

ENVIRONMENTAL PLANNING AND PERMIT PROCESS FOR THE HELLISHEIDI POWER PLANT IN ICELAND

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ABSTRACT

Geothermal energy is one of the most important energy sources in Iceland. For new projects it is essential to know well the permit processes required for the development of the energy resources. The Icelandic Government decided in 1997 to develop a Master Plan for all potential power projects in hydro and geothermal. All proposed projects should be evaluated and categorized on the basis of energy efficiency and economics, as well as, on the basis of the impact that the power developments would have on the environment. The Master Plan is comparable to the planning of land use and land protection. An act on Environmental Impact Assessment (EIA) was implemented in Iceland in 1994. Thermal power installations larger than 10 MW_e are always subjects to EIA and drilling in low temperature areas in the vicinity of hot springs and 10 km long pipelines outside of urban areas may be subject to EIA. Beside this the development has to be in accordance with the master plan of the locality. Other licences or permits are needed before the development of the resources. All of the permit processes can take considerable time and therefore it is necessary to take it into consideration in the early stages of planning.

1. INTRODUCTION

Geothermal energy is one of Iceland's most important natural resources where it accounts for just over half of the primary energy needs. The geothermal resources are closely associated with the volcanic activity. Traditionally, the geothermal fields are divided into high-temperature fields, where temperature above 200°C is found above 1 km depth and low-temperature fields, in which temperature is lower than 150°C in the uppermost kilometre. Some 30 high-temperature fields have been identified in Iceland, all within the active volcanic zone (Figure 1). The low-temperature activity is highest on the flanks of the volcanic zones but some low-temperature resources are found in most parts of the country.

The utilization of geothermal energy for heating houses began early in the 20th century. Today nearly 90% of all houses in Iceland are heated with geothermal water (Loftsdóttir et al., 2015). When starting a new project it is important to know all the permits needed for development and construction. It may take some time to obtain all the permits needed and therefore detailed planning is essential.

Through the years it has become more and more evident that utilization of energy resources (as other development) must take into account not only the energy needs and the economical aspects of the development, but also a range of other interests as well. This includes other use of land and the impact of the development on the environment and the cultural heritage. The government decided by to develop a master plan for the utilization of the energy resources, both hydro and geothermal, as a part of its goal for sustainable development.

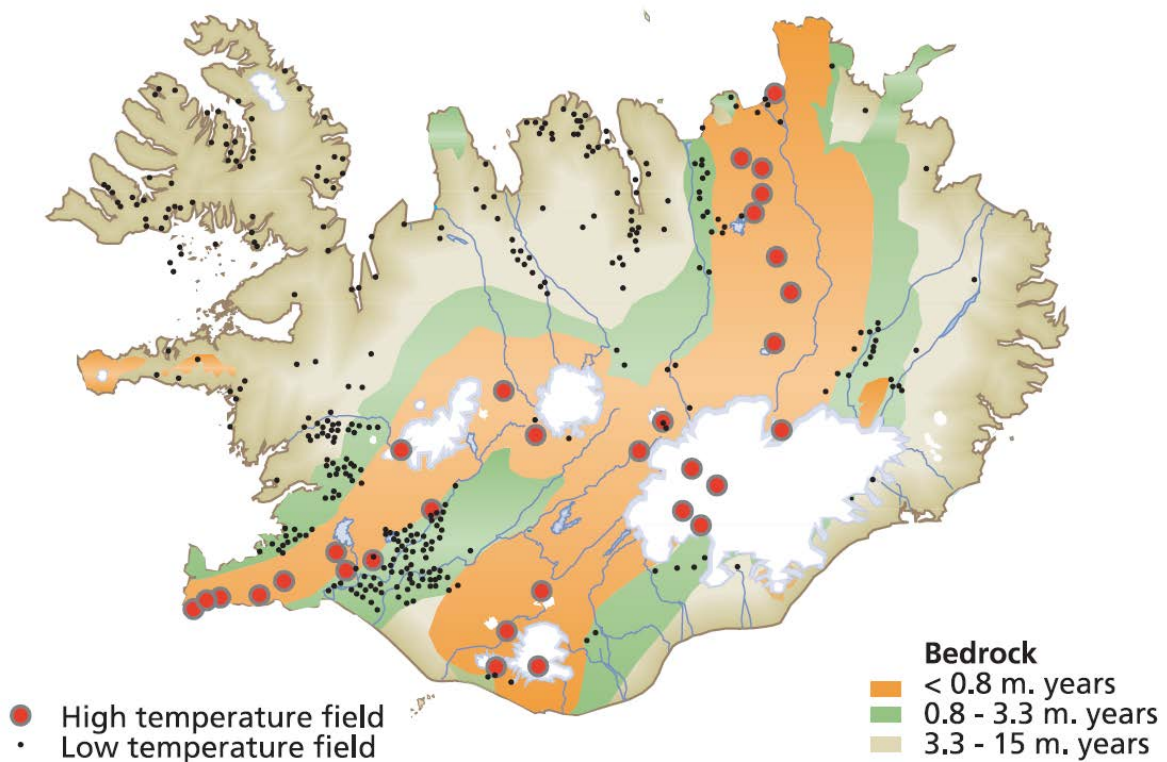


FIGURE 1: Geothermal map of Iceland

Most of geothermal district heating utilities in Iceland were built before the act on Environmental Impact Assessment (EIA) was implemented in 1994. Some geothermal projects have to fulfil the requirements of this act.

