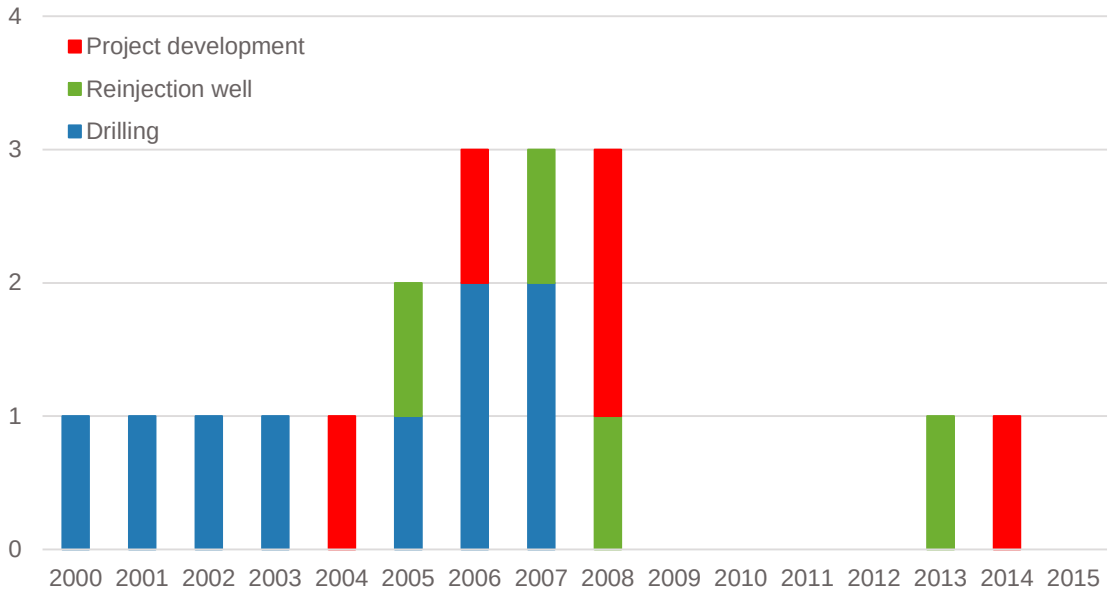

FIGURE 3: Number of projects assessed case-by-case for Hengill-Hellisheidi

5. CONNECTION OF HVERAHLÍD TO THE HELLISHEIDI POWER PLANT

In 2006 Reykjavík Energy started researching and planning for a new power plant at Hverahlíd in the Hengill area. The location is some 3-5 km SE of the Hellisheidi power plant. Five research drill holes have been drilled. From the size of the area it was estimated to sustain 90 MW_e power production. Preliminary EIA proposal for the Hverahlíd project was presented in August 2007. The EIA was published in March 2008 and finally accepted in May 2008.

In 2013 it was decided to connect the Hverahlid field to the Hellisheidi power plant to compensate for reduction in production and drawdown in Hellisheidi. The connection was submitted for screening to NPA. Since a power plant at Hverahlíd had already been accepted by EIA the main concern for the connection was the visibility. Special emphases was made to reduce the visual effect of the pipeline. A 3D model was made to assist in design, location of pipeline along roads as possible and old roads were used to hide the pipeline. After design of the pipeline the visual effects were specially introduced to NPA and public. This lead to the decision that full EIA process was not necessary.

6. CONCLUSION

Geothermal projects differ from most other projects. Due to the dynamic nature of the geothermal resource, decisive information such as exact location of facilities and geothermal fluid extraction rate

cannot be given at an early stage of development. Therefore one has endeavoured to develop the projects in steps. This leads to several decisions regarding EIA. The Icelandic EIA process does not suit for such projects and needs to be further developed regarding geothermal development.

It is important that all those who participate in the EIA process will learn from the experience gained from preceding steps and to improve the EIA process in general for geothermal projects. Especially how to discuss and assess the uncertainty that is involved and the complicated and diverse scientific data that the EIA decision is based on. The EIA has created some vital benefits such as broad consultation and created new guidelines for the development of geothermal projects.

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