MANNVIT

Landsvirkjun

THEISTAREYKIR UP TO 200 MW GEOTHERMAL POWER PLANT

EIA SUMMARY AND NATIONAL PLANNING AGENCY OPINION

MAY 2015

Contents

1. Introduction

Environmental Impact Assessment (EIA) of Theistareykir geothermal power plant was carried out during 2007-2010 in accordance with law on environmental impact assessment no. 106/2000 and was finished with the Planning Agency opinion in November 2010. Since then preparation of construction in the Theistareykir area has been ongoing with regard to the findings of the EIA process and prevailing strategy of the municipalities in the area put forward in the regional plan for high temperature geothermal fields in Thingeyjarsyslur 2007-2025. The following steps have been taken up to date:

- Regional plan for high temperature geothermal fields in Thingeyjarsyslur 2007-2025, accepted in 2008.
- Planning Agency opinion on environmental impact assessment of up to 200 MW_e Theistareykir power plant, issued in 2010.
- Municipal plan of Thingeyjarsveit 2010-2022, accepted in 2011.
- Site plan for Theistareykir power plant, accepted in 2012.
- Utilisation license for the use of groundwater at Theistareykir, issued in 2014.
- Utilisation license for the use of geothermal energy at Theistareykir, issued in 2014.
- Power development license to construct and operate Theistareykir power plant, issued in 2014.
- Development consent for the construction of 100 MW_e Theistareykir power plant units, issued in 2014.
- Updated Environmental Management Plan (EMP) for Theistareykir power plant, issued in 2015.

Constructions at Theistareykir have started and it is estimated that electricity will be delivered from the plant in October 2017.

In this report the following data, all related to EIA, has been gathered and translated to English:

- EIA report summary
- EIA report contents page
- EIA report list of appendices
- National Planning Agency opinion on EIA.

2. EIA report summary

General

Theistareykir ehf. plans to construct a new 200 MW_e geothermal power plant at Theistareykir in Thingeyjarsveit municipality and construction of an access road to the geothermal area from Husavik in consultation with the local community. Theistareykir's objective is to utilise geothermal energy in a sustainable way to produce electricity and answer market demand.

Preparations for construction of geothermal power plants at geothermal areas in the Thingeyjarsysla county are conducted in cooperation with Landsvirkjun. The project objective is to check the feasibilty of producing 400 MW_e of electricity for an aluminium plant at Bakki by Husavik, or other potential energy buyers. Parallel to the EIA for Theistareykir power plant Landsvirkjun is carrying out an EIA for a geothermal power plant at Krafla, Landsnet hf. an EIA for overhead transmission lines from Krafla to Theistareykir and Bakki by Husavik and Alcoa and EIA for an aluminium smelter at Bakki. In accordance with the minister of environment's ruling from 31th July 2008, and the Planning Agency's instructions, following the ruling, all initial EIA report of the four above mentioned projects were presented and published at the same time in April 2010, as well as the combined EIA of all projects.

Theistareykir area

The Theistareykir geothermal area is located about 25 km southeast of Husavik between Theistareykja-bunga in the east and Lambafjoll in the west. The area is dominated by flat fields at 320-370 m a.s.l. but geothermal surface manifestations reach to the level 530 m.a.s.l. on Bæjarfjall mountain. The project construction area includes the access road from Husavik to Theistareykir. By the outskirts of Husavik town the road will be at 55 m a.s.l. and will reach highest up to about 380 m a.s.l. at Grjothals 6 km east of the town. At Hoskuldsvatn the rode route goes down to 290-300 m.a.s.l. and keeps at that level most of the way to Theistareykir. Geothermal surface manifestations are prominent features in an area of 7-8 km^2 at Theistareykir. Surface studies indicate that the geothermal area at Theistareykir is close to 45 km^2.

Nine shallow boreholes have been drilled for hydrological investigation of groundwater at Theistareykir and the surrounding area. In the period from 2002 to 2008 six geothermal exploration wells have been drilled in the eastern part of the geothermal utilisation area for Theistareykir ehf. A 450 m deep core borehole was also drilled in 2007. The production potential of present geothermal wells can supply steam for one 50 MW_e electric unit.

Geological hazards at Theistareykir are mainly volcanic eruptions, earthquakes and earth movement related to continental drift and accumulation of magma in the earth's crust. Only one eruption is known of in the last 11,000 years. It occurred 2500 years ago. Since then there has been little tectonic activity in the eastern part of the area. During volcanic activity and episodes of rifting in the 18th and 20th centuries there was extensive rifting and release of tension in the northern part of the volcanic zone of Northeast Iceland. The probability of a big episode of rifting is therefore considered low in the next 100-200 years.

Project

The plan is to construct an up to 200 MW_e geothermal power plant at Theistareykir. It will be constructed in 50 MW_e modular units. The construction plan for the proposed power plant depends on electric market demand and estimated production potential of the geothermal area. Construction rate of the power plant depends on drilling results of production wells for steam supply. The National Energy Authority will be consulted regarding planning of construction stages of Theistareykir geothermal power plant.

An access road to the power plant at Theistreykir is planned from Husavik in the north. Overhead power lines are planned through the area from south to north. The main power station will be built at a construction site 1500 m north of a cabin at Theistareykir. East of the power station a cooling tower will be installed for each electric unit. An electrical substation is planned west of the power station. Three steam separator stations, a control pressure station and a steam muffler will be built.

It is projected that 40 production wells will be needed for a 200 MW_e geothermal power plant at Theistareykir. Drill pads are planned within 15 defined drilling sites. It will be possible to drill 4-6 wells on each drill pad. Production wells for steam gathering will be drilled directionally to the south under Bæjarfjall mountain. It is also planned to drill to the east under Ketilfjall mountain. Drilling sites are planned in and above the Bondholsskard pass as well as in areas west and northwest of the cabin at Theistareykir. Three exploration wells have been drilled on the same drill pad at drill site A and two wells at drill site C. The total area defined as drill sites is around 40 ha, but within those the total area of drill pads is estimated less than or around 8 ha for a fully constructed power plant. Drilling many wells on each well pad means fewer sites will be affected and leading to less disturbance of land. One pipe will be installed from each drill site and connected to a main pipe for steam transmission to a separator station.

For the Theistareykir power plant production process the enthalpy of geothermal fluid is expected to be 2,000 kJ/kg and wellhead pressure about bar_a. A 200 MW_e power plant at Theistareykir will need 340 kg/s of geothermal steam. Depending on the geothermal fluid's enthalpy this leads to discharge of 140-320 kg/s of separated geothermal water, which will be transmitted and discharged into 300-500 m deep reinjection wells.

Utilisation of geothermal energy leads to geothermal gas emission. Gas emission is temporary during testing of wells. After commissioning the gases from a geothermal power plant are emitted into the atmosphere. It is estimated that annual emission of geothermal gases from Theistareykir power plant will be 22,300 t/y carbon dioxide (CO_2), 5,470 t/y hydrogen sulfide (H_2S), 980 t/y of nitrogen (N_2), 200 t/y of hydrogen (H_2) and 14 t/y methane (CH_4).

A fresh water supply system is needed for the geothermal power plant and work camp. Fresh water will also be used for filling up of cooling systems. The water supply must meet the expected consumption of 100 l/s for a 200 MW_e power plant. Fresh water will be taken from drill holes by Skildingaholl northwest of the power house. A 4,400 m long pipeline will be buried beside the access road to the power plant from Husavik.

Access to Theistareykir power plant will be by a 31.5 km long proposed road from Husavik. It will be constructed at the present rode location the first 10 km from Husavik over Grjothals to the lake Hoskuldsvatn and from there along a track to Hofudreidarmuli further to the east. Then the rode will turn south to the end of Gudfinnugja in the Theistreykir lava field from where it will go east the rest of the way to the power station. The road will continue southwest through the geothermal field and Theistreykir to be connected to an existing track west of Bæjarfjall. Roads will be constructed within the construction area to access drill pads and construction areas as well as service roads along transmission pipes.

Estimated need for filling material for construction of Theistareykir power plant is 427,000 m^3. For the construction of the access road around 748,000 m^3 of filling material will be needed. Part of filling material for the road will come from road cuttings or 142,000 m^3. Of the total 1.175,000 estimated filling material 1,033,000 will come from six quarries. Three are planned in Thingeyjarsveit municipality and another three in Nordurthing municipality.

The developer and contractors will set up facilities north of the power station at Theistareykir for their employees during the construction period. A permanent building is planned at the same location housing employee facilities after power plant commissioning.

During the construction period storage facilities for pipes and other equipment are planned within the geothermal utilisation area, on the plains under Ketilfjall mountain east of the power station. An old quarry west of Bæjarfjall mountain, THRN-1, will also be used for storage.

Connection to the power grid

Theistareykir geothermal power station will be connected to an electric transmission system owned and operated by Landsnet hf. in accordance with the Electricity Act no. 65/2003. The proposed high voltage transmission line, Theistareykjalina 1, will lie from a substation west of the power house over the Theistareykir lava field, across Jonsnipuskard pass, past Hofudreidarmuli and Arnahvammur where it crosses Kopaskerslina 1 transmission line. South of Hoskuldsvatn the Theistreykir 1 transmission line turns northwest towards Holasandslina 1 transmission line and lies parallel it to Bakki by Husavik. Another high voltage transmission line, Holasandslina 2, is also planned from the substation at Theistareykir south to a future substation at Holasandur.

A connection will be set up with Landsnet's present 66 kV transmission line, Kopaskerslina 1, between Laxa power stations and Kopasker. An 11 kV underground cable from the connection point will lay beside the access road to Theistareykir.

Construction plan and construction labour demand

A rough construction plan for the construction of the first two units of a 200 MW_e geothermal power plant at Theistareykir is as follows:

1. Year: Road construction, construction site preparations and drilling of production wells.
2. Year: Buildings, geothermal steam supply system, drilling of production wells and preliminary production of mechanical and electrical equipment.
3. Year: Buildings, geothermal steam supply system and production of mechanical and electrical equipment.
4. Commissioning of the power plants two electric units.

It is estimated that 320 annual working units will be needed for construction of the first two 50 MW_e Theistareykir power plant units. A peek of construction labour demand of 200 at site will be reached in the project's second summer period according to the present project plan. In the third summer it is estimated that 180 will be working on site at the most.

Planning

A regional plan for 2007-2025 including the proposed project site for Theistreykir power plant has been confirmed for geothermal areas in Thingeyjarsyslur counties. A municipal plan for Thingeyjarsveit is in preparation. Information from the municipality during consultation has revealed that definition of areas for geothermal utilisation and protected areas will be according to the regional plan geothermal areas.

In the Municipal Plan for Husavik Town 2005-2025 a rode is indicated from the municipal boundary (of Nordurthing) at Sæluhusmuli north of Hofudreidarmuli and forward to Husavik. The Nordurthing municipality has been consulted on proposed construction of an access road to Theistareykir.

Environmental impact

<u>Geothermal system and energy resources:</u>

The utilisation of the geothermal resources at Theistareykir will be aimed at sustainable production. With regard to geothermal resource assessment the power plant will be constructed in units. If that construction and operation strategy will be successful it can be expected that impact of geothermal utilisation in the area will reach a balance and will cause insignificant impact on the geothermal system and energy resources. The assessment is although subject to uncertainty.

Landscape:

Landscape impact will be highest where power plant structures are proposed close to Theistareykir. Landscape in that area stands out from the surrounding landscape as it includes geothermal surface manifestations along with dense vegetation. The area is also used for outdoor recreation and organized tours to the area during the summer. The value of the landscape unit is considered high. A part of the proposed geothermal plant structures will be located within the landscape unit and therefore the impact is considered to be significantly negative.

The proposed access road to the power plant will run through several landscape units. It will have the most impact on Theistareykir lava field, but the impact will be less on other landscape units. The access road will have considerable negative impact on the landscape unit Theistareykir lava field but somewhat negative on the units Botnsvatn, Hoskuldsvatn, Grisatungur and Kviholar. Impact of the geothermal plant structures and access road on the unit Skildinga- and Storaviti lava fields will be somewhat negative.

Access road and drilling pads will have insignificant impact on the landscape units Husavik and Theistareykjabunga.

The defined size of wilderness areas around Theistareykir will be reduced by 9% as a result of the construction of the proposed geothermal plant. The proposed project will have considerable negative impact on wilderness areas.

Geology:

It is estimated that the proposed geothermal plant will have somewhat direct, negative and permanent impact on geological features that are protected with regard to law on nature conservation, such as lava fields (<10.000 years old) and geothermal surface manifestations will be disturbed by the construction of the plant.

Constructions on drilling pad O and an access road and pipelines to drilling pad L will cause somewhat negative, local impact on geological features that are subject to local protection with regard to regional plan (HÞ4). Construction of structures is however allowed within local protection site 2 (HÞ4) but special care should be taken when constructing.

It is expected that it will be difficult to identify possible indirect impact of utilisation on geothermal surface activity in the Theistareykir area and whether changes are due to exploitation or natural and/or seasonal fluctuations. It is estimated that the geothermal utilisation will have insignificant impact on geothermal surface manifestations if mitigation measures to limit pressure reduction in the geothermal reservoir will be successful. However the assessment is subject to considerable uncertainty.

Hydrology:

It is estimated that the disposal of geothermal discharge water from Theistareykir power plant will have somewhat local negative impact on groundwater closest to the reinjection well. The impact will although not exceed the groundwater table. Impact on groundwater further from Theistareykir is considered to be insignificant.

Impact of proposed access road on water supplies, the Husavik town water protection zone and protection area of the Myvatn lake and Laxa river catchment area is expected to be insignificant.

Impact of Theistareykir power plant and access road on other water supplies and freshwater resources in the Kelduhverfi area is expected to be insignificant. With regard to proposed arrangement of constructions and development the impact of the proposed access road on water supplies is expected to be insignificant.

Use of water from the Theistareykir power plant's water supply is expected to have insignificant impact on groundwater.

Flora:

The level of impact on plants dependent on geothermal environment at Theistareykir is uncertain.

As wetland by Ketilfjall mountain and around the access road to the power plant is not expected to be disturbed during construction the impact on such type of vegetation, which is rare within the construction site, is expected to be insignificant.

During the operation period there is an uncertainty regarding impact on sensitive vegetation closest to the power station, due to emission of H_2S gas from geothermal utilisation at Theistareykir. Tolerance limits of vegetation against H_2S are not known.

Fauna:

During construction there may be somewhat negative, temporary impact on birds at the construction area and it's vicinity, in particular within previously undisturbed areas.

Impact is expected to be insignificant on breeding grounds and breeding success of birds during the operation period of Theistareykir power plant. Falcon could possibly be indirectly affected due to increased hunting load on ptarmigan due to the new access road and improved access to the Theistareykir area. It could result in negative impact on falcon.

Land invertebrates:

Common land invertebrates could be considerably negatively affected during construction due to disruption of earth and laying of gravel on drilling pads, service roads and access roads. It is expected that impact on *Vallonia excentrica* a rare snail species limited to the geothermal area will be insignificant.

During operation Theistareykir power plant is expected to have insignificant impact on land invertebrates.

Biodiversity in hot springs:

Impact of the proposed project on biodiversity in hot springs and in areas with geothermal surface activity at Theistareykir is expected to be insignificant.

Air:

Impact due to the emission of geothermal gases, mainly carbon dioxide (CO_2) and hydrogen sulfide (H_2S) is expected to be insignificant.

Visual impact:

Visual impact at Theistareykir is expected to be direct, permanent and significantly negative around the power plant, west of Klifarveggur and by Bæjarfjall mountain. The area is currently almost undisturbed and is visited by tourists. The proposed project will be extensive and result in significant changes of scenery.

Drilling pads, east of Bondholsskard, will have insignificant visual impact on the wider area to the east towards Storaviti, which is 3 km away. The land in this area is relatively flat with small hills spread around. Therefore the drilling pads will only be visible in close proximity. Steam rising from geothermal wells while being tested will however be visible from quite a distance during the construction period.

Steam rising from wells being tested will be visible. It will have temporary visual impact in the Theistareykir area and under certain conditions it will be visible in populated areas outside the proposed geothermal utilisation area.

The proposed access road to the power plant site will have considerable direct and permanent negative visual impact in undisturbed areas where it will run through a flat land like Theistareykir lava field and the geothermal field. On the stretch between Husavik town and Hoskuldsvatn lake the road will have somewhat direct negative visual impact, but a current road, recently built by Nordurthing municipality, already runs through the area.

Social impact:

During a proposed four year construction period of the two first units of Theistareykir geothermal power plant it is expected that impact on transport, tourism and recreation will temporarily be significantly negative due to traffic, nuisance and noise from wells being tested. The impact is expected to be considerably positive due to number of job opportunities created during the construction period.

It is expected that impact on highland pasture within the geothermal utilisation area will be temporarily negative, especially during construction as the grazing area will be reduced and structures will affect livestock rights of way.

In a report from the Icelandic Tourism Research Centre it is pointed out that during operation the proposed project can have negative impact on current development of tourism and recreation activity at Theistareykir. However, it says that improved access due to a new access road will have considerably positive impact on transports, tourism and outdoor activity as more people will have the opportunity to visit the area and possibilities of new type of tourism could emerge. New routes will open up from nearby populated areas and Theistareykir could become a tourist destination. Direct impact on job opportunities is believed to be somewhat positive but indirect impact could be significantly positive as the energy will be used for industrial development.