2. PERMIT NEEDED FOR GEOTHERMAL DEVELOPMENT

Development of a new geothermal field requires careful planning of the project. This includes making a time schedule for the project taking into account the permits procedure which is needed for the project. A simplified diagram of a project is shown in Figure 2.

2.1 Master plan for the development of energy resources

The vision behind the master plan was to prepare an overview of the various potential energy projects in hydro and geothermal and to evaluate and rank these based on their energy and economic potential, feasibility, national economy and the estimated impact that each project would have on nature, environment, cultural heritage and the society, as well as the potential for other uses of the areas in question. The master plan should be based on the best available scientific information and conclusions should be transparent and reproducible and made available to the public. In the initial step in the development of the Icelandic master plan National Energy Authority and power companies compiled

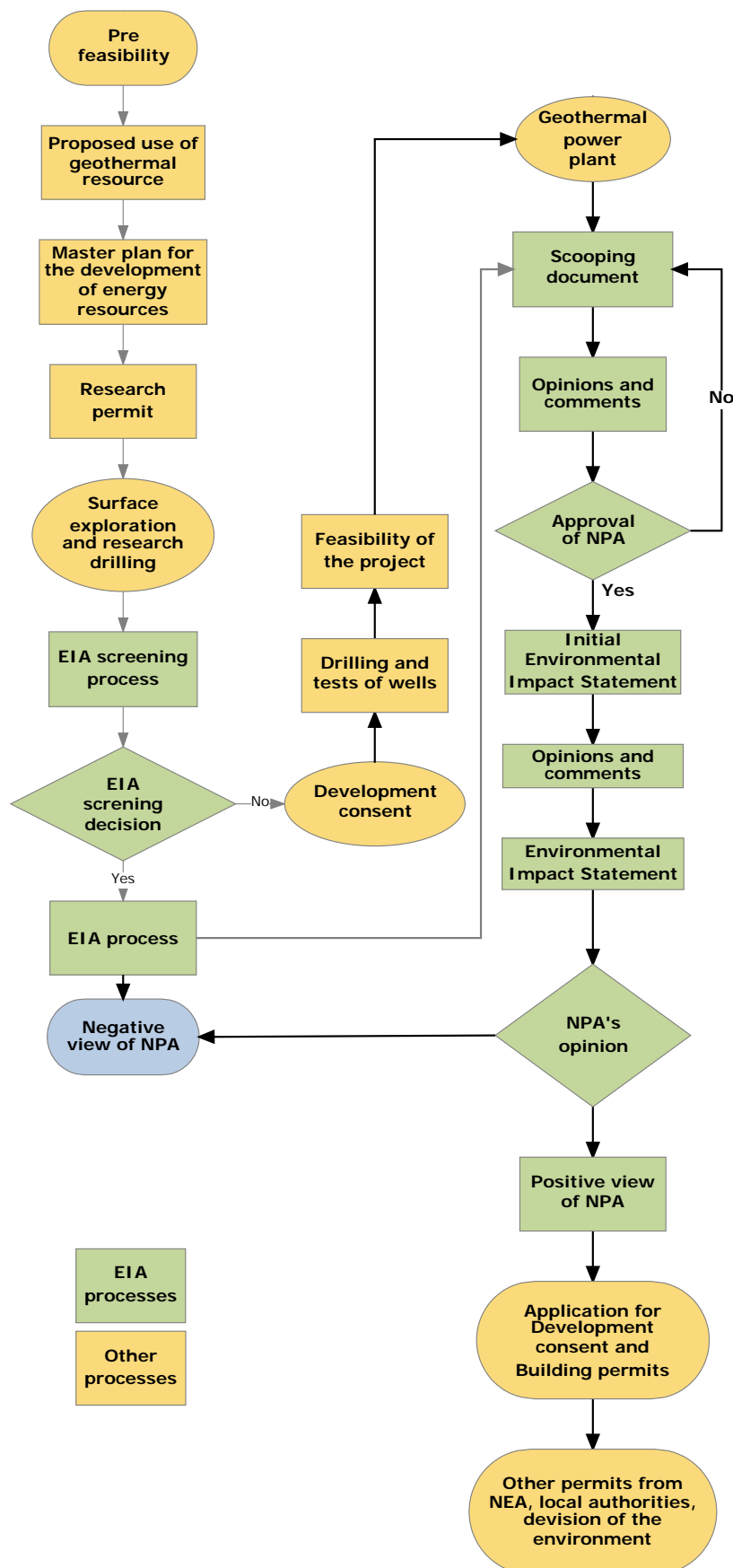


FIGURE 2: Simplified diagram of permit processes of geothermal development

reports on proposed project which they wished to have evaluated by the steering committee of the master plan. The number of projects that should be ranked during the master plan work were about one hundred. For some of the projects the available data were scarce and a large investment in data collection and exploration were needed. It was therefore decided to divide the work into phases. For the first phase 43 energy projects were selected, 19 hydropower projects and 24 geothermal projects. Four working groups were formed to deal with different aspects. These were WG1 dealing with nature, environment and cultural heritage; WG2 dealing with recreation, fishing, hunting and agriculture; WG3 dealing with social and economic impact and regional development and WG4 dealing with identification of potential power projects, project economy. Phase 1 was completed in 2003 (Steering Committee for the Icelandic Master Plan, 2003).

Preparation for the second phase of the master plan was launched in September 2004 and a steering committee of eleven representatives was appointed in August 2007. Four working groups were established to deal with different aspects in a similar manner as the phase 1 projects. The steering committee submitted its final report on phase 2 of the master plan to the Ministry of Industry and the Ministry of Environment in July 2011.