Cultural remains:

Impact of the proposed project on cultural remains within the geothermal utilisation area will be insignificant.

Impact on cultural remains on the access road route will be local and considerably negative where they will be disturbed on the part between Hoskuldsvatn lake and Hofudreidarmuli. In other parts of the route the impact will be insignificant.

Quarrying for filling material at three locations will have somewhat impact on cultural remains if old cairns need to be disturbed.

3. EIA report contents page

4. EIA report list of appendices

Appendix A1: Road Administration, 2008. *Access road drawings. Theistareykir road. Husavik – Theistreykir, conceptual design*. Planning and procurement Akureyri. Report prepared for Theistareykir ehf.

Appendix A2: Asgrimur Gudmundsson, Bjarni Gautason, Christian Lacasse, Gudni Axelsson, Gunnar Thorgilsson, Halldor Armannsson, Helga Tulinius, Kristjan Sæmundsson, Ragna Karlsdottir, Snorri Pall Kjaran, Sveinn Oli Palmarsson, Sæunn Halldorsdottir and Thorsteinn Egilson, 2008. *Conceptual model of Theistareykir geothermal system and geothermal resource assessment by volumetric method*. Iceland Geosurvey, VGK-Engineerin & Vatnaskil Engineering. ISOR-2008/024, MV-048, Vatnaskil 08.05. Report prepared for Theistareykir ehf.

Appendix A3: Kristjan Sæmundsson, 2007. *Geology of Theistareykir*. Report, ISOR-07270. Report prepared for Theistareykir ehf.

Appendix A4: Axel Bjornsson, 2008. *Geothermal area of Theistareykir. Utilisation's possible impact in the geothermal area*. School of Business and Science. Faculty of Natural Resource Sciences. University of Akureyri. Report prepared for Theistareykir ehf.

Appendix A5: Mannvit, 2010a. *Landscape analysis of proposed construction areas in Thingeyjarsysla counties.* Report. Prepared for Landsvirkjun, Theistareykir ehf. and Landsnet hf.

Appendix A6: Vatnaskil Consulting Engineers, 2009. *Distribution of chemicals in groundwater from reinjection of geothermal water into shallow wells*. Vatnaskil 09.10. Report prepared for Landsvirkjun Power and Theistareykir ehf.

Appendix A7: Gudmundur Gudjonsson, Kristbjorn Egilsson and Rannveig Thoroddsen, 2008. *Vegetation in geothermal areas and proposed transmission line and road routes in Northeast Iceland*. Icelandic Institute of Natural History, NI 08009. Report prepared for Landsvirkjun, Landsnet hf. and Theistareykir ehf.

Appendix A8: Kristbjorn Egilsson and Gudmundur Gudjonsson, 2009. *Demarcation of geothermal vegetation areas at Theistareykir*. Icelandic Institute of Natural History, NI 09003. Report prepared for Theistareykir ehf.

Appendix A9: Thorkell Lindberg Thorarinsson and Adalsteinn Orn Snæthorsson, 2007. *Birdlife in proposed construction areas of geothermal power plants in Thingeyjarsysla counties. Northeast Iceland*. Nature Research Centre. NNA-07005. Report prepared for Landsnet hf., Landsvirkjun and Theistareykir ehf.

Appendix A10: Adalsteinn Orn Snæthorsson and Thorkell Lindberg Thorarinsson, 2008. *Birdlife at proposed construction areas of access road from Husavik to Theistareykir*. Northeast Iceland Nature Research Centre. NNA-08002. Report prepared for Theistareykir ehf.

Appendix A11: Thorkell Lindberg Thorarinsson, 2007. *Distribution of the snail Vallonia excentrica (Sterki, 1893) at Theistareykir*. Northeast Iceland Nature Research Centre. NNA-07007. Report prepared for Theistareykir ehf.

Appendix A12: Solveig K. Petursdottir, Snædis Huld Bjornsdóttir, Solveig Olafsdottir and Gudmundur Oli Hreggvidsson, 2008. *Biodiversity in hot springs at Theistareykir and Gjastykki*. Matis, 39-08. Report prepared for Þeistareykir ehf.

Appendix A13: Vatnaskil Consulting Engineers, 2010a. *Theistareykir and Krafla II geothermal power plants. Modeling of distribution of hydrogen sulfide emmission from geothermal*

power planst in Northeast Iceland. Vatnaskil 09.14. Prepared for Theistareykir ehf. and Landsvirkjun.

Appendix A14: Edward H. Huijbens, 2008. *The effect of the proposed Theistareykir power plant and transmission lines from Krafla to Bakki on tourism and recreation*. Icelandic Tourism Research Centre, FMSÍ-S-01-2008. For Landsnet hf., Landsvirkjun and Þeistareykir ehf.

Appendix A15: Mannvit, 2010b. *Theistareykir power plant. Assessment of noise impact during construction and operation*. Noise map. Prepared for Þeistareykir ehf.

Appendix A16: Uggi Ævarsson, 2007. *Registration of cultural remains due to planned construction of transmission lines and power plants. Krafla – Gjastykki – Theistareykir – Bakki.* The Institute of Arceology, Iceland. FS366-07211. Reykjavik 2007. Report prepared for Landsnet hf., Landsvirkjun and Þeistareykir ehf.

Appendix A17: Uggi Ævarsson, 2008. *Registration of cultural remains at proposed road site. Husavik – Theistareykir – Kviholar*. The Institute of Arceology, Iceland. FS395-08151. Reykjavik 2008. Report prepared for Þeistareykir ehf.

Appendix A18: Omar Bjarki Smarason, 2010. *Reykjaheidi and Theistareykir. Possible Quarries for road and drillpads.* Report OBS / 08-09. Prepared for Þeistareykir ehf.

Appendix A19: Consultation with the Planning Agency (PA) in November and December 2009, for further instructions following the PA's approval of the EIA scoping document on November 6, 2009.

Appendix A20: Thorolfur H. Hafstad, 2010. *Theistareykir. On groundwater and discharge water.* Report. ISOR-10020. Report prepared for Landsvirkjun Power.

Appendix A21: Vatnaskil Consulting Engineers, 2010b. *The concentration of hydrogen sulfide from power plants in Northeast Iceland compared to regulation limits.* Memorandum July 20th 2010. Report prepared for Landsvirkjun and Þeistareykir ehf.

Appendix A22: Remarks and comments on preliminary EIA report.

Appendix B1: Gudmundur Gudjonsson, Kristbjorn Egilsson and Rannveig Thoroddsen, 2008. *Vegetation in geothermal areas and proposed transmission line and road routes in Northeast Iceland*. Icelandic Institute of Natural History, NI 08009. Report prepared for Landsvirkjun, Landsnet hf. and Theistareykir ehf. Maps.

5. Opinion of the National Planning Agency on EIA

Contents

Theistareykir power plant up to 200 MW_e geothermal power plant in Thingeyjarsveit and Nordurthing municipalities.

Opinion of the National Planning Agency on EIA

Main results

According to the EIA report Theistareykir ehf. plans for sustainable utilisation of geothermal energy by gradually increasing production. Therefore the developers existing plan is not to over exploit the geothermal system, that is power production will not be so intensive that it must stop completly for up to 50 years after 30-40 years of production ore decrease radically to rest the system. No history of production is available at Theisareykir and therefore the sustainable production potential of the geothermal system has not been estimated yet.

According to the conclusion of volumetric assessment it has been predicted that a 200 MW_e production can not carry on for more than 40 years but then it seems that production must be reduced ore stopped for a period of time for the geothermal system to recover. It is the National Planning Agencys (NPA) opinion that with regard to the EIA report definition of sustainable geothermal utilisation that this type of plan for production must be regarded as unsustainable/over exploitation. It is the NPA's opinion that it is not possible to carry out a realistic assessment of a 200 MW_e Theistareykir power plant's impact on the geothermal system as a resource. For this the planned power plant will be too large with regard to present knowledge. The NPA concludes that there is a significant uncertainty on what effect the proposed 200 MWe power plant will have on the geothermal energy resource and it is more than likely that when a power plant is of this size, that utilisation will not be sustainable.

The Planning Agency believes that with regard to visual impact, impact on landscape and impact on tourism, including noise impact, that the overall environmental impact of an extensive project such as Theistareykir power plant, will be significantly negative. With regard to the project disrupting about 110 ha of nearly undisturbed lava fields that are specially protected the impact will be significantly negative. However, there is a great uncertainty of the projects impact on geothermal surface activity. With regard to the project disrupting about 180 ha of land that has considerable vegetation cover the project will have a somewhat negative impact but the impact of hydrogene sulfide on fauna is uncertain. Impact on land invertibrates will be locally considerably negative but there is uncertainty of impact on biodiversity in hot springs. Impact on groundwater will be insignificant.

It is the Planning Agencys opinion that environmental impact due to the construction of the project and related operation depends on working arrangements and implimentation of mitigation measures presented during the EIA process and monitoring of procedures and impacts during construction and operation periods.

The Planning Agency is of the opinion that the following conditions must be set when issuing permits:

1. Pipes that Theistareykir ehf. plans from Bondholsskard pass down to the plains, as well as pipes planned west of the Theistareykir farm site, shall be layed underground.
2. Teistareykir shall prepare a monitoring program on changes in geothermal surface activity in constultation with the National Energy Authority and the Environment Agency of Iceland. Investigations according to the monitoring program should start as soon as possible and results are to be presented to licensors anually.
3. During construction Theistareykir ehf. shall delimit the area where protected plant species have been detected as well as wetlands beneath the Ketilfjall mountain.

Reykjavik, 24. November 2010

1. Introduction

1.1 The Planning Agency review

On April 26th 2010, Theistareykir ehf. submitted an initial EIA report for up to 200 MW geothermal power plant at Theistareykir in Thingeyjarsveit and Nordurthing, for National Planning Agency's official review in accordance to law on environmental impact assesssment no. 106/2000.

The project and the initial EIA report were advertised officially on April 30th 2010 in Logbirtingabladid Gazette, Frettabladid national newspaper, Morgunbladid national newspaper and Myflugan local newspaper and also in Hlaupastelpan local newspaper on April 28th and Skarpur local newspaper on April 29th 2010. The initial EIA report was made available for public review from April 30th to June 14th 2010 at the local municipalities' offices at Skutustadahreppur and Thingeyjarsveit, in Nordurthing town hall in Husavik and at Husavik library, in the National Library and at the National Planning Agency. The initial EIA report was also accessible at the following websites: www.lv.is, www.theistareykir.is, www.mannvit.is and www.skipulag.is.

The Planning Agency asked the following statutory consultees for official comments: Nordurthing municipality, Thingeyjarsveit municipality, Icelandic Tourist Board, the Cultural Heritage Agency of Iceland, the Directorate of Fisheries, Health Inspectorate of North East Iceland, the National Energy Authority, the Environment Agency of Iceland and the Public Road Administration. During the official review process no comments from other bodies were received. The Planning Agency forwarded the comments made by the statutory consultees to the developer.

On October 6th 2010, Theistareykir ehf. submitted an EIA report for up to 200 MW geothermal power plant at Theistareykir in Thingeyjarsveit and Nordurthing, to the Planning Agency and asked for official opinion on the environmental impact of the project.

During the preparation of the Planning Agency's opinion the agency went on a site visit to the proposed construction area. Due to significance of the matter and similtaneous work on EIA opinions of related projects, the Planning Agency got an extenstion to publish the opinion until November 25th 2010.

1.2 Domuments submitted to the Plannning Agency for review

Initial environmental impact report. Theistareykir Power Plant, up to 200 MW_e geothermal power plant in in Thingeyjarsveit and Nordurthing municipalities. April 2010.

Other documents:

Appendix A1: Public Road Administration, 2008. *Access road drawings. Theistareykir road. Husavik – Theistreykir, conceptual design*. Planning and procurement Akureyri. Report prepared for Theistareykir ehf.

Appendix A2: Asgrimur Gudmundsson, Bjarni Gautason, Christian Lacasse, Gudni Axelsson, Gunnar Thorgilsson, Halldor Armannsson, Helga Tulinius, Kristjan Sæmundsson, Ragna Karlsdottir, Snorri Pall Kjaran, Sveinn Oli Palmarsson, Sæunn Halldorsdottir and Thorsteinn Egilson, 2008. *Conceptual model of Theistareykir geothermal system and geothermal resource assessment by volumetric method*. Iceland Geoservey, VGK-Engineerin & Vatnaskil Engineering. ISOR-2008/024, MV-048, Vatnaskil 08.05. Report prepared for Theistareykir ehf.

Appendix A3: Kristjan Sæmundsson, 2007. *Geology of Theistareykir*. Report, ISOR-07270. Report prepared for Theistareykir ehf.

Appendix A4: Axel Bjornsson, 2008. *Geothermal area of Theistareykir. Utilisation's possible impact in the geothermal area*. School of Business and Science. Faculty of Natural Resource Sciences. University of Akureyri. Report prepared for Theistareykir ehf.

Appendix A5: Mannvit, 2010a. *Landscape analysis of proposed development areas in Thingeyjarsysla counties.* Report. Prepared for Landsvirkjun, Theistareykir ehf. and Landsnet hf.

Appendix A6: Vatnaskil Consulting Engineers, 2009. *Distribution of chemicals in groundwater from reinjection of geothermal water into shallow wells*. Vatnaskil 09.10. Report prepared for Landsvirkjun Power and Theistareykir ehf.

Appendix A7: Gudmundur Gudjonsson, Kristbjorn Egilsson and Rannveig Thoroddsen, 2008. *Vegetation in geothermal areas and proposed transmission line and road routes in Northeast Iceland*. Icelandic Institute of Natural History, NI 08009. Report prepared for Landsvirkjun, Landsnet hf. and Theistareykir ehf.

Appendix A8: Kristbjorn Egilsson and Gudmundur Gudjonsson, 2009. *Demarcation of geothermal vegetation areas at Theistareykir*. Icelandic Institute of Natural History, NI 09003. Report prepared for Theistareykir ehf.

Appendix A9: Thorkell Lindberg Thorarinsson and Adalsteinn Orn Snæthorsson, 2007. *Birdlife in proposed development sites of geothermal power plants in Thingeyjarsysla counties. Northeast Iceland*. Nature Research Centre. NNA-07005. Report prepared for Landsnet hf., Landsvirkjun and Theistareykir ehf.

Appendix A10: Adalsteinn Orn Snæthorsson and Thorkell Lindberg Thorarinsson, 2008. *Birdlife at proposed development sites of access road from Husavik to Theistareykir*. Northeast Iceland Nature Research Centre. NNA-08002. Report prepared for Theistareykir ehf.

Appendix A11: Thorkell Lindberg Thorarinsson, 2007. *Distribution of the snail Vallonia excentrica (Sterki, 1893) at Theistareykir*. Northeast Iceland Nature Research Centre. NNA-07007. Report prepared for Theistareykir ehf.

Appendix A12: Solveig K. Petursdottir, Snædis Huld Bjornsdóttir, Solveig Olafsdottir and Gudmundur Oli Hreggvidsson, 2008. *Biodiversity in hot springs at Theistareykir and Gjastykki*. Matis, 39-08. Report prepared for Þeistareykir ehf.

Appendix A13: Vatnaskil Consulting Engineers, 2010a. *Theistareykir and Krafla II geothermal power plants. Modeling of distribution of hydrogen sulfide emmission from geothermal power planst in Northeast Iceland*. Vatnaskil 09.14. Prepared for Theistareykir ehf. and Landsvirkjun.

Appendix A14: Edward H. Huijbens, 2008. *The effect of the proposed Theistareykir power plant and transmission lines from Krafla to Bakki on tourism and outdoor activity*. Icelandic Tourism Research Centre, FMSÍ-S-01-2008. For Landsnet hf., Landsvirkjun and Þeistareykir ehf.

Appendix A15: Mannvit, 2010b. *Theistareykir power plant. Assessment of noise impact during construction and operation*. Noise map. Prepared for Þeistareykir ehf.

Appendix A16: Uggi Ævarsson, 2007. *Registration of cultural remains due to planned developments of transmission lines and power plants. Krafla – Gjastykki – Theistareykir – Bakki.* The Institute of Arceology, Iceland. FS366-07211. Reykjavik 2007. Report prepared for Landsnet hf., Landsvirkjun and Þeistareykir ehf.

Appendix A17: Uggi Ævarsson, 2008. *Registration of cultural remains at proposed road site. Husavik – Theistareykir – Kviholar*. The Institute of Arceology, Iceland. FS395-08151. Reykjavik 2008. Report prepared for Þeistareykir ehf.

Appendix A18: Omar Bjarki Smarason, 2010. *Reykjaheidi and Theistareykir. Possible Quarries for road and drillpads.* Report OBS / 08-09. Prepared for Þeistareykir ehf.

Appendix A19: Consultation with the Planning Agency (PA) in November and December 2009, for further instructions following the PA's approval of the EIA scoping document on November 6, 2009.

Appendix A20: Thorolfur H. Hafstad, 2010. *Theistareykir. Groundwater and discharge water.* Report. ISOR-10020. Report prepared for Landsvirkjun Power.

Appendix A21: Vatnaskil Consulting Engineers, 2010b. *The concentration of hydrogen sulfide from power plants in Northeast Iceland compared to regulation limits.* Memorandum July 20th 2010. Report prepared for Landsvirkjun and Þeistareykir ehf.

Appendix A22: Remarks and comments on initial EIA report.