Phase 1 of the master plan emphasized the utilization of geothermal and hydropower resources in Iceland for power production. This was changed somewhat in phase 2 in that both utilization and conservation were considered on an equal basis. This is reflected in the official name of the final report: "Master plan for conservation and utilization of nature areas with emphasis on hydropower and geothermal energy" (Steering Committee for the Icelandic Master Plan, 2011).

The third phase of the master plan started in March 2013 when a new steering committee was formed. The task in the third phase is to further evaluate the energy options that could not be appropriately categorized in the second phase. A number of new energy options was also evaluated and, for the first time, options in wind power was considered. A draft result proposal was published in May 2016 and open for public opinion and comments to August 2016. Following that a proposal to the parliament will be submitted and finalized by parliamentary resolution. Figure 3 show the ranking of power projects from view of conservation and utilization.

2.2 Permit from landowner and research permission

Landowners can undertake research on their properties without a special research permit. The research by landowners does not include the right to utilize the resource. All others than owners have to apply for a research permit from the Ministry of Industry. The ministry calls for an opinion from the Ministry of the Environment and the National Energy Authority. Usually the Ministry for the Environment asks for the opinion of The Environment and Food Agency of Iceland. In the application most often the developer applies for priority for development if research gives a satisfactory result. So far the research permits have been issued with priority to develop within a certain time limit. The selection of the site to apply for the research and development permit has until now been in accordance with the interest of the developer.

2.3 Utilization permit

In Iceland a utilization permit is issued for all use of geothermal energy other than for electrical production. If co-generation is planned two permits are needed, i.e. a utilization permit for all direct use or cascading use and a permit for power utilization. When the developer applies for a research permit it is usually connected to some priority for utilization. Following research, the developer has to formally apply for utilization permit to the Ministry of Industry. In the application the utilization is described and a monitoring program of the resource is introduced. This application usually follows the Environmental Impact Assessment. The ministry asks for the opinion of the local authority, National Energy Authority and The Environment and Food Agency.

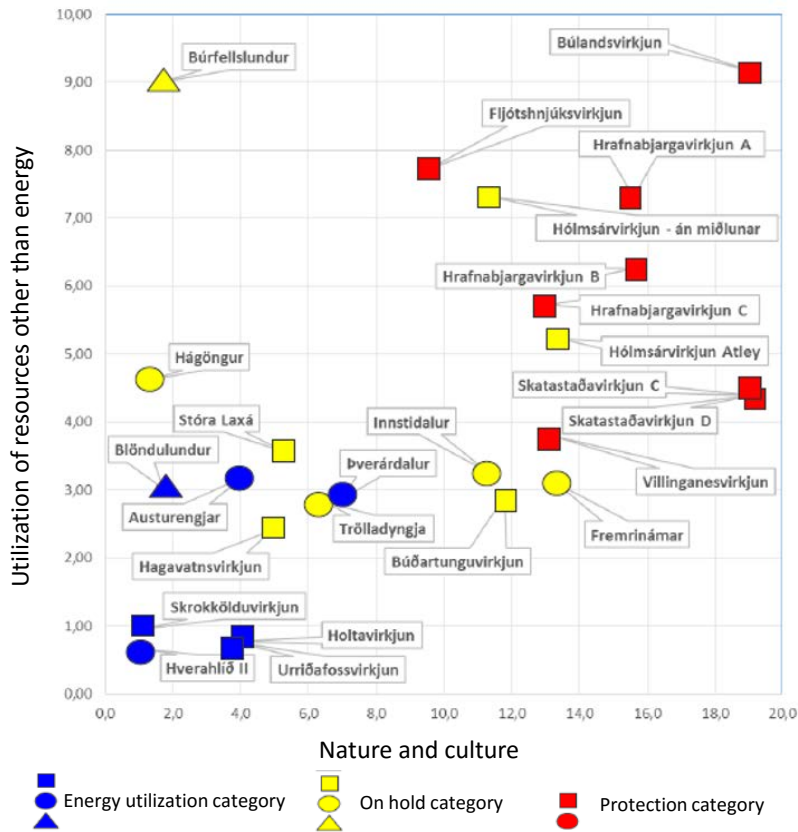


FIGURE 3: Ranking of power projects of phase 3 from the view of conservation (lower left) and utilization (upper right)