Appendix B1: Gudmundur Gudjonsson, Kristbjorn Egilsson and Rannveig Thoroddsen, 2008. *Vegetation in geothermal areas and proposed transmission line and road routes in Northeast Iceland*. Icelandic Institute of Natural History, NI 08009. Report prepared for Landsvirkjun, Landsnet hf. and Theistareykir ehf. Maps.

Official comments were recieved from:

- Nordurthing Municipality by letter dated 4. June 2010
- Thingeyjarsveit Municipality by letter dated 24. June 2010
- The Directorate of Fisheries by letter dated 12. May 2010
- Cultural Heritage Agency by letter dated 8. June 2010
- The Health Inspectorate of NE-Iceland by letter dated 1. June 2010
- The National Energy Authority by letter dated 4. June 2010
- The Environment Agency of Iceland by letter dated 1. June 2010
- The Public Road Administration by letter dated 4. June 2010

Environmental Impact report: Theistareykir Power Plant, up to 200 MW_e geothermal power plant in in Thingeyjarsveit and Nordurthing municipalities. October 2010

2. Project and objective

Theistareykir ehf. plans to develop an up to 200 MW_e geothermal power plant at Theistareykir in Thingeyjarsveit municipality and the aim is to construct it in 50 MW_e units. Also an access road will be built to the power plant site from Husavik. Further construction of the proposed power plant depends on electric market demand and estimated production potential of the geothermal field.

It is presented that the main power station will be built about 1,500 m north of the hut at Theistareykir, along with cooling towers east of it and a substation to the west. Separator stations, control pressure stations and steam mufflers will also be built. A 220 kV overhead transmission line is planned through the area from north to south as well as a service road for the power line, which will become a fully built-up road in the future.

The construction rate of the power plant depends on the results of further geothermal energy utilisation by drilling of production wells. Theistareykir's objective is to utilise geothermal energy in a sustainable manner to produce electricity and respond to market demand.

Drilling and testing: According to the EIA report it is projected that 40 production wells will be needed for a 200 MW_e power plant. They will be located at 15 defined drilling sites and within those sites it will be possible to drill 4-6 wells on each drill pad. The plan is to drill directionally under the mountains Bæjarfjall and Ketilfjall and that there will also be drilling sites above the Bondholsskard pass, besides sites west and north of the hut at Theistareykir. After drilling the well it will be shut down for it to warm up for 1 to 3 months before testing and production potential assessment of the well. A removable wellhead silencer and borehole housings will be installed at each well to prevent accidents occuring.

Geothermal steam supply system: The steam supply system gathers geothermal liquid from the wells and separates steam from water. Steam pressure will be kept steady by adjusting performance of production wells as requiered and to minimize blasting of excess steam. Furthermore the system discharges geothermal water to a discharge system. The geothermal steam supply system will be constructed according to experience from similar discharge systems in high enthalpy geothermal fields in Iceland. Steam transmission pipes from drill pads will be connected to common separator stations that are located about half a kilometer away from the power station. The main structures of the steam supply system are: Steam transmission pipes with a length about 9.8 km, separator stations, transmission pipes to power station, control pressure stations and steam mufflers. It is proposed that pipes will be on the surface, not underground and that pipe routes, design and choice of color and texture will be such that the pipes will adjust to the surrounding environment.

Water supply and discharge system: According to the EIA report borholes will be drilled for collecting fresh water by Skildingaholl, northwest of the power station. A 4,400 m long pipeline will be buried beside the access road to the power plant. The water supply must produce 100 L/s for a 200 MW_e electric power plant. During drilling, on drilling sites A and C, discharge liquid will be piped to a small channel and onwards into a pond by Tjarnaras, where the fluid will dissapear through fissures into groundwater. It is proposed to apply the same arrangement when drilling at sites B, E, F, K, L and M. At drill pads on drilling sites D, H; I,J, N and O, further away from the pond the plan is to discharge drilling fluid into fissures, drill 10-60 m deep boreholes on the edges/borders of drill pads, or dig swallowing pits. Swallowing pits will also be used for disposal of discharge water while testing wells. Fluid discharge from the power plant will consist of geothermal water, condense water and cooling water besides other discharge. Geothermal water will be piped to reinjection wells and after deairing condense water will be added to cooling water cycle along with heated fresh water.

Table 1. Technical parameters of proposed Theistareykir Power Plant. Based on EIA report.

Defined drill sites		Number Total area	15 400,000m^2
Drill pads		Average area/well Total area	1,900 m^2/holu 77,000 m^2
Wells		Number Depth	Up to 40 Up to 3,000 m
Steam supply system	*Transmission pipes from wells*	Diameter Pipelines	0,4-1 m 9,800m
	Steam separator station	Height Area	10 m 2 x 240 m^2 and 1 x 590 m^2
	Pipes from separator station	Number Diameter Pipelines	4 1 m 2,000 m
	Control pressure station	Height Area	6 m 580 m^2
	Steam muffler	Number Height	2 12 m
Discharge system	*Reinjection area*	Number Total Area	2 74,000 m^2
	Reinjection well	Number Depth	4-7 300-500 m
	Discharge transmission pipes	Number Pipelines	3 4,800 m
Water supply	*Bore holes*	Number Depth	2 Allt að 100 m
	Water supply building	Height Area	4 m 84 m^2
	Water pipeline	Length	4,400 m
Roads	*Access road to power plant site*	Length Width	31.5 km 6 m
	Road within geotermal field	New roads Existing roads Width	8,800 m 6,300 m 4-6 m
Quarrying	*Quarries*	Number	5
	Filling material	Power plant Access road	427,000 m^3 748,000 m^3
Power house site	*Main power station*	Height Area	12 m 7,000 m^2
	Cooling towers	Height Area	13 m 4 x 900 m^2
	Storage facilities and workshop	Height Area	8 m 1,600 m^2
	Employee facilities	Height Area	3 m 300 m^2
Power grid connection	*Underground cable*	Voltage Length	11 kV 11 km

The amount of geothermal water will be 140-320 L/s for a 200 MWe power plant and it will be discharged below the groundwater table into 2 to 7 300-500 m reinjection wells, lined down to 250 m depth. The wells will be located at a reinjection area north of separator station II and a reinjection area west of separator station I. Reinjection wells will be drilled at the same time as production wells and reinjection of geothermal water into shallow wells will start at comissioning of the power plant. The plan is to start reinjection into deeper wells in consultation with the National Energy Authority when operational data has been collected and the nature of the geothermal system involved is better understood. Due to possible failure of the discharge operations, making it impossible to transmit geothermal water into reinjection well, it will be important to have a temporary discharge area at hand. In emergency situations geothermal water will be transmitted to steam mufflers by steam separator stations where 15% of the water will evaporate and what is left will be discharged into 100 m deep borholes beside the steam mufflers. About 80 L/s of cooling water that will be discharged from the cooling towers of a 200 MW_e power plant will be piped to 30-60 m deep borholes east of the cooling towers.

Road construction: According to the EIA report a 31.5 km long access road is planned from Husavik to Theistareykir. It will be constructed at the present road location the first 10 km from Husavik over Grjothals to the lake Hoskuldsvatn and from there along a track to Hofudreidarmuli further to the east. Then the road will turn south to the end of Gudfinnugja in the Theistreykir lava field from where it will run east the rest of the way to the power station. The road will continue southwest through the geothermal field at Theistareykir to be connected to an existing track west of Bæjarfjall. Roads will be built within the construction area to access drill pads and construction sites as well as service roads along transmission pipes.

Quarrying: Of the total 1,175,000 estimated filling material all will come from quarries except for 142,000 m^3 that will come from road cuttings. Location of concrete material has not been decided.

2.1 Alternatives

Buried pipes. According to the EIA report pipes for transporting steam, geothermal water and fluid discharge will be installed on the surface on concrete foundations as is most common in high enthalpy geothermal fields. Existing technology that makes it possible to bury steampipes is only applied in limited cases such as when roads are beeing crossed. Preinsulated pipes with urethane and plastic coating will not withstand more than 140 °C but in steam gathering pipes and transmission pipes temperature over 170 °C is to be expected. A different technology is to lay steam pipes in culverts or concrete ducts. A 2 m deep and 4 to 6 m wide ditch would be needed for a concrete duct. A 4 m wide service road besides the ditch would be built during construction. Therefore the width of disturbed land would be 8-10 m. The cost of buried pipes would be double that of traditional surface pipes. Problems could arise due to thermal ground and it can be expected that piperoutes and connections may have to be changed, which will be more difficult if the pipes are buried. Water entering the ducts could lead to erosion of foundations and pipes. Pipes will not be buried in culverts or ducts unless it is necessary such as where roads need to be crossed.

Cooling towers. According to the EIA report air emission from the cooling tower will be saturated with moisture and therefore most of the time steam plumes will rise from the tower. Steam plumes may be reduced by installing hybrid cooling towers. Disadvantages of this type of cooling towers, compared to traditional cooling towers, are that they are 2.5 times more expensive, they are larger and higher, their power consumption is 30% higher and the power plant's owerall power efficiency will reduce. Hybrid coolong towers are therefore not a viable option at Theistareykir.

Acess road route. According to the EIA report two alternatives in the section from Theistareykir to Hofudreidarmuli of the acess road to the power plant, routes A and B, are introduced and compared, in accordance with the scoping document and in consultation with the Planning Agency. The comparison is based on existing information on nature, geology, landscape, birdlife and size of the

project. According to a regional plan accepted on January 16th 2008 the proposed location of a new access route to Theistareykir is the same as the road designed as alternative A. Alternative B is based on existing areal photographs and geographical databases and dimensions for road, excavations and fillings are assessed. Possible collection of snow with respect to winter road conditions is discussed. Included in the comparison of alternatives is a discussion on the access road's connection to other components of the Theistareykir power plant project and how it will affect the size of the project, the impact area and the overall environmental impact.

Main results of the comparison are as follows. The road can be constructed according to route B so that the quality of road design and plan profile will be comparible to route A. Assumptions for cost comparison of alternative A and B are not equal with regards to precision of baseline information because route A has been surveyed but not route B. There is though no indication other than the cost of each meter in lenght should be similar, note however later remarks on prevention of snow collection. Route B will be about 7% longer than route A. The centerline of the existing track will be within road on 33% of the way on route B, which reveals that it is difficult to more than roughly keep the route of a new road within the existing track if all design requirements are to be met. The existing track, or remains of it, will be left and visible outside route B 50% of the way. At Sæluhusmuli it gets very snowy in two several hundred meters long road sections. From south of Raudholl to Theistareykir the old track lies in slumps where it was easyer to pave rather than on top of rocky hills, and more snow collects by the track. A road constructed on the same route as a track like this or close to it, will inevitably be a worse road than one that is designed taking snow collection into account. It is therefore concluded that if a road, according to route B, needs to be 1 m higher than route A to prevent snow collection the cost of each length meter of such a road could be doubled with regard to regular design criteria.

Road route B will run through two HÞ4 protection provisions according to the regional plan and so will route A. Construction is allowed within these areas but special care should be taken in construction and design of structures. Disturbance of a number of cultural sites that have been registered on both routes can be prevented by further implementation of the road design and alternatives A and B. There being no difference between them. A road according to route A will be more useful for transporting filling material from a quarry east of Jonsnipa and for construction of a transmission line from the power plant.

It is the developers opinion that road routes A and B will have a comparable impact on landscape, geological features, protection provisions and cultural remains but that route B will have a greater impact on fauna or similar to that of route A. The developer also considers that no further studies have revealed evidence to believe that a new road according to route B will lead to the proposed Theistareykir power plant having less environmental impact than if the road would by built according to route A. As it is in accordance with an accepted regional plan and the local municipalities' policy, a shorter road, better connected to other project components of Theistareykir power plant and related projects, lower risk of snow collection, lower estimated construction and operation cost, in addition to the possibility of using the old track as a hiking or riding trail, the developer is of the opinion that a new road according to route A is a much more feasible alternative than according to route B.

The developer emphasizes that a road according to route B is not considered an option and that the environmental impact of this alternative was therefore not reported in the initial environmental impact report.

According to the Environment Agency of Iceland's comment the proposed road construction will have a considerably negative impact on a lava field that is protected according to article 37 of Act no. 44/1999 and on a nature conservation area. Due to lava fields north of Theistareykir having already been disturbed by the existing track, on the section from Hofudreidarmuli to Theistareykir, a new access road according to route B will cause less disturbance of lava fields than a road according to route A that runs through undisturbed lava. The possibility of using the existing track as a hiking or

riding trail, after a road has been built according to route A should not be considered as a positive impact of this alternative and neither should the connection to other projects. Power transmission lines have their own service tracks so proximity to the power plant access road is irrelevant. In the Environment Agency's opinion it is necessary to take into consideration that route A is closer to a falcon nest, which is a red listed of threatened species and is also a protected species. Nesting places most often used by falcon will be both near the proposed road and in line of sight. This will significantly increase the probability of disturbing falcon breeding at these locations. The Environment Agency is of the opinion that route B should be preferred with regard to impact on falcon breeding grounds.

The developer points out that route B runs through comparable geological features and partly through the same landscape units as route A. Both routes run through ten kilometres of lava fields that are protected according to the nature conservation act. It is restated that nothing hase been revealed during further investigations that gives reason to believe that a proposed access road according to route B would cause less environmental impact than according to route A. The developer can therefore not accept the Environment Agency's view. It is also to be noted that in the summer of 2007 the distance between the falcons nest and the proposed access road was 500 m, or about 850 m away from the existing track (route B). It is not accepted that this difference in distances can be expected to result in route A being a worse alternative than route B regarding impact on birds.

In the Environment Agency of Iceland's comment it is pointed out that if the access road is to be built according to route A, then the power transmission lines from the power plant will cross the road in two places and lead to increased visual impact of the transmission lines for those that will be driving to and from the power plant. The Environment Agency is therefore of the opinion that route B is a better option.

It is **the National Planning Agency's** opinion that road construction will have a significantly negative impact on protected geological features due to disturbance of 110 ha of lava fields during construction. The Agency agrees with the Environment Agency that road construction according to route B, along or nearby the existing track, will have less impact on lava fields than a road according to route A. It lies further away from fissures and faults, the high and rough edge of the Theistareykir lava field, domes and channels with collapsed parts and it would not cut through the Theistareykir lava field to the same extent as a road according to route A. There will be considerable visual impact from power transmission lines on route A, east of Jonsnipuskard, but this can be reduced considerably by building the road according to alternative B. According to a report on proposed power transmission lines from Theistareykir where it says that with regard to safety of electricity supply a route north of Hofureidarmuli is considered acceptable and the Planning Agency is of the opinion that Landsnet should investigate the possibility of a different location of Theistareykjalina 1, which will run over Hofureidarmuli. In that context the route of the access road should also be investigated.

It is the National Planning Agency's opinion that the impact on fauna from road construction according to routes A and B will be comparable except where route A runs quite some distance through undisturbed land while route B follows an existing track to Theistareykir. The developers opinion is that road construction will have insignificant impact on fauna and based on discussion it can be concluded that the reason is that no protected fauna will be disturbed.

The Planning Agency points out that according to Appendix 16, there are 6 small cairns besides the existing track from the power plant site to north and west towards Hofudreidarmuli. The Cultural Heritage Agency's opinion on disturbance of cairns is not available at this point, but they must be consulted if the road will be built according to route B. A road according to route A will not have any impact on cultural remains on the section of comparison.

Zero alternative. According to the EIA report a zero alternative means that no geothermal power plant will be built at Theistareykir. It is difficult to predict on future development in the area in case there would be no power plant construction and in light of present land use, due to lack of

information. There would be no further disturbance due to construction and operation of Theistareykir power plant and access road. If present exploration wells will not be utilised as production wells in the near future the plan is to restore the area to its original state as much as possible in consultation with licensors and supervising bodies. It is concluded that if construction of the proposed project will not continue then the area will not change much compared to its present state. Nature and the enviroment can be expected to evolve on its own without the impact of a power plant and improved access to the area.

2.2 Impact character and impact significance

The Envrionment Agency points out that definitions from the developer on concepts on impact significance does not comply to the definitions put forward in the Planning Agency guidance on impact character and significance from December 2005.

The developer says that the report authors have been using the term ”somewhat“ from the year 2006. The reason is that the gap between ”insignificant” impact and ”considerable” impact is too wide according to the report authors. Therefore a decison was made to add the concept ”somewhat“ in between. The decision was taken in consultation with the National Planning Agency at that time in connection with inital environmental report of Alcoa Fjardaal aluminum plant, but it is possible to alter the methodology provided in the Planning Agency guidance in consultation with the Agency. In that respect the concepts introduced in table 9 were redifined with regard to the Planning Agency guidance.

The National Planning Agency points out that in the developers´s EIA report, environmental impact of the project on certain environmental aspects have been assessed. Impact signficance is described with reference to impact significance values where the most negative value is significantly negative, then considerably negative, after that somewhat negative, insignificant/no impact and later on somewhat positive, considerably positive and finally and most positive impact valued as significantly positive. Explanations of definitions of the above mentioned values is found in EIA report (table 9). In Planning Agency guidance from 2005 on classification of environmental aspects, criteria, character and significance of impact, there are recommendations of concepts regarding impact significance which can be used when assessing environmental impact. The Planning Agency is currently revising these guidance and in light of experience the Agency believes that in many instances the significane will need to be defined with the value, which the Agency names somewhat negative, which would be listed between considerably negative and insignificant impact, that is how the developer does in his EIA report. In these cases impact is normally local, and would not cover extensive area and the impact area where not subject to conservation or would be sensitive for changes, but the impact could be permanent and irriversible. The Planning Agency will, in this opinion, use the same concepts as the developer uses in the EIA report to describe joint environmental impact of all the four projects.

3. Conclusion on environmental impact assessment

3.1 Impacts on geothermal system and energy resources

According to tha EIA report utilisation of geothermal steam will lead to reduced pressure in the geothermal system. If a new pressure balance is reached, lower than the original pressure state, the power production is defined as sustainable utilisation, but if pressure balance cannot be reached it is defined as unsustainable geothermal utilisation. Theistareykir ehf. plans for sustainable utilisation of geothermal energy by gradually increasing production at Theistareykir based on the knowledge and experience of production potentional of the geothermal system. Depending on results being positive it is predicted that the impact of geothermal utilisation in the area will reach a balance and will have an insignificant impact on the geothermal system and energy resources. The assessment is although subject to uncertainty. It is emphasized that the definition of sustainability must not be confused with renewability. One describing the method of utilisation and the other the nature of the resource and that geothermal energy is a renewable resource.

It is stated that interpretation of data from extensive surface investigations and exploration drilling in the geothermal field has resulted in a conceptual model of the geothermal system and volumetric resource assessment. Most extensive data on the geothermal system is available on a short east-west section north of Bæjarfjall mountain, showing that beneath the Theistareykir plain north of Bæjarfjall there appears to be an upflow zone, connected to both a northerly fissure system and an east-west fissure zone. The highest permeability and lowest temperatures are connected to a fissure zone with open cracks and rifts south of Tjarnaras (Well ÞG-2) but west of Ketilfjall mountain it seems that the bedrock is closed below 1,900 m depth (ÞG-3) but temperature there is very high. Main features of the concept model of the Theistareykir geothermal system are based on this data. Horizontal flow is assumed both to the east and west, powerful downflow into a fissure zone that well ÞG-2 was drilled into and even a downflow east of well ÞG-3. A resistivity boundary indicates that the geothermal system is restricted south west of Bæjarfjall. Results of TEM and MT resistivity surveys indicate a large geothermal area at Theistareykir, up to 45 km^2 but that the main upflow zone of the system is located on a NNE-SSV fissure system north of Bæjarfjall. The mimimum size is 10 km^2 and is based on the area where geothermal surface manifestations have been detected and data from exploration wells, but calculations on the most probable size of the geothermal system indicate that the area's size is an average of the two figures or 27.5 km^2. Results of the volumetric assessment cover a broad size range, mainly due to uncertainty of the geothermal systems size and geothermal recovery factor. This reflects how badly the systems production potential is known. Furthermore the volumetric assessment method does not take into account important factors that play an important role in potential of geothermal systems, such as pressure drop due to exploitation, possible formation of a steam cap, inflow and impact of reinjection (except through the geothermal recovery factor). All these factors can promote increased potential. Volumetric assessment is a good method for initial assessment of a geothermal system‘s production potential before information on the above mentioned factors is available. This method can although not be applied to assess sustainability.

It is stated that Theistareykir, being located within the volcanic zone and existence of open fissures, will probably lead to a powerful inflow. Also that temperature near boiling point, at least in part of the geothermal system, will cause formation of some kind of steam cap when production has started, unless inflow becomes the more powerful. In addition to this it will be possible to increase and support energy production potential of the geothermal system by reinjection and deeper drilling in the future will probably significantly increase the production potential. All indicates that results of the volumetric assessment can be considered as the lower limit but it should be kept in mind that this is based on limited data.

It is stated that a numerical model is in preparation for the geothermal system at Theistareykir, which is based on all available data on the system. Those results and further drilling in the area will be used for assessing the energy production potential of the system more precisely than has been possible up till now. Methods for measuring and monitoring the geothermal field are also listed.

In the National Energy Authority's comment it is emphasized when applying for possible power development licenses, more detailed information must be available for a reasoned decisions on each individual stage of the project. It may be revealed that the time, which the developer has estimated to be sufficient to provide enough data on how the geothermal system responds to exploitation for him to decide on possible extension, will not be long enough. The developer must therefore take into account the uncertainty this involves.

The developer points out that the National Energy Authority will be consulted regarding plans for construction stages when further data is available and regarding deep reinjection when experience of utilisation has been gathered and properties of the geothermal system are better known.

The National Planning Agency points out that according to the EIA report most of the data on the geothermal system exists for one about 3 km long east-west section north of Bæjarfjall from well ÞG-2 in the west to well ÞG-3 in the east. The area is delimited to the east and west but could reach further south beneath Bæjarfjall and somewhat northwards.

The Agency points out that there are indictations from other high temperature areas that upflow zones are rather narrow and have even proven narrower than was assumed at the time when environmental impact assessment was carried out. As an example of this it is pointed out that on Skardsmyrarfjall at Hellisheidi it was assumed certain that the area could be utilised to produce energy for a 120 MW_e power plant, but it only produces one third of this energy and by Hverahlid at Hellisheidi, where it was assumed certain that the area could be utilised to produce energy for a 90 MW_e power plant, a need for doubling the geothermal utilization area has been introduced. Therefore it is the Planning Agency's opinion that existing indications of the uppflow zone at Theistareykir being narrow should be taken seriously and that the proposed utilisation area according to the EIA report might not support as much geothermal energy utilisation as expected.

The National Planning Agency believes it is clear that in the EIA process the developer should address possible impact of utilising natural resources, this meaning geothermal energy, cf. points 3d and 1d of article 18 of reglulation no. 1123/2005 on environmental impact assessment. The Planning Agency believes that one of the most important issues regarding assessment of a geothermal power plant's impact on the geothermal system as a resource is whether utilisation will be sustainable and what possible impact utilisation will have on renewability of the resource. Related to this is the assessment of whether the impact on the geothermal resource will be reversible and what timescale is used for such assessment. The Planning Agency believes that a sustainable processing is met when production is in balance with natural renewability of the geothermal system with energy- and mass flow from its outward margins. According to Guðni Axelsson et al. (2006) it would be possible in that manner to maintain unchanged energy utilisation from the system for a long period of time or 100-300 years. According to the EIA report a sustainable utilisation of the geothermal energy will be ensured by increasing the utilisation gradually in units, relative to knowledge and experience of the systems utilisation potential at each time and in this way it can be ensured that geothermal utilisation will be sustainable. In that respect the developer has decided that the utilisation will not be aggressive i.e. it is estimated that the utilisation will not be on the level that it needs to be stopped after 30-40 years, for up to 50 years, or it needs to be significantly reduced in order to rest the geothermal system.

The Planning Agency points out that according to the EIA report the sustainable production potential of a geothermal system is not known at the start of utilisation, but this can be assessed based on prevailing data on internal type and nature of the geothermal systems and data on how they respond to utilisation. Such estimations will be more reliable parallel to more experience of the energy utilisation of the geothermal system concerned. It is clear that no energy utilisation experience is

currently in Theistareykir geothermal area and therefore no prevailing assessment of sustainable energy utilisation capacity from the geothermal system is available. It has been accepted that it is not possible to predict sustainability based on the volumetric assessment which is used to estimate how much heat is kept in the bedrock and groundwater of the geothermal system and how large part of that can be used for geothermal utilisation in given time. According to findings of the methodology it is possible that a production capacity of 200 MW_e can only be maintained for 40 years. After that the utilisation will need to be reduced and possibly the production will need to be paused to enable the geothermal system to recover. The Planning Agency believes that to ensure that utilisation of geothermal energy will be sustainable, as proposed by the developer, and for it to be possible to realistically assess the possible impact on the geothermal energy resource and its renewability the plan must not be too large a power plant. Or else it is more than likely that utilisation will need to be looked at as an aggressive, regardless of the developer's intention of sustainable utilisation. The Planning Agency points out that geothermal power plants and thermal power plants with the capacity of 50 MW or more, and other power plants with 10 MW electric power production capacity, are always subject to environmental impact assessment according to paragraph 2 in appendix 1 of Act no. 106/2000. The proposed Theistareykir power plant is 20 times over the above mentioned criterias that were probably primarily defined due to uncertainty of what impact utilisation will have on the geothermal energy resource.

The National Planning Agency believes that aggressive utilisation which proposes such extensive production that it needs to be paused for decades, may have a significant impact because it must be ensured that it will be possible to supply the elctricity that has been promised. This impact can lead to that increasing pressure will be on enlarging the energy utilisation area meant to increase the colonisation by the energy companies of new and often untouched geothermal areas, but it is clear that geothermal areas are limited resource and unique on a global scale. In both cases there will be possible negative impact on protected areas, geological features, landscape, flora and birds along with impact on outdoor activity and tourism.

With regard to the previous discussion the Plannig Agency believes it is not possible to put forward a realistic evaluation on impact of 200 MW_e Theistareykir power plant on geothermal energy as a resource. The main reason is that the power plant put forward is too large according to prevailing knowledge and therefore too high hopes have been built up regarding estimated electricity production. The Agency considers it impossible to argue that a 200 MW_e power plant will have insignificant impact on geothermal resources as is stated in the EIA report although it carries a disclaimer that this assessment is subject to uncertainty. Significant uncertainty prevails on which will be the impact of the proposed 200 MW_e power plant on the geothermal resources. Furthermore the Agency points out that according to a report by Gudni Axelsson (2009) by planning a smaller power plant overinvestment can be avoided and it will be possible to gather data that can be used to determine the system's production potential with greater accuracy than is possible at the beginning.

3.2 Visual imact and impact on landscape and protection, recreation and tourism

3.2.1 Visual impact

In the EIA report it is stated that the proposed construction at Theistareykir will be highly visible in the immediate vicinity and from areas at higher altitudes, including Bondholsskard pass, due to the location of the power plant structures in the plains north of Bæjarfjall mountain.

It is stated that no actual mitigation measures due to visual impact are proposed but the assessment process entailed some changes in the arrangement and location of the proposed structures. Steam and geothermal water transmission pipes will be buried when crossing roads and visual impact will be diminished by choosing color, texture and degree of gloss of the pipe's aluminium coating.

According to the EIA report the conclusion is that visual impact at Theistareykir will be significantly negative, direct and irreversible especially around the power plant, west of Klifarveggur and north of the slopes of Bæjarfall mountain. Today there are very few structures in the area and it is a tourist attraction, but the proposed projects are extensive and will result in significant changes of appearance.

Drilling sites east of Bondholsskard pass will have an insignificant impact in the area east of it in the direction of Storaviti crater that is about 3 km away. The area is flat but moundy so little will be seen of the drilling sites exept very close to them. Steam rising from wells during testing will temporarily be visible from a considerably greater distance. Steam rising from wells during testing all over the geothermal field will temporarily change the scenery and have a visual impact in the area and under certain conditions it will be visible in populated areas outside the proposed geothermal utilisation area.

It is stated that the proposed access road to the power plant site will have considerable direct and permanent negative visual impact in undisturbed sites, where it will run through a flat land like Theistareykir lava field and the geothermal field. On the stretch between Husavik town and Hoskuldsvatn lake the road will have somewhat direct negative visual impact, but a current road, recently built by Nordurthing municipality, already runs through the area.

In a comment the Environment Agency of Iceland points out that for images in the initial EIA report, which show the effect of changed appearance in the gethermal utilisation area, to be more realistic, it would have helped to add activity connected to construction and operation, also it is pointed out that steam pipes seem completely flexible and adjusting to their surroundings. Attention is drawn to that the embankements of the road are shown as very high on an image and it is pointed out that when constructing a road to Hverahlid at Hellisheidi, for Reykjavik Energy, it was successfully kept lower in a flat area causing considarbly less impact than when roads are raised as shown in the image.

The developer points out that at this stage in the preparation of a geothermal power plant it is difficult to visualize the precise appearance of structures and changes that the project will have on the scenery. Emphasis is given to show position and coverage rather than a detailed description. It is not possible to compare a year-round road of category C7 to the road to Hverahlid at Hellisheidi. The developer will consult specialists and relevant authorities on reclamation of disturbed areas and road slopes.

In a comment the Environment Agency of Iceland points out that there is a good view at Theistareykjabunga and that because now there are no structures east of Bondholsskard pass drilling sites and associated structures will affect the panorama of the whole landscape unit.

The developer notes that a drill pad and associated equipment will hardly be detectable from afar and will according to visibility maps remain visible within the Theistareykjabunga landscape unit within 2 km and from the peaks of Thorunnarfjoll mountains and the brim and Storaviti crater. Under certain weather conditions steam rising from well being tested will be visible beyond that.

In a comment the Environment Agency agrees to the proposed mitigation measures that are presented but points out that it could be appropriate to start utilisation of drilling sites closest to the power station, but suspend utilisation of drilling sites O, K, L, N and M as they are much further away and long pipelines, road connections and dispersed structures will have large impact on appearance.

The developer states that he can not accept the Environment Agency‘s recommendations to suspend utilisation of drilling sites K, L, M and N.

It is **the National Planning Agency‘s** opinion that experience from other power plants, such as Reykjanes power plant at the one hand and Krafla power plant and Hellisheidi power plant on the other, show that visual impact of structures depends very much on local conditions. Therefore visual impact of the structures of Reykjanes power plant, which is located on flat land, but in the rough lava, is much less than the impact of the other two power plants structures, as pipelines are located on slopes and the power station buildings at the valley bottoms. The Agency supports the developer

conclusion that the impacts of changes in appearance at Theistareykir will be significantly negative, direct and irreversible around the power plant, beneath the slopes of Bæjarfall mountain and west of Klifarveggur. The proposed access road will cause considerably direct negative and irreversible visual impact especially in undirsturbed areas where it runs through flat land like the Theistareykjahraun lava field and the geothermal utilisation area at Theistareykir, but en the section between Husavik and Höskuldsvatn the impact will be somewhat negative. Drilling sites east of Bondholsskard pass may have considerable visual impact, both from near surroundings to the east and from the slopes of Bæjarfjall and Ketilfjall mountains. Further east from Storaviti, which is 3 km away and from Thorunnarfjoll the structures will cause a somewhat negative visual impact. Visual impact can be reduced considerably by burying transmission pipes from wells and by selecting color and texture on pipes and borehole housings to adjust to the surroundings.

The Planning Agency considers very important to minimize visual impact of structures in the vicinity of the geothermal area and heritage site beneath the slopes of Bæjarfjall. The area is a kind of center at Theistareykir and should be treated as such. Bondholsskard can bee seen far from the north and west and the road and steam pipes on the pass may have significant negative visual impact.

The Planning Agency believes that when issuing permits conditions must be set that the pipes that the developer plans from Bondholsskard pass down to the plains, as well as pipes planned west of the Theistareykir farm site, shall be layed underground. The scale and height of the road to drilling site F and continuing to the Theistareykir cabin must be minimized. The proposed access road will have a significantly negative visual impact where it runs trough the plains west of Klifarveggur to Hofudreidarmuli.

The Planning Agency agrees with the Environment Agency that on account of visual impact it is appropriate to start by utilizing drilling sites that are closest to the power station, but drilling sites O, K, L, N and M should be suspended due to the long distance to the sites and great visual impact caused by long pipelines and road connections.

The Planning Agency believes that visual impact of steam emission from wells being tested are underestimated for geothermal power plants, even though it is assessed that it will be temporary at each well. Experience shows that steam from wells is almost constantly being emmitted in geotermal utilisation areas especially untill full production potential of the power plant has been reached, which in the case of Theistareykir may take years. Makeup wells are then drilled and tested periodicly as well as there will be persistent steam plumes rising from the power plant itself and will be visible from afar under certain conditions.

3.2.2 Impacts on landscape and conservation value

According to the EIA report a landscape analysis was carried out to assess the projects impact. The whole territory which is considered to be within the impact area was categorized and classified into 9 landscape units. This classification was based on geology, vegetation, hydrology, land use and landform, which form the caracter of the landscape unit. The value for each unit was obtained by summing several factors, namely, wilderness, recreational value, protective value and geothermal surface manifestations.

It is concluded in the EIA report that Theistareykir and Theistareykjabunga landscape units have a high conservation value. At Theistareykir landscape differs from its surroundings due to the effect of geothermal manifestations along with dense vegetation. It is also stated that the greatest effect on landscape will be close to Theistareykir where geothermal power plant installations are planned and that their impact will be significantly negative. The proposed access road will run through svereral landscape units and will have a considerably negative impact on the Theistareykir lava field landscape unit, but somewhat negative on the units Botnsvatn, Hoskuldsvatn, Grisatunga and Kviholar. Impacts of power plant structures and access road on the landscape unit Skildinga- and Storaviti lava fields will be somewhat negative but insignificant on the landscape units Husavik and Theistareykjabunga.

Defined wilderness areas that will be affected by the project will decrease by 9% and the impact is considered considerably negative.

In its comment the Environmental Agency accepts that impact on the Theistareykir landscape unit will be significantly negative and considerably negative on the unit Theistareykir lava field. The Agency is of the opinion that the environment at Theistareykir is unique and that is therefore important that there be undisturbed areas left for tourists/nature lovers, to the extent that they give a picture of the characteristics of the area. It is noted that according to plans the conservation area will cut through with drilling sites and steam pipes which will have considerably negative impact. In the opinion of the Environment Agency a drilling site east of Bondholsskard will have a significantly negative impact of on the Theistareykjabunga landscape unit that undisturbed by construction and said to be one of the largest shield volcanoes in the country with regards to volume, or 20 km³. Impact on wilderness will be significantly negative. In a commnent on the joint environmental impact assessment, the Agency emphasized that no construction takes place east of Bondholsskard.