2.4 Master Plan (municipal plan)

The master plan is in the hands of the municipality. If the developer discovers that the master plan does not include the proposed geothermal utilization then the municipality has to be contacted and the policy regarding this project is required following the amendment of the master plan. Figure 4 shows the minimum time needed for minor and major amendments of master plans.

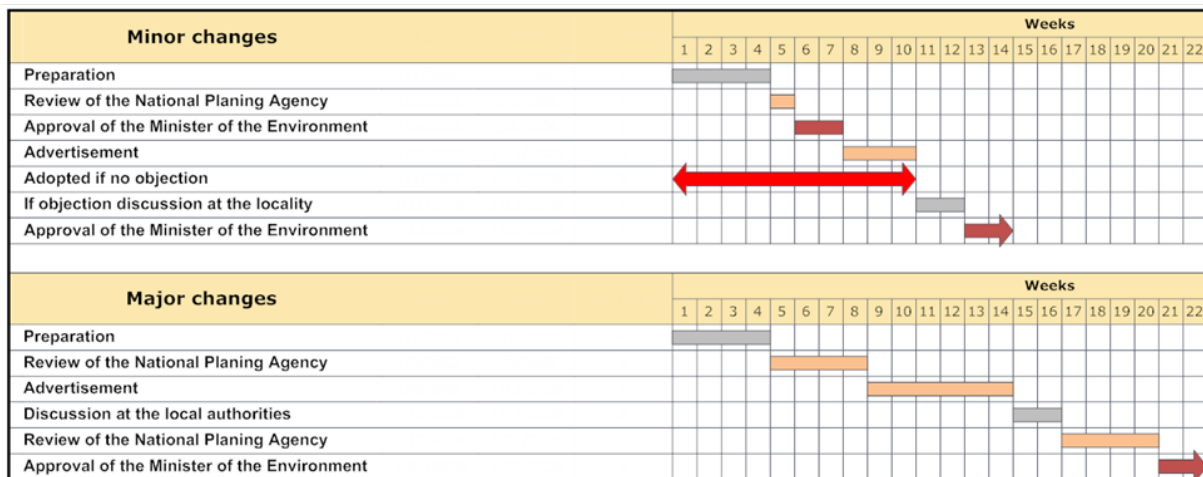


FIGURE 4: Minimum time for minor and major changes of municipal master plans in Iceland

If a local authority considers that an approved municipal plan needs to be amended but that the amendments are so insubstantial then it shall send a proposal on the amendments, with reasons, to the Planning Agency. The Environment and Food Agency is asked for their opinion. The Planning Agency shall forward the proposal to the minister together with its comments within a week of receiving the proposal from the local authority. If the minister approves the proposal, it shall be advertised. If no objections are received within three weeks of the advertisement, the proposal shall be regarded as adopted. If objections are received to the proposal after it has been advertised, the local authority shall hold one discussion on the objections. The local authority's conclusion shall be sent to the minister for approval.

If on the other hand the local authority considers it necessary to amend an approved municipal plan, the whole procedure takes a longer time. Preparation of the amendment of a master plan includes strategic environmental assessment (SEA) according to a new law implemented in 2006.

The process is that first the proposal and its objectives and premises shall be presented to the inhabitants of the municipality at a public meeting or in another satisfactory manner. The presentation shall be advertised in a conspicuous way. The advertisement shall give any interested party the chance to make objections to the proposal before a certain time limit, which shall not be less than six weeks after the publication of the advertisement.

After a public presentation, the proposal shall be presented to the local authority for discussion. Following the discussion, the local authority shall submit the proposal to the National Planning Agency for examination. If the National Planning Agency makes no comments within four weeks of its receipt of the proposal, the proposal shall be advertised without the amendment.

Strategic Environmental Assessment is needed for master plans and has to be included in the documentation when the plan is proposed.

2.5 Local plan

Local plans are made on the basis of the municipal plan in a statement and on a land use map. The Environment and Food Agency is asked for their opinion. When the local authority has agreed to advertise a local plan proposal, it shall be advertised and publicised in the same way as a municipal plan. This process can take 8 to 12 weeks.

2.6 EIA process

The objective of the Environment Impact Assessment is to ensure that, before the starting of a project the assessment of the environmental impact has to be carried out in order to minimise as far as possible the negative environmental impact of the project.