The developer notes that the Environment Agency comments on the impact on Theistareykjabunga landscape unit that is undisturbed and in addition, there is a great panorama. In this case it is the opinion of the developer that impacts on different environmental aspects are being added upp and it is iterated that impact on this landscape unit will be insignificant because only a small part of it is desturbed. Wilderness areas as defined in the vicinity of Þeistareykir are expected to reduce the equivalent of almost 9% of the original size due to the proposed project.

The Planning Agency agrees that the Theistareykir landscape unit has high value and that impact of structures will be significantly negative. The Planning Agency believes that assessment of the value of the Theistareykir landscape unit should have taken into account the value of cultural remains around the ruins of the Theistareykir farm. The Planning Agency also points out that the territory around Theistareykir has been nearly unaffected by construction activities until recently and it is the Agency‘s opinion that every effort should be made to minimize environmental impact of the proposed project. The impact on wilderness areas will be considerably negative. The proposed access road will have a significantly negative impact on the landscape units Theistareykir lava field and Skildinga- and Storaviti lava field, but less on other landscape units.

The Planning Agency believes that if disruption from construction east of Bonhlolsskard pass is kept close to Bæjarfjall and Ketilfjall mountains, at the edge of Storaviti lava field, that it will not significantly decrease the Theistareykjabunga landscape unit. Even though there are no structures east of the pass the Agency is of the opinion that impact on the landscape unit will not be significant. The Planning Agency believes that when issuing permits the location of drill pads L and M must be studied to keep them as close to the mountains as possible as well as service roads and pipelines so that disturbance of the geological formation Theistareykjabunga will be as little as possible. For example the drill pad L should be parallel to Ketilfjall but not stretched to the east. The initial size of the drill pad should be just for one well and in its design account should be taken that most of its traces could easily be removed if drilling is unsuccessfull. No drillpad should be prepared before it has been decided to bring a drill rig to the respective site so as to prevent uneccesary disturbance.

3.2.3 Recreation and tourism

According to the EIA report construction time for the first two units Theistareykir power plant will cover four years. At the time, it is believed that impact og recreation and tourism will be significantly negative due to traffic, nuisances and noise from the wells being tested, but improved access due to the introduction of new road will have a considerably positive impact. Construction will change the appearance and experience of the area and present tourist operations and part of recreational activities can therefore neither be practiced in its present form, nor will it be possible in the future to promote the area in the same manner as has been practiced. Visits to the area should still increase though more as a brief stops and general tours, such as to view the structures and unique natural phenomenon. Part of recreational activity will remain unchanged or even increase.

According to the EIA report construction will have various types of noise impact, such as traffic, equipment, machinery, drilling and testing of wells. Generally it drilling a well takes about a month and testing takes 4-6 months. It can be assumed that noise from drilling and testing of wells will be most prominent during the first years of the construction period while production wells for the power plant's first two 50 MW_e units are being drilled and during the fourth year of construction due to drilling of well for the next two 50 MW_e units. According to regulation no. 724/2008 on noise the noise level in the industrial site may not exeed 70 dB (A) at the side of buildings and not exceed 40 dB(A) in quiet zones in rural areas. Drilling sites A and B are close to the cabin at Theistareykir and drilling site L is above Bondholsskard pass, where hikers and tourists will be passing by and therefore it is apparent that noise at that location will exeed 40 dB(A) and that the impact on recreational activity will temporarily be significantly negative. During operation noise is espected to be rather stable in the Theistareykir area, a steady drone from steam mufflers by the power station, cooling towersand production wells. It is assumed that noise will be below reference limits for industrial sites (70 dB (A) at the outside wall of buildings) and according to calculations it will be below 40 dB (A) by the cabin at Theistareykir and that there will be insignificant impact on recreational activity. It is impossible to schedule well testing, that can take 4-6 months, with respect to the tourist season since in the case Theistareykir there is no special tourist season.

In the Icelandic Tourist Board's comment it is pointed out that Theistareykir power plant will be constructed on nearly undisturbed land in an area that has just been discovered as a tourist destination. It is emphasized that during construction account should be taken of tour operators that utilise the site at present so that the project will have the least negative impact on current operations. Furthermore that it should be attemped to improve future tourist facilities at and near Theistareykir. Structures must be planned and designed so that they adjust to the landscape and topography and emphasize the uniqueness and beauty of the area. Providing good information is an important element in reducing tourists' negative experience of disturbance that inevitebly is part of this type of projects.

The developer points out that among other things, it will depend on the strategy that will be accepted on land use in development plans for the area, what kind of possibilities and opportunities may be created for a different type of tourism activity in the region. At this stage there are no plans on the construction of major facilities for tourists and tourist operators, but there will be rest rooms and waste management facilities in power plant buildings. Possibilities have been explored to arrange and locate structures so that they will adjust to the surroundings and it has been emphasized that location of pipelines, design, color schemes and texture of pipes as well as completion of drill pads will take into account the surrounding environment and that visual impact will be mitigated. It is proposed to set up information boards at travel routes and tourist destinations during construction.

In a comment on the combined environmental impact assessment, the Environment Agency refers to the results of an expert report regarding the impact that the proposed Theistareykir power plant and overhead transmission lines from Krafla to Bakki by Husavik will have on tourism and recreation, in which there are put forward proposals for the sake of tourism and recreation in the area and refers to the conclusion of the report which is as follows:

"Tourism is a growing industry in the region, and although not expected to revolutionize society and the economy as fast as large scale projects it has potential for growth that must be taken into account and allowed to thrive on its own terms. It is necessary to give it space with the planned projects and will require consultation with stakeholders and those that have an interest in tourism and recreation. Thus it should be possible to assess further the value of the objectives beeing set and at the same time give the tourist sector an oppertunity in the region, taking into account the public strategy put forward in the region."

The Environment Agency notes that despite the above remarks that in the initial EIA report there is no discussion of how consultation with tour operators and those who utilise the area for recreation has

been or will be implemented and whether the project has in some way taken into account the current use of the area. The Environment Agency considers appropriate to the initial EIA report should have set out proposals on how construction could be planned so that the impact on tourism and recreation in the region would be reduced as possibel and how to conduct consultation with the relevant parties. The initial EIA report is too focused on the likelihood of the construction of power plant infrastructure leeding to better access to areas for day trips and increased number tourists who travel independently. It is however not assessed whether this change, which is considered positive for this tourist group and the expected negative impact on the tourism and recreation which is currently practiced, will be positive on the whole and that tourism in the region will benefit from it.

The developer responds by describing how consultation and public presentation has been organized and refers to the answer to the Icelandic Tourist Board‘s comment.

The National Planning Agency supports the conclusion of the EIA report that the project will change the appearance and experience of the region and that tourism which is now operated and part of recreation practiced there will therefore neither thrive in its present form, nor can the area be promoted for future utilisation in the manner that has been practiced. The number of tourists on the other hand, will probably increase as the area is beeing discovered as a tourist attraction due to improved access. In the opinion of the Agency noise accompanying geothermal power plants will prevent travellers from visiting geothermal utilisation fields and it is clear that the calm that has prevailed at the deserted farm and geothermal area at the foot of Bæjarfjall mountain will no longer exist and with that the experience that outdoor enthusiasts and other tourists, have aspired. Although the noise from the power plant, when no wells are beeing tested, will be below the limit, for quiet areas in rural areas, the noise in the vicinity of the cabin at Theistareykir, a steady drone (power station, steam separators, cooling tower) will still cause considerably negative impact. When wells are tested the impact of noise will be significantly negative and circumstances like that can be expected somewhat continuously for years while the power plant is under construction and then a few months at a time when maintenance wells will be tested. Considerable negative impact on recreational activities will therefore be inevitable.

Furthermore the Planning Agency notes that too much is made of the positive impact on tourism and recreation due to improved access to new areas. In the expert report on the impact of Theistareykir power plant and transmission lines it is stated that Theistareykir is a destination that is less known than well-defined and well-known destinations in the region. However Theistareykir classifies as a destination that is evolving and beeing discovered and therefore at the so-called "survey" stage if classified according to a tourist destination‘s life cycle and number of visitors. The Planning Agency believes that too much is made of the positive impact of increased access to Theistareykir, because the number of tourists in this area could increase without the implementation of the project. In addition, construction of Theistareykir power plant will offer similar entertainment opportunities as the Krafla geothermal area and therefore it is not at all certain that the number of tourists will increase at Theistareykir, and tourists would be satisfied to visit one high temperature geothermal area with a geothermal power plant.

3.3 Impacts on geology

It is stated in the EIA report that the structures at the geothermal utilisation are, such as roads and pipelines, drill sites and building sites, will be largely on geological formations that are protected under the Nature Conservation Act e.i. recent lava fields. Construction will also affect areas with geothermal surface manifestations, also protected under the Nature Conservation Act. The impact will not affect the main geothermal area at Theistareykir which is defined as protected area (HÞ1). According to the regional plan neither will structures of any kind be authorized within the area nor will other disturbances. Structures will in two cases affect protected areas 2 (HÞ4) at the drilling site O and access road and pipes to drill pad L. Quarries will be mostly in older geological formations except area

RHN-10/11 that will be in a lava field from the end of the Ice Age and the conservation value of geological formations is considered low to moderate. The access road from Husavik will be run through basalt formation from the Ice Age east to Hofudreidarmuli but through lava fields from there, especially Theistareykir lava, Skildinga lava and Storaviti lava. It is stated that the proposed project will have somewhat negative, direct and irreversible impact on the lava fields that are protected but that direct disruption will be about 109 ha.

It is stated that it can be expected to be difficult to assess the potential indirect impact of geothermal utilisation on geothermal manifestations in the Theistareykir area and to determine whether changes can be connected to utilisation or natural and / or seasonal fluctuations. It is assumed to geothermal utilisation will have an insignifican impact on geothermal surface manifestations if mitigative measures to minimize pressure drop in the geothermal reservoir are successful. The assessment is although subject to uncertainty. It is stated that measurements and observations will be applied to monitor surface changes due to utilisation, such as changes in geothermal surface manifestations, by taking samples and photopraphs.

In the Environment Agency‘s comment it is stated that the proposed project will have a significant negative impact on lava fields and areas with geothermal surface manifestations, which are protected under article 37 of Act No. 44/1999 and within a specially listed protective provision. Since lava north Theistareykir has already been disrupted by the current track from Hofudreidarmuli to Theistareykir construction of a road according to route B will disrupt less of lava than according to route A that runs an untouched lava field.

The developer notes that in areas such as Theistareykir it is impossible to avoid disrupting the lava fields because they cover the majority of the area. Instead, care has been taken not to disrupt remarkable geological phenomena or geological formations. It is not accepted that the project will have a significant negative impact on geological formations, but that it will have a somewhat direct, negative and irreversible impact, taking into account the criteria and the limited scope of the impact on respective geological formations.

In a the Environment Agency‘s comment on the combined environmental impact assessment, it is noted that the Agency believes that it should not be concluded that the environmental impact will be insignificant based on the assessment being subject to considerable uncertainty. Also it is cited that in a report by Axel Björnsson he notes that some pressure drop can be expected in the geothermal reservoir and that geothermal surface activity will increase because of drilling, at least initially. The Agency therefore believes that increased surface activity can be expected at Theistareykir which can cause a negative environmental impact, comparable to the changes in surface activity at Reykjanes due to geothermal utilisation there.

In the Environment Agency‘s comment on the combined environmental impact assessment it is noted that it is not reported whether monitoring of changes in the Theistareykir area will be equivalent to that of the Krafla area, but that it is expected to be difficult to detect potential indirect impact of geothermal utilisation on surface activity and whether changes are connected to utilisation or natural and / or seasonal fluctuations. The Environment Agency believes that surface manifestations should be monitored, and that the natural changes should not prevent monitoring of the geothermal area. The Environment Agency also notes that it is not clear from the discussion of the initial EIA report whether monitoring will lead to any action if changes due to utilisation are revealed.

The developer notes that changes in geothermal surface manifestations at Theistareykir will be monitored, by taking samples and photopraphs. It is iterated that as stated in the assessment report, it is very important for the developer to sustain effective environmental monitoring and relevant registration to assess any changes that may occur in surface manifestations. Responding to changes will be assessed each time. If a steam pad is formed the best mitigative action is to drill production wells in to the steam pad to utilise steam for electricity generation, as at Svartsengi and Reykjanes.

In its comment the Environment Agency notes that the rehabilitation area for quarry No. ÞRN-1, southwest of the Bæjarfjall mountain, is too broadly defined relative to current boundary of the quarry.

The developer iterates that the main purpose of excavation in quarry ÞRN-1 is rehabilitation, but to succed in levelling the slope of the ravine it will be neccesary go beyond the current boundary of the quarry.

The Planning Agency believes the construction in the geothermal utilisation area will have a significant negative impact and construction of an access road, a significantly negative impact on geological formations that are specially protected, because about 110 ha of lava disrupted by structures. The Agency agrees with the Environment Agency that building a road, according route B on and near of existing track will have less impact on lava fields a road ccording to route A because it will be located further away from fissures and faults, the high and rough edge of Theistareykir lava field lava domes (Bungur) and lava channels with collapsed parts and it would not cut as much through the lava field.

The Planning Agency believes, in the light of submitted data and experience from other high temperature geothermal fields, that there is great uncertainty regarding whether there is a risk of pressure reduction due to geothermal utilisation causing formation of a steam pad and / or changes of surface activity in the area. It is clear that there will be natural changes in surface activity in each area over time. There may be seasonal fluctuations in surface activity for example due to changes in the supply of water and that is widely known. Major gradual changes may occur on the upward flow channels of steam which could, for example explain documented changes in the geothermal area at Theistareykir between 1984 and 1991, and events, such as earthquakes, are known from other areas that can also be the cause of major changes in surface activity.

The Planning Agency notes that the in a Regional plan for high temperature geothermal fields in Thingeyjarsyslur for 2007 - 2025 the area west and north of Bæjarfjall mountain and up the slopes of the mountain, as well as two smaller fields, defined as protected areas of category 1 and within it no structures or disturbance is allowed. The Planning Agency therefore believes it is clear that there is no project intended at Theistareykir that could have an impact comparable to construction or other disturbance, although there will be indirect impact, within a category 1 protected area. Examples show that the difference in the natural changes in surface activity can be discerned from changes attributable to geothermal utilisation such as when the new hot springs formed at Hvitholaklif at Krafla and a recent significant expansion of geothermal surface manifestations at Reykjanes power plant. It should also be kept in mind that there is no guarantee that a possible change in surface activity at Theistareykir will only be within the areas already containing surface manifestations. It is noted in the case documents that fissures and faults lie from north to south and increased surface activity could therefore for exampel be shifted to the north and into an area of protected cultural remains in Theistareykir fields.

The Planning Agency emphasizes what the developer states regarding mitigating measures to limit the pressure drop in the geothermal reservoir. If they are succesfull then geothermal utilisation will have an insignificant impact on geothermal surface manifestations. This assessment is although subject to uncertainty and in the EIA report the following is also stated: "Mitigation measures are complex in the full meaning of the word." It is also stated that if a steam pad is formed, then the best mitigative action is to drill production wells into the steam pad to utilise steam for electricity generation, as at Svartsengi and Reykjanes. The Planning Agency notes that the developer does not refer to results on whether drilling into the steam pad at Svartsengi and Reykjanes has lead to reduced surface activity. A major change of hot springs, vegetation and even cultural remains can go on for years before mitigation will be effective. It should also be noted that increased surface activity which may be a positive experience for tourists and temperature changes of water or soil can create habitat for thermophilic species. These are issues that licensors must take into account.

The conclusion of Axel Björnsson (2008) on the need for monitoring of natural changes is supported. Changes in the geothermal area must be observed regularily, several times a year at first (monthly), to get an overview of the seasonal changes. Later the number could be reduced down to annual observations that would be carried out under similar weather conditions at each occasion. In licenses for the project conditions need to be set for monitoring of changes in surface activity and that observations according to the monitoring program should start immediately and the results presented to licensors annually. Plans for mitigation, drilling into the steam pads, reinjection and / or a reduction in production, would have to be prepaired, as far as possible, at the beginning of the operation.

The Planning Agency emphasises that there will be no further excavation in quarry THRN-1, in a ravine on the slopes of Bæjarfjall mountain, but the quarrying has already caused significant negative impact on the appearance of the mountain side. The Environment Agency should be consulted on determining arrangements for rehabilitation of the quarry. The Planning Agency considers that the developer should reject the idea that the quarry‘s bottom could serve as a storage area because it will increase negative visual impact of the significant disruption already caused by quarrying.

3.4 Impacts on cultural remains

3.4.1 Impacts in geothermal utilisation area

According to the EIA report 30 cultural remains have been registered in the fields of the old Theistareykir farm during an archeological survey. Cultural remains registered in the land of Theistareykir are typical for highland pastures, including fences, docks, riding trails and cairns. In development plans for Theistareykir there is a cultural protection area defined around the old Theistareykir deserted farm, ruins, earthworks and a cabin. In selecting the location of the proposed building sites, drilling sites and service roads account has been taken of registered cultural remains in the geothermal utilisation area and on the route of an access road from Husavik. No cultural remains will be disrupted by proposed drilling sites but special account must take of cultural remains at west edge of the Theistareykir farm field because the pipeline route from drilling site A lies near to the cultural remains protected area. Also cultural remains will be taken into account when locating strucuters in the vicinity of drilling site O. The Cultural Heritage Agency of Iceland will be consulted during construction activity. It is the conclusion of the EIA report that impact on cultural remains in the geothermal energy utilisation area will be insignificant.

In the Cultural Heritage Agency‘s comment of Theistareykir area it is noted on the northeast and beyond the cultural remains protected area there are the remains of two fences/earthworks (UN-250x:040 and 041) and that drilling site F is only a few dozens of meters away from the western fence/earthwork. It is important that the earthworks will be clearly labeled or fenced off during construction in the area. It will be necessary to locate pipes from drilling site A as far from the cultural protected area as possible. The western edge of the protected area should also be fenced off in consultation with the Agency to prevent unintentional disruptions of cultural remains. During construction it is required to label cairn (UN-250x:094) in the vicinity drilling site O. The Cultural Heritage Agency believes that the impact of the proposed project in the geothermal utilisation area of Theistareykir power plant will be primarily be visual impact and thereby the value of experiencing the remains of the old Theistareykir farm. Many structures that will rise close to the farm mound must have an impact on people's experience of the ruins of a farm which was located far from other settlements until now, in a remote and pristine place. It needs to be considered to keep construction as far from the farmstead as possible and also it should be considered whether it is possible for example, to bury pipes where they are planned closest to the farm.

The developer notes that when choosing location of the proposed building sites, drill pads and service roads account has been taken of registered cultural remains in geothermal utilisation area at Theistareykir. The intention is to follow the pipelines that are presented in the EIA report, and that pipes in the vicinity of the Theistareykir farm be on the surface. The Cultural Heritage Agency will be

consulted on labeling during construction and permissions applied for if disturbance of cultural remains is required.

The Planning Agency supports the Cultural Heritage Agency note on the need of earthworks outside the cultural protected area at Theistareykir be clearly labeled or fenced off during the construction in the area so the remains will not be disrupted. Also, that pipes from drilling sites A, D and N and possibly the reinjection pipe to THG-02, should be located as far away from the cultural protected area as possible. According to the figure 135 in the EIA report it should be possible to move the pipeline up to 50 meters further west than shown. Then the western edge of the protected area should be fenced off to prevent unintentional disruptions of cultural remains. The Planning Agency also aggrees with the Cultural Heritage Agency tha impact of the proposed project Theistareykir will primarily be visual impact and thereby the value of experiencing the remains of the old Theistareykir farm where many structures will rise close to the farm mound. The negative impact can preferably be reduced by locating structures as far from the cultural protected area as possible and that pipelines near the western edge of farm mound should be buried needs to be set as a conditions for permits for the project. Moreover, a condition must be set that Cultural Heritage Agency will be sent all further registration of cultural remains at risk of being disrupted and a permit applied for when the disruption is inevitable. The Planning Agency points out the necessity of a represetand of the Cultural Heritage Agency checking on all the labeling of cultural remains, which will be carried out in order to avoid unneccesary disruption of cultural remains before construction starts in the vicinity of the respective cultural protected area and his recommendation should be complied to.

The Planning Agency believes that although cultural remains at Theistareykir are not will not be directly disrupted that impact in the area will be somwhat negative, but not insignificant as stated in the EIA report, due to the effect that structures will have on the experience those tha visit the old deserted farm. It is also noted that the risk that changes in surface activity caused by geothermal utilisation, could affect the cultural protected area at Theistareykir, is subject to uncertainty. The possibility of changes in surface activity, due to geothermal utilisation, extending into the cultural protected area needs to be be monitored.

3.4.2 Impact of access road

In the Cultural Heritage Agency‘s comment on the proposed access road was criticized that in the initial EIA report‘s discussion on cultural remains, only cultural remains which were registered in 2008 are included but it failes to report cultural remains that had been registered earlyer.

The developer corrected this and sought further comments of the Cultural Heritage Agency on addional data outlined in the EIA report. It shows that of 32 registerd remains in the vicinity of the proposed access road 24 are within 150 m from its center line and therefore beeing in grave danger due to road construction. These remains are 19 cairns, three trails / tracks, one ruin and one bridge. Most are located on the section between Hoskuldsvatn and Hofureidarmuli where the impact will be locally considerably negative because cultural remains will be disrupted or destroyed. In other sections of the access road road the impact will be insignificant. As a mitigative measure cultural remains near the proposed route of the access raod will be labeled and fenced off, to reduce the risk of destroying cultural remains during construction.

In a further comment the Cultural Heritage Agency stated that 3 trails need to be measured and if disrupting can not be avoided a permit must be applied for to the Cultural Heritage Agency. For preventive reasons the bridge (UN-313: 192) needs to labeled and most of the cairns, or contractors made aware of them, but 3- 4 cairns will inevitably be covered by the road and permit must be applied for to the Cultural Heritage Agency to disrupt them.

The Planning Agency believes that construction of a road between Husavik and Theistareykir according route A will have a somewhat negative impact on cultural remains because some cairns will be disrupted and also possibly old trails, especially between Hoskuldsvatn and Hofudreidarmuli. A

number of cairns in this region also need to be labeled to ensure that they will not be disrupted. Furthermore, the old trail close to the outskirts of Husavik town (UN-313: 191) is at high risk because of the proximity to the road and a trail south of Hoskuldsvatn (UN-322: 086) at some risk, since it lies close to the road. Together the trails and cairns form a historical context of a route between Husavik and Kelduhverfi as well as Theistareykir, which is worth protecting as coherent as possible.

3.4.3 Impact of Quarrying

In a comment of the Cultural Heritage Agency on quarrying it is pointed out that the initial EIA report does not specifically address the potential impact of quarrying on cultural remains but according to the available data it may be assumed that registered cultural remains may be at risk at quarries RHN-5 and RHN-6. The impact on cultural rermains from quarrying at these sites must be assessed and the results should be reported to the Cultural Heritage Agency.

According to the EIA report an archeological survey that was conducted on behalf of the developer at sites proposed for quarrying. Cultural remains were discovered at three of them, RHN-5, 6-RHN and RHN-10/11, a total of four remains and all of them cairns. It is stated that they all have in common that their role is unknown and all are at high risk due to the proposed quarrying. The developer states that if the quarries RHN-5, 6-RHN and RHN-10/11 will be utilised the National Heritage Agency will be consulted.

The National Planning Agency agrees that it is important that the developer consults the National Heritage Agency at early stages if the the quarries RHN-5, 6-RHN and RHN-10/11 are to be utilised and that the required licenses are applied for as appropriate.

3.5 Impact on flora and fauna

3.5.1 Impact on flora

3.5.1.1 Impact in geothermal utilisation area

In the EIA report the result is revealed that consierable uncertainty is on impact of the proposed project on geothermal plants in Theistareykir. Wetland is a rare vegetation type within the construction area, but as impact is neither expected to occur on wetland sites close to Ketilfjall mountain nor in the vicinty of the access road, impact on wetland is believed to be insignificant. There remains an uncertainty regarding impact from hydrogene sulfide (H_2S) on sensitive vegetation in closest vicinity to the power station during operation of the power plant and tolerance limits of vegetation against H_2S are not known.

It is stated that the goethermal utilisation area is mainly vegetated land and shrubby heathland vegetation is predominant, but other vegetation types which the power plant structures will affect i.e. buildings, drilling pads, roads, pipelines and quarries, is mainly grassland and heather heathland. On the planes close to the deserted farm at Theistareykir and on the slopes of Bæjarfjall, Ketilfjall and other mountains, considerably diverse landscape character can be found, flora is diverse, cultural remains apparent and hot springs prominent. Several warm spots with hot spring mud, but in those spots and close vicinity there could possibly be a growing conditions for rare geothermal plants such as *nadurtunga*, which has been found in the area and does only grow where geothermal heat is found. Other species which have been identified in warm soil at Theistareykir is *blakolla* and *dwarf type of graedisura*, but these species are fairly common at a low altitude in some of the warmest areas of the country, but are only found close to geothermal areas inland, with higher altitude. Also, for the first time, the species *villilin* has been found in the Theistareykir area and it is believed that the geothermal heat creates conditions for the species to evelove seed.

It is stated that specialists from the Icelandic Institute of Natural History (IINH) believe that at all locations where warm spots are found in Theistareykir, it can be expected that rare geothermal vegetation can exist. Therefore a large areas has been defined and two other smaller areas, on a

vegetation map, where geothermal plants are found or it is likely that they can have the conditions to thrive. The IINH recommends that these sites should be protected from further disruption and also as much as possible from the impact of hydrogene sulfide in steam emission from boreholes. It is not possible to move all construction arrangements away from the defined areas and therefore there remains a risk that during construction the growth spots of the species *nadurtunga* and more geothermal species will be disrupted. This applies to the following parts of the constructions:

Drilling pad H, road/track and pipeline route towards the drilling pad is close to a warm spot by the middle of Ketilfjall slope. The westernmost part of drilling pad A will be located close to Hitur area. Pipeline and track from drilling pads D and N will cross the Hitur area. Part of the access road will run close to Hitur site and cross the southern most part of Tjarnaras.

It is stated that up to 73 ha ofshrubby heathland, 10 ha of heather heathland and 10 ha of grassland could be disrupted as a result of the proposed project.

Wetland is located at three small spots, less than 1 ha, by the roots of Ketilfjall mountain. One spot of wetland is very close to drilling pad H and a pipeline and track from the drilling pad will run through the edge of another wetland spot, located further south.

In the Environment Agency‘s comment on Theistareykir power plant and also on the joint impact assessment it is stated that it should be expected that discharge during drilling from all drilling pads will be diverted to shallow sinkholes if it will not be possible to divert it to fractures which can cope with the predicted amount of discharge. It is not considered acceptible that discharge from the proposed wells will be directed to surrounding channels, as that would result in danger of scaling from the water and that could have negative impact on vegetation and the visual appearence could be highly unacceptible. It is also important to monitor the function of sinkholes or fractues as a receptor, during testing and drilling, and actions will be put forward if it looks as they will not cope with the amount of geothermal water. Surface discharge during drilling and testing of wells should not be practised.

The developer points out that he cannot accept that surface discharge during testing or drilling of wells will not be allowed. Where the bedrock by drilling pads is not too dense the discharge from drilling and later on testing of wells, will be released to fractures or shallow sinkholes. Where that will not be possible the discharge from well testing has been diverted through plastic pipes towards a natural channel, that includes natural geothermal water and rain water from a hot spring area, and runs to the pond at Tjarnaras. The discharge water from wells includes small amount of minerals that could cause scaling. Inspection bodies and licensors will be consulted during the licensing process regarding more detailed arrangement of release of discharge water from drilling pads. Most exploration wells that have been drilled include high proportion of steam and fluid release has therefore been little from wells during testing and scaling in channels barely visible. Discharge from well during testing is geothermal water and chemical composition and temperature according to that could cause scaling.

In the Environment Agency comments it is pointed out that as wetland is limited in the aera it is important not to disrupt wetland sites by Ketilfjall and it should be explored if there is possible risk of pollution and/or disruptance on wetland sitesfrom drilling pad H.

The developer states that special care will be taken neither to disrupt the wetland site nor divert discharge water from boreholes to the site.

In the Environment Agency comments it is pointed out that is must be ensured that no disruption will take place on sensitive habitats of *nadurtuna*, which besides Iceland is only found in Azorislands and is rare on a country scale and on a red list of threatened species, *blakolla*, dwarf type of *dvergsura* and *villilin* that are not common in Northeast Iceland. It is necessary that habitats of red listed threatened species will be delimited. It does apply in particular to the construction period and it will need to be followed-through that those habitats will not be disrupted.

The developer points out that as wetland spots by Ketilfjall and near the access road will presumably not be disrupted during construction, the impact on that vegetation type, which is rare within the construction area, believed to be insignificant.

In the Environment Agency comments the Agency refers to Reykjavik Energy researches which show that chemical pollution, hot steam and hot water can cause mosses and plants to be damaged. Also that mercury, sulphure, arsen and boron can accumulate in vegetation close to wells and other structures that release steam/hot water. It is clear that sensitive vegetation located close to proposed drilling pads and other structures that release steam can be affected. Vegetation protection limits have not been defined but it is important to monitor vegetation succession in the construction area and react if negative impact will be visible. Outside the industrial area the stipulations of regulation no. 514/2010 on concentration of hydrogene sulfide in air do apply.

The developer points out that it is possible that geothermal water and steam from testing of wells will have temporary impact on vegetation during testing of new production wells. During operation there remains uncertainty on impact of hydrogene sulfide (H_2S) on sensitive vegetation in closest vicinity to the power station as vegetation protection limits against H_2S are not known. Changes of vegetation will be monitored in consultation with experts and inspection bodies.

In the Environment Agency comments on the joint impact assessment it is pointed out that a special attention should be on changes of surface activity at Theistareykir as such changes can cause negative impact/undesirable impact on *nadurtunga* habitat and mitigative actions will need to be taken if necessary.

The developer points out that changes of surface activity in the geothermal area will be monitored after the plant becomes operational.

The **Planning Agency** says it is clear that construction of the power plant will almost all take place on vegetated land. That is mainly shrubby heathland and other common vegetation types, along with grassland which is partly an old cultivated land. Main structures, such as drilling pads, roads, pipelines and buildings will in almost all cases be located outside the area that has the highest conservation value as growing sites of geothermal plants. The developer believes that impact on flora will be insignificant but when construction disrupts vegetation on a total of 90 ha of land, the Planning Agency believes that impact on flora will be somewhat negative.

The Planning Agency agrees with the Environment Agency opinion that it is not acceptable to release discharge water on the surface neither during drilling nor testing of wells, even though natural channels are available in the area. The discharge that would flow on surface could cause negative impact on vegetation due to sediment content, scaling, chemical composition or temperature. The value of the hot spring area and the closest vicinity is based on its own natural evolution and any intervention of natural surface processes, even though it lasts for a short period of time, should be limited as possible. Intervening the area by large structures does not justify that impact on smaller scale features is acceptable. Interplay of geothermal activity and vegetation is part of the uniqueness of geothermal areas, which has conservation- and research value, and should be protected. The Planning Agency believes that in the same way that pipes can be laid for drilling water towards drilling pads the discharge water can be diverted towards an acceptable reinjection site, fracture, borehole or shallow sinkhole and the same applies to discharge from wells during testing. When drilling, the practise has been to lay plastic pipes on surface for drilling water when temporary water usage is needed. It is preferabel to lay permenanent pipelines in road shoulders and temporary pipelines should be laid next to roads as pipes that lay for several months on vegetated land can cause impact on vegetation, which could take a long time to recover. With regard to visual impact it is also preferable that surface pipes will not be laid shortest distance across the land. The Planning Agency believes that a conditon must be set in development consent on that discharge from drilling will be diverted in pipes towards reinjection site, shallow sinkhole, fracture or borehole and the same applies to discharge from testing of wells.

The Planning Agency agrees with the opinion of the Environment Agency that it is necessary that habitats of red listed of threatened species will be delimited in consultation with the Environment Agency. In that consultation it will be decided how the delimiting will take place (fences/signs/in tenders/on schedule drafts etc.). The Planning Agency points out that it is stated in the expert report from IINH that vegetation at Theistareykir is very diverse and rare geothermal plants are found in small spots which cannot be identified on a vegetation map. It is pointed out that nadurtunga grows only in warm soil where hot steam is prevailing and if natural geothermal areas dry up and cool down all species will be lost. Therefore it is the duty of all bodies related to construction at Theistareykir to avoid any damage to habitat of nadurtunga. The IINH recommends that a special notice will be taken of species diversity in Theistareykir and the Plannig Agency agrees.

The Planning Agency points out that wetland is found in the area at very limited spots by Ketilfjall and it is very important that constructions will be in the way that the wetland and water reservoir will not be disrupted. To ensure the protection of the wetland it must be fenced off, so everybody working on the construction, is made clear where limits cannot be crossed. The development consent must clearly state that wetland by Ketilfjall will be fenced off.

The Planning Agency agees with the Environment Agency opinion that by refering to Reykavik Energy researches it is clear that even though chemical composition of emission from wells and from the proposed power plant will be different from the situation in Hellisheidi, sensitive vegetation in close vicinity to proposed drilling pads and other structures that release steam, can be affected by chemical pollution. Even though no vegetation protection limits have been defined it is important to monitor vegetation succession in the construction area and react if negative impact become visible. Also it must be ensured with appropriate equipment that as little moisture as possible will be in steam mufflers when testing new wells. Where uncertainty remains on impact of hydrogene sulfide (H_2S) on sensitive vegetation in close vicinity to the power station, changes on vegetation will be monitored. Experts and inspection bodies will be consulted, which means that well a founded plan on monitoring of possible impact of H_2S on vegetation will be made.

The Planning Agency agrees with the Environment Agency opinion regarding a special inspection must take place on the changes of surface activity in Theistareykir that can be caused by the power plant as such a change could result in negative/undesirable impact on vegetation and not only on red listed threatened species habitats. Increased surface acitivity can also create conditions or habitats for heat dependent species. Inspection of changes to vegetation is connected to monitoring of impact of the geothermal utilisation on surface activity, which is discussed along with possible mitigation measures in chapter 3.3.