Table 1 lists projects related to geothermal utilization which are or may be subject to the Environmental Impact Assessment.

Annex 1 of the EIA Act lists projects which are always subject to the Environmental Impact Assessment. Among them are geothermal power plants and other thermal power installations with a heat output of 50 megawatts or more and other power installations with an electricity output of 10 megawatts or more. The whole process of the EIA can take more than a year depending on how much research has to be carried out.

In Annex II of the EIA Act there is a list of projects that may have significant effects on the environment and are therefore subject to an EIA. These projects are assessed on a case-by-case basis depending on their nature, size and location and other criteria presented in Annex III of the EIA Act. It is within the National Planning Agency's purview to decide whether these projects are subject to an

EIA. The decision by the National Planning Agency on whether a project is subject to assessment may be appealed to the Minister for the Environment.

TABLE 1: Geothermal projects which are or may be subject to the EIA

Annex 1. Projects which will always be subject to environmental impact assessment
Geothermal power stations and other thermal power installations with a heat output of 50 megawatts or more and other power installations with an electricity output of 10 megawatts or more.
Systems for groundwater abstraction where the annual volume of water abstracted or irrigated is 10 million m ³ or more.
Overhead electrical power lines, outside urban areas, with a voltage of 66 kV or more.
Annex 2. Projects which may have substantial effects on the environment and are assessed on a case-by-case basis,
Deep drillings, in particular: i. drilling of production holes and research holes in high-temperature geothermal regions; ii. geothermal drilling in low-temperature areas where mineral sources or hot springs are on the surface or in the near proximity.
Drilling for drinking water supplies of 2 million m ³ annually or more.
Industrial installations for the production of electricity, steam and hot water, hydroelectric power stations with an output of 200 kW or more and geothermal heating production amounting to 2,500 kW gross power or more.
Installations for carrying gas, steam and hot water; transmission of electrical energy by underground cables, which are 10 km in length or longer and buried in the ground or placed in tunnels, outside of urban areas; transmission of electrical energy by overhead cables in protected areas; and submarine cables.
Water pipelines outside of urban areas 10 km or longer, and underground.
Groundwater abstraction and diversion of groundwater.

The Environmental Impact Assessment process is divided into several steps which are described in more detail in the following chapters. Figure 5 shows the outline of the process and Figure 6 the time schedule for the process as it is described in the act on Environmental Impact Assessment (The National Planning Agency Website).

2.6.1 Screening process

The first step in the process is to find out if a project is subject to EIA. Among projects which always are subject to EIA are geothermal power stations and other thermal power installations with a heat output of 50 megawatts or more and other power installations with an electricity output of 10 megawatts or more.

FIGURE 5: The Environmental Impact Assessment process in Iceland

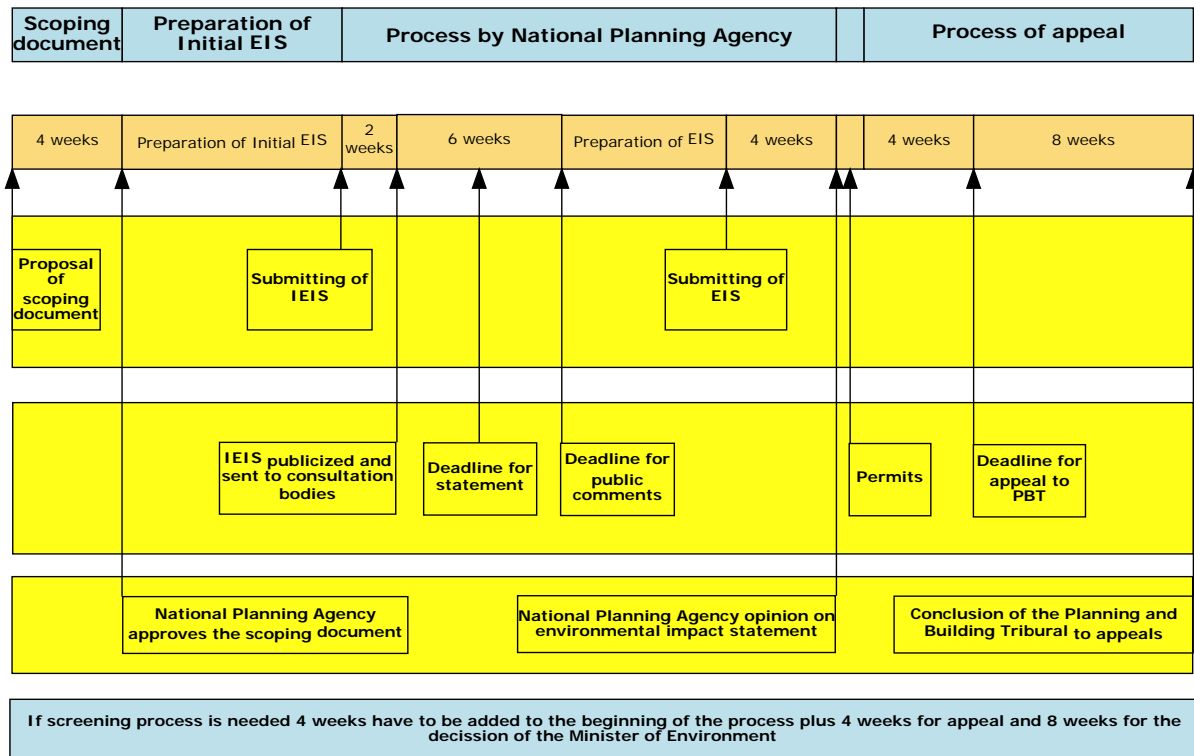


FIGURE 6: The time schedule for the Environmental Impact Assessment process according to the law

Other projects which may have substantial effects on the environment are assessed on a case-by-case basis. Drilling of production holes and research holes in high-temperature geothermal fields fall under this section as well as geothermal drilling in low-temperature geothermal fields close to geothermal manifestations.

Within four weeks of the receipt of data on the project, the National Planning Agency shall give notification as to whether the project shall be subject to assessment.

2.6.2 Scoping Document Proposal

If a proposed project is subjected to Environmental Impact Assessment the developer shall submit a scoping document proposal to the National Planning Agency as early as possible in the preparatory stage of the project. In this proposal, the developer shall describe the project, the project site and alternatives which could be considered and provide information on the planning of the project site and how the project will comply with development plans. The plan shall also propose which aspects of the project and of the environment should be emphasised, describe what data are already available, which data will be produced where and how and have a plan for making information available and for public consultation. The developer shall make the scoping document proposal known to the consultation bodies and to the general public and may consult with the National Planning Agency. The scoping document is the most important document regarding the Environmental Impact Assessment as it is in this stage that it is decided and agreed upon what research and data is needed for the assessment.

The National Planning Agency shall make a decision on the developer's proposal within four weeks of its receipt, having received the opinion of the licensors and other parties, as appropriate. For geothermal power plants the principal consultation bodies are the local government, The Environment and Food Agency of Iceland, National Energy Authority, The Archaeological Heritage Agency and the Division of the Environment of the local community or the region. The National Planning Agency

can approve the scoping document proposal with or without comments. Should the Agency make comments, they shall become part of the scoping document. If the National Planning Agency does not approve the scoping document proposal, the Agency must provide grounds for its decision, indicate what it deems to be deficient and instruct the developer as how the scoping document should be further elaborated. Approved scoping document proposal is then made known to the licensors and consultation bodies.

When the scoping document has been approved the main work is to collect information according to the document. Some of the data needed can only be collected during a certain period of the year. This includes mapping and research on the flora, and birds have to be counted during the nesting time.

2.6.3 Initial Environmental Impact Statement (IEIS)

Work on data collection and its interpretation and preparation to the Environment Impact Statement can take several months depending on availability of data.

The report shall specify the effects, direct and indirect, which the proposed project and related activities may have on the environment and the interaction of individual environmental factors. The report shall also explain upon what premises the assessment is based. It shall describe the aspects of the proposed project which are regarded as most likely to have an impact upon the environment, including its scale, design and location and what environmental monitoring is planned. The main alternatives considered, and their environmental effects, shall always be explained and compared. A non-technical summary shall be prepared describing the report's main findings.

When the developer is ready with the initial environmental impact statement it is submitted to the National Planning Agency. Within two weeks of the National Planning Agency receiving the initial environmental impact statement, the agency shall assess whether the report meets the criteria and is consistent with the scoping document.

The agency may refuse to accept the initial environmental impact statement for review in those cases when it does not meet the above-mentioned criteria. In such cases the National Planning Agency shall provide guidance to the developer regarding further elaboration of the initial environmental impact statement. When the National Planning Agency has approved that the statement meets the criteria and is consistent with the scoping document it shall publicise the proposed project and the initial environmental impact statement.

The initial environmental impact statement shall be made easily accessible at a location near the project site and at the National Planning Agency for six weeks, which shall also be the time limit for submitting written comments to the National Planning Agency. Anyone may comment on the initial environmental impact statement which has been made public. The National Planning Agency shall call after the opinion of the licensors and other parties as appropriate. The consultation bodies shall express their views as to whether the initial environmental impact statement has discussed aspects within their area of concern in a satisfactory manner and, furthermore, whether the proposed mitigating measures are satisfactory. They shall, if there is cause for so doing, specify what should be investigated further and point out possible mitigating measures.

2.6.4 Environmental Impact Statement (EIS)

The National Planning Agency shall send to the developer the opinions and comments it receives. When the developer has received the opinions and comments, the developer produces a final environmental impact statement on the basis of the initial environmental impact statement. In the environmental impact statement the developer has to discuss the comments and opinions given, and express its position regarding the comments and opinions. The report is then submitted to the National Planning Agency.