3.5.1.2 Impact of road construction

In the EIA report it is stated that the vegetation type by the proposed access road, alternative A, within the power plant site and to the west towards Skildingaholl, is continuous shrubby heathland on lavafield. From Skildingaholl towards Hofudreidarmuli the land is scarcely vegetated, mainly heather heathland and larger parts with little or no vegetation or unvegetated lava field. Shrubby heathland is prominent at the bottom of slopes and grassland in spots spread around the area. From Hoskuldsvatn lake to Husavik about third of the road route is fully vegetated lava field and around 20 % has diminished vegetation. On about 2 km section west of the Theistareykir hut, the road will be laid close to Hitur and over southern part of Tjarnaras where geothermal plants may possibly grow. It is stated that the area of land that will be disrupted by the road construtions outside the energy utilisation area will be more than 90 ha from which 45 ha will be shrubby/heather heathland, around 35 ha scarcely or not vegetated and around 10 ha reclaimed land covered with pine wood and lupine.

The Planning Agency believes that despite of the fact that the flora that will be disrupted does not have conservation value, a considerable amount of vegetated land, around 90 ha, will be directly

affected by the construction of an access road and therefore the Planning Agency believes that impact on flora will be somewhat negative.

3.5.2 Impact on fauna

3.5.2.1 Impact on birds

In the EIA report it is stated that during construction it is believed that birds can be negatively affected, temporary and locally due to noise, incresed traffic, heavy machinery traffic and due to disruptance of habitats and nesting grounds, mainly at previously undisturbed areas. During operation the impact on nesting ground and life expectancy of birds is considered to be insignificant. It is believed that birds will move away from older nesting grounds and to find new ones further away from construction area. Access road and improved access to Theistareykir could although possibly increase the stress on the ptarmigan species which could result in indirect impact on life expectancy of falcon. Overall, researches have revealed that species diversity and density of birds in the energy utilisation area and on proposed road route is little.

In the Environment Agency comments it is pointed out that it is uncertain that impact on birds will be only temporary as it is foreseen that steam will rise from the proposed plant and there will be both traffic and noise pollution. Nothing is mentioned on possible impact from well testing, but they are usually tested for several months in a row and also there will be need for mainaenance wells. Therefore there should have been discussion on impact on birds during operation. Road alternative A runs close to falcon nesting grounds and the Agency believes it to be necessary to take notice of that fact as the falcon is on a red list of threatened species and protected. The nesting grounds of falcon that has most frequently been used will both be close to the proposed road and also visible and chanses of disturbance of falcon nesting in these areas will increase significantly.

The developer points out that it is a possibility that falcon will stop using some of the nesting grounds due to disturbance, but it is not foreseen that constructions will have impact on life expectancy of falcon. It is important to inspect and monitor falcons nesting in construction areas and arrange construction time so that it will have as little impact as possible, if nests are located close to construction areas. When the power plant is operational it is estimated that maintenance drilling will need to take place every 2-4 years and impact of that on birds during operation of the power plant is believed to be insignificant.

The Planning Agency accepts that birds can be somewhat negatively, temporary and locally affected due to noise, increased traffic, heavy machinery traffic and due to disruptance of habitats and nesting grounds from disruptance, mainly at previously undisturbed areas. It is most likely that this disruptance will take place during construction, mainly if birds will be disturbed during nesting. During operation it can also be expected that birds will be affected due to traffic and noise. Construction time and operation time are however not clearly defined periods. It is clear that Theistareykir power plant will be constructed in units, presumably in 50 MW units, and it has not been clarified when construction of the plant will be finalised. From start of operation there can also be ongoing construction work perhaps with pauses for decades. Therefore it may be expected that long term impact on birds could be more than if construction work lasts only for few years and will overall be somewhat negative. The Agency believes that the fact that distance from falcon nesting grounds will be 500 or 850 m does not really have the final saying on whether falcon can lay eggs, rather than it would be nuicanse during nesting period. The Agency believes it to be important that with regard to nesting of falcon, construction of access road should be outside the nesting period. Increased traffic close to a nesting ground could also have negative impact and it is important that falcon habitat will be monitored in the vicinity to construction areas as proposed by the developer.

3.5.2.2 Impact on biota of pond

In the EIA report no discussion is on biota of a pond by Tjarnaras where a proposal is made to release temporary discharge.

In the Environment Agency comments it is stated that it is unacceptable that the plan is to divert discharge from drilling to a natural pond without any assessment of amount of discharge water during drilling and chemical composition of the discharge water. A discussion is missing on possible impact on biota of pond.

The developer states that it is planned to research the boita of the pond before constructions on Theistareykir power plant start. It is restated that testing of wells will be kept as short as possible to reduce the release of geothermal water into the pond as much as possible.

The Planning Agency refers to discussion on release of discharge water in chapter no. 3.5.1.1 on flora.

3.5.2.3 Impact on land invertebrates

In the EIA report it is stated that during consruction there will be considerable, negative and local impact on common invertebrates due to disruption or where land will be covered with gravel when constructing drilling pads, tracks and roads. It is estimated that impact on a rare snail, Vallonia excentrica, which is dependent of geothermal heat, will be insignificant as the sites where it is found is all within the local protection areas, but no disruption from proposed construction will be within those areas. Impact on land invertebrates during operation is considered to be insignificant.

The National Planning Agency agrees that considerable negative and local impact will occur on common invertebrates due to disruptance of land. It is pointed out that changes to surface activity which could be caused by the utilisation, could have negative/undesireble impact on invertebrates. A reference is made to chapter on flora and if monitoring reveals that geothermal energy utilisation will have undesirable impact on vegetation it is likely that impact will also occur on invertebrates and mitigation measures for plant protection will also benefit invertebrates.

3.5.3 Impact on biodiversity in hot springs

In the EIA report it is stated that biodiversity in hot springs at Theistareykir is relatively unique, as freqency of previously undiscoverd species is very high and relationship percentage low. It is presumed that areas of geothermal surface activity will not be disturbed by the proposed project, which is in conformity with the regional plan strategy and Icelands official strategy on implementation of the agreement on biodiversity. If the proposed geothermal utilisation will cause changes to surface activity, biodiversity in and around hot springs can possibly be affected. However, it is believed that changes of the hot spring area due to geothermal utilisation will not be more than expected to occur by natural causes and even considerably less or similar to annual fluctations. Therefore the impact of the proposed geothermal utilisation on biodiversity in hot springs in Theistareykir is believed to be insignificant and no mitigation measures are proposed.

The National Planning Agency agrees that when locating the proposed project, sites with active surface activity will not be disrupted. With regard to the regional plan strategy and Icelands strategy on implementation of the agreement on biodiversity it is clear that changes to the hot spring area, due to geothermal utilisation, will not comply with these strategies. Biodiversity in hot springs at Theistareykir is relatively unique due to high freqency of previously undiscoverd species and low relationship percentage. Uncertainty on if and which changes will occur on geothermal surface activity as a result of geothermal utilisation, is so high that it cannot be reasonably argued that impact on microorganism in hot springs will be insignificant. A reference is made to further discussion on changes and impact on surface activity in chapter on impact on geology.

3.6 Impact on groundwater and surface water

It is stated in the EIA report that impact of the power plant and the access road on water reservoirs or freshwater springs in Kelduhverfi will be insignificant. Use of water for the power plant is believed to have insignifiacant impact on groundwater. It is stated that average chemical composition of main elements in water from geothermal wells in Theistareykir will be under potable water limits according to regulation, unless for boron and aluminum. Amount of trace elements is low and with regard to impact from that on ecology the risk of impact is believed to be minimal or none for all elements. It is stated that geothermal water from the power plant will be reinjected into shallow wells at a depth of 200-300 m. According to dispersion calculations it is believed that concentration of elements in around 2 km distance from reinjenction wells will be less than 10% of original concentration of elements in the geothermal water and almost not detectable. The reinjection into shallow wells will not benefit the goethermal system and will have insignificant impact on the system. According to planned reinjection arrangement, chances of scaling from geothermal water is believed to be minimal. It is pointed out that geothermal effects are found in highest levels of groundwater in Theistareykir and by Lon in Kelduhverfi there are spots where the groundwater temperature is 10°C. It is also stated that the groundwater flow to Lon in Kelduhverfi is expected to be 20-30 m^3/s (calculated 29 m^3/s). Reinjection of geothermal water will have somewhat local, negative impact on groundwater closest to reinjection wells.

It is stated that temporary discharge of discharge water from drilling and testing of wells will be in the way that water will be diverted in a channel, through fractures or shallow sinkholes, based on local condition at each site.

Monitoring of discharge will be carried out by recording the amount and chemical composition of geothermal water. A regular inspection will be made of chemical and isotopic composition of water in the groundwater system at Theistareykir.

In comments from the the Health Inspectorate of NE-Iceland it is pointed out that part of the proposed acces road to the power plant area will run through a water protection zone of Husavik town water reservoir, from Hofudreidarmuli and down to the water reservoir by lake Botsvatn. Quarries RHN-1 and RHN-5 are also located within water protection zones. It is necessary to assess the risk during construction and operation of the road and discuss possible mitigation measures to protect the water reservoir.

The developer points out that he will follow current rules on constructions in water protection zones in consulation with the the Health Inspectorate . When applying for licences an assessment will be made whether there will be any risk of polluting the water reservoir due to construction and traffic. The developer will put forward conditions and requirements to contractors regarding environmental – and safety issues and in an action – and emergency plan the contractor will need to describe actions if pollution occurs in the water protection zone.

It is stated that Vatnaskil consulting engineers have used groundwater- and flow model for Northeast Iceland to calculate possible impact on Husavik water reservoir. According to the groundwater model, quarries and proposed access road are located outside the water basin of the water reservoir.

In the Environment Agency comments on Theistareykir power plant and joint impact assessment it is stated that it is unacceptable that dicharge from the proposed production wells will be diverted through channels, neither when drilling nor testing of wells, as there is a risk of scaling from the water and that will have negative impact on vegetation and negative visual impact.

The developer points out that he cannot accept that surface disposal of discarge water when drilling or testing of wells will not be possible.

In the Envinment Agency comments it is pointed out that disposal of discharge water from geothermal power plants has been a greater problem than initally expected, both in Hellisheidi and in Svartsengi.

Therefore a trustworthy system will need to be at hand for temporary discharge at each given time to gather possible maximum temporary discharge, as it is clearly stated in the initial EIA report that surface discharge will never be an option.

The developer emhasises that the aim is that reinjection wells will be drilled at the same tima as production wells for Theistareykir power plant and that shallow reinjection of geothermal water will start as soon as the power plant becomes operational. Also, the plan is to locate shallow sinkholes for temporary discharge of geothermal water from the power plant, which could last for hours or days.

The National Planning Agency believes that results from the groundwater model reveal that the proposed road and quarriying for its construction will be south of the groundwater basin of Husavik water reservoir. Every reason is to be careful within the water protection zones during construction of the access road . With regard to prevailing information the impact of proposed access road construction and quarrying on water reservoir and water protection zone of Husavik will be insignificant.

The Planning Agency agrees with the opinion of the Environment Agency regarding it not be acceptible to release dishcarge water on the surface, further discussion is referred to in the chapter on vegetation.

The Planning Agency points out that in the EIA report it is stated that groundwater flow into Lon in Kelduhverfi is presumed to be 20-30 m^3/s. In comparsion the average flow of Ellidaar river is 5 m^3/s. Groundwater is a resource that needs to be protected as unpolluted as possible and therefore it is important not to change the groundwater flow into Lon, both in case of temperature and chemical composition. Discharge of geothermal water will therfore need to be into wells that have been cased down to 200-300 m, below groundwater table as the developer proposes, to ensure the least possibility of mixing water up to groundwater surface layers. Boreholes for reinjection of geothermal water will need to be located, as proposed, as close to the geothermal area as possible where natural effect from the geothermal system occurs, and ensure that impact north along the groundwater flow will be as little as possible.

The Planning Agency believes that before the power plant becomes operational an outermost requriement is that reinjection wells have been drilled and necessary pipes constructed. At the same time a temporary discharge system must be in place. These are necessary project components that ensure that water will not need to be discharged on surface with the risk of creation of ponds, vegetation and land disruptance, and visual impact from pond and steam. Temporary discharge includes geothermal water to be discharged to surface of groundwater and if that occurs in large proportions, for longer periods of time, it is possible that impact will occur far to the north from the geothermal area, which is undesirable. In licensing processes it is necessary to put forward clear limits on amount of water that can be temporarily discharged and for how many days a year.

The Planning Agency agrees with the developer that impact from discharge of geothermal water will be somewhat negative on groundwater closest to reinjection wells. A part from that, it is not likely that impact on groundwater, water reservoir and freshwater springs in Kelduhverfi will be negative due to water supply for the power plant, constructions and operation of the plant and the access road. It is important that monitoring of chemical composition of groundwater will be in the manner that if undesirable changes will occur in the groundwater, which can be related to operation of the power plant, it will be analysed in time and sufficent measures applied.

The Planning Agency believes that changes in surface activity, that could be caused by utilisation, will need to be monitored as such a change could have negative/undesirable impact on water reservoir in the geothermal area and surroundings. Inspection of changes in water reservoir is connected to monitoring of impact of geothermal utilisation on geological features, surface activity and flora that is further discussed in relevant chapters.

3.7 Impact on air quality

In the EIA report it is stated that main gases in the geothermal steam at Theistareykir are carbon dioxide (CO_2) 77%, hydrogene sulfide (H_2S) 18,9%, nitrogen (N_2) 3,3%, hydrogen (H_2) and methane (CH_4) 0.05%. Total release of geothermal gases from a 200 MW_e geothermal power plant is believed to be 28,960 tonnes a year. From trace elements that are carried with steam, the main concerns relate to mercury (Hg).

Carbon dioxide and methane are greenhouse gases, but despite methane is a much more powerful greenhouse gas than carbon dioxede its release from the proposed geothermal power plant is negligible compared to the release of carbon dioxide. Release of carbon dioxide from the power plant will presumably amount to 0.5% of total release of greenhosue gases in Iceland for the year 2007. Geothermal power plants are however not subject to emisson allowances according to law on emission of greenhouse gases no. 65/2007.

It is stated that the release of hydrogene sulfide to air will increase with geothermal production, but the gas is smelly and toxic in large amounts. It is estimated that annual total release of H_2S will be around 5,500 tonnes. The smell of H_2S can be detected at very low concentration or only 7 µg/m³ and somtimes the threshold criteria for discomfort is around 42-50 µg/m³. International threshold criteria (WHO) for health protection is 150 µg/m³ for 24 hour average. According to calculations there are no chances of 24 hour average of H_2S will reach health protection limits in Husavik town or in Adaldalur and in the impact area of Theistareykir power plant the concentration of H_2S in air will not reach threshold criteria. The developer believes that therefore there is no need for an abatement facilities to remove H_2S from the power plant emission as calculation models tend to over interpret distribution boundaries and concentration of emission. It is recommended that concentration of hydrogene sulfide (H_2S) in air will be regularly measured close to the power plant and inside the power station to monitor if concentration will reach health protection limits and work environment limits. Also, the measurements should be compared to calculated distrubution. In light of results from measurements the frequency of inspection measurements will be decided and further mitigation measures propsed if needed. The result of the EIA report is that impact caused by the release of geothermal gases from Theistareykir power plant, mainly carbon dioxide (CO_2) and hydrogene sulfide (H_2S) will be insignficant.

In comment from the Environment Agency it is pointed out that a new regulation has been published which limits the maximum concentration of hydrogene sulfide to 50µg/m³ on average during 24 hours. It is pointed out that total annual release from Theistareykir power plant, Krafla power plant (current), Krafla power plant II and Bjarnarflag power plant, will be around 29,600 tonnes, which is considerably more than Hellisheidi and Nesjavellir power plants released combined in the year 2008, but release from those power plants has caused considerable nuicance for inhabitants in the capital area such as odour pollution and incresed oxidation on electrical equipment. Populated areas in the capital area are located around 20-30 km away from Hellisheidi power plant. The above mentioned geothermal power plants in Northeast Iceland are located within 30 km from the settlement in Reykjahlid.

The developer points out that results from air dispersion calculations, according to regulation no. 514/2010, from Theistareykir power plant along with current power plants on Northeast Iceland are the following:

- Probabilities of that running 24 hour average of H_2S will pass 50 µg/m³ are none in Husavik, Adaldalur and Kelduhverfi if a 200 MW_e Theistareykir power plant will be added to current power plants in Northeast Iceland.
- Annual average concentration will not reach 5 µg/m³ except in close vicinity of the 200 MW Theistareykir power plant.
- The impact area of Theistareykir power plant will not reach lake Myvatn.

It is not believed to be necessary to remove hydrogene sulfide from Theistareykir power plant emission. The developer will however ensure that concentration of hydrogene sulfide in air will be within environmental limits in laws and regulations. If concentration will pass the health protection limits in populated areas, special mitigation measures will be made, for example cleaning of the power plant emission.

In the Enviroment Agency comments, a special request is made on information on highest hourly values which have come up in dispersion calculations for Reykjahlid, Husavik and Kelduhverfi, which are closest to the power plant sites for all seven incidents that were examined and it is pointed out that regulation on concentration of hydrogene sulfide in air no 514/2010 is ment to protect public health. In comments made for joint EIA it is also pointed out that it has happened that concentration of H_2S close to power plants in Iceland has passed 15 minutes threshold criteria of the Administration of Occupational Safety and Health and therefore the concentration which tourists could experience close to the power plant or testing wells will need to be explored further.