Within four weeks of receiving the environmental impact statement, the National Planning Agency shall deliver a reasoned opinion on whether the report meets the criteria of this Act and regulations issued on the basis of the Act, and whether the environmental impact is satisfactorily described. The opinion shall explain the main premises of the assessment, including the quality of the data on which the assessment is based, and its conclusions. The opinion also discusses the developer's response to the comments and opinions received when the initial environmental impact statement was made public.

If the National Planning Agency view is that further conditions should be laid down for the project, or that other and more extensive mitigating measures are required than those for which provision is made in the environmental impact statement, the Agency has to specify such conditions and mitigating measures, and the reasons for them. If the National Planning Agency finds that the developer's environmental impact statement is inconsistent with the preliminary assessment report in important aspects, it shall be presented again to the public.

When the National Planning Agency has given its opinion, this shall be made known to the Minister for the Environment, the developer, the licensors, the consultation bodies, and also those who made comments on the initial environmental impact statement during the period of public presentation. The public will have ready access to the National Planning Agency's opinion and the environmental impact statement, and the Agency shall advertise in a national newspaper that the opinion and environmental impact statement are complete. The final decision upon development is in the hands of local authorities as a development permit.

2.7 Permit for power utilization

The permit for power utilization was issued by the Ministry of Industry after obtaining the view of the National Energy Authority but to-day it is issued by National Energy Authority. It can now be appealed to the Ministry of Industry.

2.8 Permit from the Archaeological Heritage Agency

If archaeological heritage is likely to be disturbed or damaged during development a special permit is needed from The Archaeological Heritage Agency.

2.9 Special permits according to special laws

In some cases special laws may be dealing with specific areas. In such cases special permits may be needed. An example is a law regarding groundwater around the lake Thingvallavatn just north of the Hengill Mountain.

2.10 Development consent

The development consent is obtained from the relevant local authority. The project has to be in accordance with the master plan of the municipality as well as the local plan. Development consent may not be issued until the opinion of the National Planning Agency on the environmental impact assessment has been given. When issuing a development consent the licensor shall examine the developer's environmental impact statement on the project, and adopt a reasoned view on the National Planning Agency opinion on the assessment of its environmental impact. The licensor shall publish its decision on the issue of a permit and the findings of the National Planning Agency opinion on the environmental impact assessment within two weeks of the permit being issued. The decision shall specify the authorities for appeal, and the deadline for appeal, where relevant. The development consent may be appealed to the Planning and Building Tribunal.

2.11 Building permit

A building permit from the local authority is required for construction of all buildings and has to be issued before excavation for foundations. A building permit incorporates the approval of general drawings and intended construction of a building. It can be issued when the local authority has confirmed the decision by the building committee to grant a building permit, the building officer has signed the general drawings and the building permit fee has been paid in accordance with the valid rules, or agreement has been reached on their payment. A decision by a local authority to issue development and building permits under the Planning and Building Act for a project subject to environmental assessment may be appealed to the Planning and Building Tribunal within a month of the decision of the local authority to issue a development permit.

2.12 Operating licence

When starting up the operation of a business which may have a polluting effect on the environment it is necessary to apply for an operating licence from the Division of the Environment of the local community or the region. Before issuing an operating licence the licensor has to ask for the opinion of the National Planning Agency and The Environment and Food Agency.

2.13 Summary of permits for geothermal utilization

As seen from above the whole process requires careful planning and a clear view of the project to estimate the time it takes to receive all the permits needed for geothermal projects. Some of the licences can be applied for at the same time but most often data is needed and cannot be obtained without some prior permits. The minimum time required for permits according to laws and estimated time needed is listed in Table 2. In some cases the Environmental Impact Assessment process is needed for exploration drilling. The data obtained from the exploration drilling is needed to evaluate the geothermal field. After the feasibility study the Environmental Impact Assessment is always needed for the power plant. This process can therefore take considerable time. Table 3 shows the timeframe for the permit process for the 1st stage of the Hellisheidi power plant.

TABLE 3: Summary of estimated time required for permits needed for geothermal development

Permits	Minimum time according to laws (weeks)	Estimated time (weeks)
Research permit		16
Utilization permit		
Environmental Impact Assessment	50	56
Permit for power utilization		32
Master plan	22	22
Local plan	8	22
Building permit		2
Operating license		12

3. ENVIRONMENTAL IMPACT ASSESSMENT FOR THE HELLISHEIDI POWER PLANT

The main environmental factors which usually have to be dealt with in the environmental impact statement of geothermal power plants are:

- *Geological factors* including the geothermal field, its size and impact on the reservoir.
- *Water resources and disposal*. This includes extensive knowledge of the groundwater systems, their size and flow patterns.
- *Landscape and visual effects*. This is one of the main factors where the public is concerned.

- *Tourism and recreation.* Often there may be conflict between developer and other uses of the land such as tourism.
- *Biology.* Vegetation, hot spring microbiology and - fauna have to be studied.
- *Other parameters* such as noise, pollution, air quality and cultural relics.

3.1 The Hengill geothermal area

Extensive geological, geophysical and geochemical surveys have been carried out throughout the Hengill area in conjunction with the Nesjavellir and Hellisheidi projects. The pioneering work of Saemundsson (1967) became the foundation of the present full-size map database, including all major geological units, location of hot springs and fumaroles, fault lines and thermally altered grounds. The Hengill geothermal area has been described in several papers during last decades (see for example Franzson et al. (2010) and Gunnlaugsson and Gíslason (2005)).

Aeromagnetic, gravity and DC-resistivity surveys were carried out between 1975 and 1986. These delineated a 110 km² low-resistivity area and showed a negative and transverse magnetic anomaly coherent with the most thermally active grounds (Björnsson et al., 1986). Transient electromagnetic soundings (TEM) were carried out between 1986 and 2000 to revise the resistivity map. Approximately 100,000 micro- earthquakes vibrated the Hengill area between 1994 and 2000. The quakes group together on lines striking either E-W or N-S, but surprisingly not to the NNE, as seen in the surface geology (Árnason and Magnússon, 2001). A geochemical study was carried out using gas chemistry from fumaroles to predict temperature and to distinguish between different sub-fields (Ívarsson, 1998). The study indicates the existence of three different centres with higher temperature, coinciding with the volcanic centres.

Reservoir simulation models have been part of reservoir assessment and management in the Hengill area since 1986. Initially the modelling effort focused on the Nesjavellir site (Bödvarsson et al., 1990a, 1990b). An intense field monitoring program was set up in order to gather data for future maintenance and recalibration of the numerical model. In 1992 the model was recalibrated (Bödvarsson, 1993) and the second update of the model was carried out in 1998 (Bödvarsson, 1998). Drilling of new wells in the Hellisheidi field, together with surface exploration activities, indicate that the Nesjavellir and the Hellisheidi fields can be regarded as belonging to the same system, with a common up flow zone under the Hengill Mountain. The numerical model was recalibrated once more and extends over the entire Hengill geothermal field (Björnsson et al., 2000, 2003).

3.2 Groundwater

Groundwater research is important for geothermal utilization in high-temperature areas especially if the energy is going to be used in combined heat and power plant. Geothermal water from high-temperature fields cannot be used directly for heating and large volumes of groundwater are needed. Cold water is also needed for drilling and the groundwater flow has to be well-known for planning disposal or reinjection of the geothermal fluid.

The groundwater system in the Hengill and surrounding area is very complicated. Precipitation in this area is among the highest in Iceland but runoff on the surface is very limited. Most of the runoff has thus to take place underground. Concurrent with geothermal reconnaissance, an extensive study is also being carried out on groundwater flow, including the drilling of 20-30 groundwater research wells.

3.3 Other research and investigations

Other research and investigations were carried out such as landscape classification and visual effects, tourism and recreation, biology, noise, pollution, meteorological study, air quality, archaeological study and cultural relics.

The biological study included mapping of vegetation in the project area, study of bird live, study of invertebrates on land and in water and study of microbiology in hot springs. Vegetation in the developing area is mostly moss, grass and small shrubs. Grassland is less widespread than the moss-covered areas. About quarter of the area is lava with a moss covering. Animal live is rather scarce, possibly because of shortage of surface water in the area.

Cultural remains in the area are particularly linked to transportation and many old trails cross the area. The area is popular for recreation and marked hiking trails and publication of hiking maps have increased its accessibility.

The conclusion of an Environmental Impact Assessment is that the project will not have a significant effect on the environment.

4. COMPARISON OF THE DEVELOPMENT PROCESS FOR NESJAVELLIR AND HELLISHEIDI POWER PLANTS

Two power plants are now in operation in the Hengill area, Nesjavellir on the northern side of the mountain and Hellisheidi on the southern side. The Nesjavellir power plant was constructed in 1986 to 1990 before the Environmental Impact Assessment Act was implemented. The preparation of the Hellisheidi power plant was on the other hand after the implementation of the act. The process of these two power plants is though very similar.

At Nesjavellir the surface exploration led to research drilling and environment became soon one of the main issues. Natural runoff from the geothermal field is towards the lake Thingvallavatn. The outflow was mapped and the chemical content was investigated as well as trace elements in the geothermal water and the ecosystem. These factors have been monitored since. All off-road driving was prohibited and emphasis on minimize the environmental impact. Open seminar was held after decision on development was taken. This has similarity to the public advertising and consultation during EIA process.

5. CONCLUSION

The permit processes can take considerable time. Some of the licences may take up to a year to obtain. When planning a project, time has to be taken into consideration to avoid a delay of the project since often the permit process can be done at the same time as other preparation. In general the formal processes open up for other views and angles which can lead to better projects.

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