The developer points out that maximum limits, as the Environment Agency points out, would give misleading image of possible impact. Also, maximum limits are never used when comparing to criteria in the EIA chapter. Therefore it would be normal and sufficient to assess environmental impact with regard to requirements and environmental limits put forward in new regulation on concentration of hydrogene sulfide in air. Stipulations of regulations will be fulfilled with regard to emission limits and air quality.

In the Environment Agency comments it is pointed out that in discussion on baseline situation of air it is stated that regarding trace elements, that are carried with steam, the main concerns relate to mercury (Hg). More detailed information on possible environmental impact of mercury need to be provided and in particular which amount will presumably be carried with geothermal steam.

The developer points out that there are almost no possibilities that mercury can be carried with steam from cooling towers, wherefrom emission of noncondensible geothermal gases will occur. Mercury is found only in water saturated steam.

The Planning Agency believes that impact due to hydrogen sulfide (H_2S) is the aspect that could have most negative impact on air quality. The Planning Agency believes that impact from H_2S will be insignificant in populated areas in Adaldalur, Kelduhverfi and Husavik and believes it neither to be necessary to put up measuring stations in and around populated areas nor an abatement facilities for hydrogen sulfide emmited from the power plant. The Planning Agency emphasises that the consentration of hydrogen sulfide in air will be measured on a regular basis in close proximity to the power plant and inside the power station as planned by the developer. That will be done to monitor if the consentration will reach health protection limits and labour protection limits. Chapter on flora discusses possible impact from H_2S on sensitive vegetation.

3.8 Status of plans and licenses

Regarding status of plans and licensing for Theistareykir power plant the Planning Agency points out the following:

Proposed project is in conformity with the Regional plan for gethermal sites in Thingeyjarsyslur 2007-2025 which was accepted by the minister for the environment January 16th 2008.

Municipal plan for Thingeyjarsveit is in progress. The Planning Agency points out that in the Regional plan for gethermal sites in Thingeyjarsyslur 2007-2025 it is stated: ”When more detailed results have been gathered, based on, amongst others, results of exploration wells, the boundaries of the energy utilisation area will need to be redefined in the municipal plan with regard to exploration wells aiming at minimising the volume of buildings and structures. A special focus should be on minimising the energy utilisation area east of Ketilfjall and on Theistareykir lavafield.”

Construction of Theistareykir power plant access road from municipal boundaries by Saeluhusmuli, north of Hofudreidarmuli and onwards to Husavik town, is in conformity with municipal plan of Husavik town 2005-2025, which was accepted by the minister for the environment on December 1st 2006 and change that was accepted by the minister for the environment March 31st2010.

Municipal plan of Nordurthing 2010-2030 has been advertised, in accordance with article 18 of planning and building law no. 73/1997 (now 123/2010), that started on October 28th and deadline for comments is to December 19th 2010.

The project is subject to development consent from Nordurthing and Thingeyjarsveit municipalities according to article 27 of planning and building act no. 73/1997 (now 123/2010) and a building permit according to article 43 of planning and building act.

The project is subject to operation permit for operations that can cause pollution from the Health Inspectorate of NE-Iceland according to regulation no. 785/1999 on operation license for industries that can cause pollution.

The project is subject to a power development license to construct and operate Theistareykir power plant, granted by National Energy Authority according to paragraph 1, article 4 according to stipulation in article 32 no. 65/2003 on electric power.

If cultural remains will need to be disrupted a permit from the Cultural Heritage Agency is needed in accordance with law on cultural remains no 107/2001 before the action takes place.

Before development consent is issued the developer must provide a plan on quarrying in accordance with law on nature conservation no. 44/1999 where magnitude, type of material, production period and finishing of site is described.

The Planning Agency points out that if holders of quarries want to utilise material from quarries where mining was started before July 1st 1999, or open new quarries related to other projects than the ones that are part of the joint impact assessment, that will count for as an indipendent project, which would be subject to law on EIA no. 106/2000 if its size will reach threshold criteria defined in annex 1 and 2 of the law.

The Planning Agency points out that if changes will be made on the proposed project, it will need to be notified to the Planning Agency in accordance with article 6 of law on EIA no. 106/2000 with reference to clause 13 a in annex 2 of the law.

4. Planning Agency conclusion

With reference to article 11 in the law on environmental impact assessment no. 106/2000 and article 24 of regulation no 1123/2005 on environmental impact assessment the Planning Agency has reviewed the EIA report from Theistareykir ehf., which was put forward in accordance with article 10 of the same law. The EIA report from the developer was based on the previously advertised initial EIA report, statements and comments received during the initial EIA report review period along with Theistareykir ehf. answers to comments.

The Planning Agency believes that the Theistareykir ehf. EIA report does fulfill requirements put forward in law and regulations on environmental impact assessment regarding the issues stated in article 18 of regulation no. 1123/2005. The Planning Agency believes that statements and comments received during the review process are sufficiently addressed and also the answers to the comments.

Impacts on geothermal system and on geothermal energy resource. The Planning Agency believes it is clear that in the EIA process the developer should address possible impact of utilazing the geothermal resource and if the energy utilisation will be sustainable and what is the possible impact of the utilisation on the renewability of the resource. The Planning Agency believes that a sustainable utilisation is met when production is in balance with natural renewability of the geothermal system with energy- and mass flow from its outward margins. In that manner it would be possible to maintain unchanged energy utilisation from the system for a long period of time (100-300 years) as stated in the EIA report. According to the EIA report a sustainable utilisation of the geothermal energy resource will be ensured by increasing the utilisation gradually in units. In that respect the developer has decided that the utilisation will not be aggressive i.e. it is estimated that the utilisation will not be on the level that it needs to be stopped after 30-40 years for up to 50 years or it needs to be significantly reduced in order to rest the geothermal system. The Planning Agency believes that this goal, to keep the energy utilisation within sustainable limits, is positive but it is difficult to see how that goal will be achieved referring to how intense the proposed energy utilisation is presented and also with regard to the information put forward in the EIA report on that sustainable energy utilization from geothermal systems is unknown when energy utilisation commences. However, production potential can be estimated based on prevailing data on internal type and nature of the geothermal systems and data on how they respond to energy utilisation. Such estimations will be more reliable parallel to more experience of the energy utilisation of the geothermal system concerned. It is clear that no energy utilisation experience is currently in Theistareykir geothermal area and therefore no prevailing assessment of sustainable energy utilisation capacity from the geothermal system is available. It has been accepted that it is not possible to predict sustainability based on the volumetric assessment which is used to estimate how much energy is contained in the bedrock and groundwater of the geothermal system and how large part of that can be used for geothermal utilisation in given time. According to findings of the methodology it is possible that a production capacity of 200 MW_e can only be maintained for 40 years. After that the utilisation will need to be reduced and possibly the production will need to be paused to enable the geothermal system to recover. The Planning Agency believes that such utilisation will need to be looked at as an aggressive one but not sustainable with regard to the above discussion and among others with regard to above definition of sustainable utilisation of geothermal energy. Such an aggressive production can, according to the Planning Agency, lead to that increasing pressure will be on enlarging the energy utilisation area to increase the production or meet the decreased performance of boreholes in order to keep the electricity production unchanged. In addition an aggressive production is, according the Planning Agency, meant to increase the colonisation by the energy companies of new and often untouched geothermal areas, but it is clear that geothermal areas are a limited resource and unique on a global scale. In both cases there will be possible negative impact on protected areas, geological features, landscape, flora and birds along with impact on outdoor activity and tourism. Furthermore, there are prevailing clues that

the upflow zone in Theistareykir could be narrow and therefore the Planning Agency points out that the energy utilisation area put forward in the EIA report does maybe not support the amount of energy that is hoped for.

With regard to the previous discussion the Plannig Agency believes it is not possible to put forward a realistic evaluation on impact of 200 MW_e Theistareykir power plant on geothermal heat as a resource. The main reason is that the power plant put forward is too large according to prevailing knowledge and therefore too high hopes have been built up regarding estimated electricity production. It is pointed out that the proposed Theistareykir power plant is 20 times larger than the criteria put forward on what size of geothermal power plants are subject to EIA with regard to annex 1 in law on environmental impact assessment. That criterion is presumably, mainly presented taking into consideration the uncertainty of impact on the geothermal resource resulting from geothermal power production.

Based on previous dicsussion the Planning Agency believes that a significant uncertainty prevails on what will be the impact of the proposed 200 MW_e power plant on the geothermal energy resource and it is more likely than not with a power plant of that size, that the energy utilisation will not be sustainable.

Visual impact and impact on landscape, conservation value, outdoor activity and tourism. The Planning Agency believes it cannot be escaped, with regard to visual attributes, landscape impact and impact on tourism including noise, that overall impact of a project of the size such as the proposed Theistareykir power plant, will be significantly negative. It does especially apply to the area north of Bæjarfjall mountain where the main geothermal surface activity is apparent and also the remains of the old Theistareykir farm. The area has a high conservation value, mainly in accordance with local protection in the regional plan, protection of cultural remains and nature conservation register. Despite of the developers' intention to locate structures to prevent direct impact on the prevailing remains the overall appearance of the area will change completely with structures that will be located close to protected areas. In addition, a considerable uncertainty remains regarding possible side effects of geothermal utilisation on geothermal surface acitivity in the geothermal area or outside that area and if it will be negative impact.

It should be emphasised that structures will not be spread around the area more than is necessary. In that respect it would be more accaptable that utilisation would be started on drilling pads closest to the powerhouse, but drilling pads O, K, L, N and M would come later as distances to those pads are considerable with visual impact relating from long pipes and roads. During licensing of the project the location of drilling pads L and M must be analysed in order to minimise possible reduction of the landscape unit Theistareykjabunga. Also to reduce visual impact by laying pipes from boreholes in that area underground or use special color or texture to hide the pipes. In the licensing process the conditions must be set that the developer must be required to lay all pipes down from Bondholsskard underground and also pipes west of the old farm remains at Theistareykir. The size of road towards drilling pad F and onwards to Theistareykir hut must also be minimised. It is clear that the proposed access road from Husavik to the power plant site will cause considerably negative impact on the landscape units Theistareykjahraun lava field and Skildinga- and Storavitishraun lavafields, but less impact on other landscape units. It would have been preferred to analyse better other options of road location across the lava fields.

Experience of tourists who want to visit a remote abandoned farm at the border of a unique geothermal area and experience silence and isolation of Theistareykir will change completely. The type of tourism currently visiting the area and part of current recreational activity will not be the same and impact of the proposed power plant on tourism and recreational acitivity will be considerably negative. The area will not be promoted in the future in same way as today. However, the number of tourists may increase due to better transports and access.

Impact on geology. The Planning Agency believes it cannot be avoided that impact on lava due to the proposed project will be considerably negative and significantly negative impact will arise from the construction of Theistareykir access road. Around 110 ha, mainly undisturbed lava fields, will be disrupted but lava is protected under special article in law on nature conservation and conservation of geological formations is also a priority matter according to government strategy. The Planning Agency believes that impact on geothermal surface activity, which can be related to energy utilisation, is a matter of uncertainty. Changes in surface activity can both be positive and negative. Increased surface activity and changes to hot springs can possibly lead to negative impact on biodiversity in hot springs and several plant species. However, those changes can create conditions or ecosystem for heat tolirated species and also have impact on tourism travelling in the area, as powerful geothermal activity can be related to positive experience for tourists. In the Regional plan for Thingeyjarsyslur 2007-2025 an area west and north of Bæjarfjall mountain and reaching slightly up to its side, along with two other smaller sites, are defined as local protection areas with category 1 protection and structures and disruption is not allowed within those areas. Therefore the Planning Agency believes clear that there is no intention to construct in Theistareykir structures or cause disturbance, even though the impact is indirect, within a local protection area with category 1 protection. Plans for intended mitigation measures, drilling in steam pad, water reinjection or/and reduction of production, would presumably need to be made at the start of operation.

Impact on cultural remains. The Planning Agency agrees with comments made by the Cultural Heritage Agency on the importance of defining and labelling cultural remains in order to avoid possible disturbance related to oversights. It is important that construction work will not be too close to the deserted farm at Theistareykir as construction and structures will cause visual impact and impact on the experience value of the cultural remains. Additionally, pipes close to the west boundaries of the old farm will need to be underground and appropriate requriements made in the licensing process. The Planning Agency believes that even though cultural remains in Theistareykir will not be directly affected, impact on the area as a whole will be somewhat negative. It is pointed out that it is uncertain if changes in surface activity can cause impact on the defined areas of cultural remains at Theistareykir and supervising that aspect will need to be part of a monitoring program. In the area between Hoskuldsvatn lake and Hofudreidarmuli the proposed access road can cause somewhat negative impact. Cultural remains will also need to be defined and labelled within the impact area of the access road. A license from the Cultural Heritage Agency will need to be applied for if cultural remains will need to be disrupted.

Impact on flora and fauna. The Planning Agency believes it cannot be avoided that impact on flora of a project of that scale will be somewhat negatvie. The project will eliminate vegetation on 90 ha area and also around 90 ha of semi vegitated land due to access road constructions. The Planning Agency believes it not to be acceptable to perform surface discharge of during drilling or testing of wells as it can have negative effects on flora and fauna in a pond by Tjarnaras, due to silt content, scaling, chemical content or heat. The development consent will need to include conditions on that fluid discharge from drilling and testing period of wells should be diverted in a pipe towards reinjection site, shallow sinkhole, crack or borhole. The Agency agrees with the Environment Agency‘s opinion that it is necessary that red listed threatened species habitats will be delimited in consultation with the Environment Agency as those habitats are found on such a small sections of land that they cannot be identified on vegetation maps. Wetland is apparent in the area but only on small spots by Ketilfjall and to ensure it will be protected it needs to be clearly delimited. The development consent will need to put forward requierments on definition of habitats of red listed threatened species and wetland by Ketilfjall during construction.

The Planning Agency agrees with the Environment Agency comment on that changes on surface activity in Theistareykir possibly caused by utilisation must especially be monitored, as such a change can cause negative/undesirable impact on vegetation and not only on red listed threatened species habitats. If monitoring reveals that geothermal energy utilisation does have undesirable impact on

flora, mitigation measures should be available, such as drilling in steam pads, reinjection or/and reduction of production. It is clear that prevailing uncertainty remains on impact of H_2S on sensitive plants and it will need to be monitored if changes will occur on vegetation due to hydrogen sulfide emission and have action plan available if needed.

The Planning Agency agrees that impact on birds could be somewhat negative, temporary and local during construction, mainly in previously undisturbed areas. The most danger of disturbance is during nesting time but most birds can easilly find new nesting grounds. The most sensitive bird species is probably the falcon and therefore it is important that road constructions close to falcon nesting grounds will not take place during nesting and that occupation of falcon close to the construction area will be monitored.

The Planning Agency points out that despite of uncertainty related to which changes the geothermal utilisation can have on surface activity it cannot be reasonably argued that impact of the proposed plant on biodiversity in hot springs will be insignificant. Changes on geothermal activity could have impact on small invertibrates such as rare snail species (*Vallona excentrica*). Apart from that, impact will be local and considerably negative. A reference is made to further discussion on changes and impact on surface activity in chapter on geology.

Impact on ground- and surface water. The Planning Agency believes it is likely that impact on groundwater, water reservoir and freshwater springs at Husavik or in Kelduhverfi will be insignificant due to water usage for the power plant, structures and operation of the plant and access road. However, it is important to follow general rules that apply to constructions within water protection zone of Husavik. Due to importance of unpolluted groundwater and the large groundwater current running to the north, west of Bæjarfjall mountin and to Lon in Kelduhverfi, it is necessary to monitor chemical composition of the groundwater. If undesirable impact occurs in the groundwater that can be related to the power plant operation, it needs to be analysed timely and an action plan prepared. Surface discharge of water during drilling or testing of wells is not acceptable. Further discussion on that matter is in chapter on flora and fauna. Surveillance on changes to hydorolgy is connected to monitoring of impact of energy utilisation on surface activity and flora which is further discussed in chapters concerned.

Impact on air quality. The Planning Agency believes that impact due to hydrogen sulfide (H_2S) is the factor that could have most negative impact on air quality. The Planning Agency believes that impact from H_2S will be insignificant in populated areas in Adaldalur, Kelduhverfi and Husavik and believes it neither to be necessary to put up measuring stations in and around populated areas nor abatement facilities for hydrogen sulfide from the power plant. The Planning Agency emphasises that the consentration of hydrogen sulfide in air will be measured on a regular basis in close proximity to the power plant and inside the power station as planned by the developer. That will be done to monitor if the concentration will reach health protection limits and labour protection limits. Chapter on flora discusses possible impact from H_2S on sensitive vegetation.

The Planning Agencys believes that the level of environmental impact due the construction of the project and related operation depends on working arrangements and implimentation of mitigation measures presented during the EIA process and monitoring of procedures and impacts during construction and operation periods.

The Planning Agency believes that the following conditions must be set when issuing permits:

- Pipes that Theistareykir ehf. plans from Bondholsskard pass down to the plains, as well as pipes planned west of the Theistareykir farm site, shall be layed underground.
- Teistareykir shall prepare a monitoring program on changes in geothermal surface activity in constultation with the National Energy Authority and the Environment Agency of Iceland. Investigations according to the monitoring program should start as soon as possible and results are to be presented to licensors anually.

- During construction Theistareykir ehf. shall delimit the area where red listed threatened plant species habitats have been detected as well as wetlands beneath the Ketilfjall mountain.

Reykjavik, 24. November 2010

Rut Kristinsdóttir

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