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# Testing the New Geothermal Sustainability Assessment Protocol on Hellisheidi Geothermal Heat and Power Plant

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**ABSTRACT**

Hellisheidi Geothermal Heat and Power Plant (Hellisheidi), located in southwest Iceland, is the first geothermal powerplant in operation to be assessed under the Geothermal Sustainability Assessment Protocol (GSAP). The GSAP is an assessment tool for sustainability and is modelled on the international Hydropower Sustainability Assessment Protocol (HSAP). At the core of both protocols is the promotion of proven best practices for energy development worldwide. The protocols are products of a wide consensus of stakeholders, including international NGOs, governments and financial institutions. The GSAP is still in development stage and the Hellisheidi assessment was its second test.

The assessment for operational stage consists of a detailed review of 16 topics, giving a holistic assessment on how well the plant conforms to international best practices for sustainable development. The assessment was carried out by two independent assessors in 2017/2018 and included a site visit, 70 interviews with internal and external stakeholders and 505 documented evidences. Before the final report was released, a draft was discussed in workshops with both internal and external stakeholders.

Hellisheidi meets proven best practice on six topics, while exceeding basic good practices on six topics. The project meets basic good practices on two topics and two topics were deemed irrelevant for the project. The results of the assessment show that Hellisheidi has low adverse environmental and social impacts, and important positive socio-economic effects, primarily by supplying clean and low-cost power to the national electricity grid and hot water to serve heat demand in the capital area of Reykjavík and neighbouring communities. District heating makes an important contribution to the quality of life in Iceland. The assessment's results are currently being followed up by a detailed action plan to address the identified gaps.

## 1. INTRODUCTION

The Geothermal Sustainability Assessment Protocol (GSAP) is a framework to assess the performance of geothermal power projects according to a defined set of sustainability topics, encompassing environmental, social, technical, and financial issues.

The Protocol was developed by a working group of Icelandic power companies and government agencies. It is modelled on the Hydropower Sustainability Assessment Protocol (HSAP), developed by the International Hydropower Association (IHA) in partnership with a range of government, civil society and private sector stakeholders (www.hydrosustainability.org). Iceland was one of the early supporters of the HSAP and is now an active user. The working group focused on keeping changes from HSAP to GSAP to a minimum to maintain the international recognition and multi-stakeholder consensus obtained for the HSAP as discussed in a separate paper prepared by the working group for the WGC 2020 conference.

The GSAP is in a development stage, and the assessment of the Hellisheidi project was its second test. Tools for the Preparation and Operation stage have been developed; and other tools for other stages in the project cycle (early stage/project selection, and implementation) may be developed over time. Following the example of the hydropower sector, objectives for the geothermal Protocol are that it should be (i) globally applicable, i.e. can be used on all types and sizes of geothermal projects, anywhere in the world; and (ii) consistent, i.e. with quality controlled to ensure reliability of assessment findings.

Previously, a Preparation stage tool was tested, on the Theistareykir project under development by Landsvirkjun. That assessment report has been published at Landsvirkjun's website. It was decided to use Hellisheidi for the test of the Operation stage tool, because it is the last geothermal project commissioned in Iceland before Theistareykir, and one of the largest geothermal projects worldwide. Currently, there is no quality control system for the GSAP. For the test assessments, accredited Lead Assessors from the HSAP were contracted.

## 2. THE PROJECT

The Hellisheidi power plant is located on the southern side of the 803 m high Hengill volcano, about 25 km southeast of Reykjavík. The Hengill high-temperature field has an extension of about 110 $km^2$. Hellisheidi is ON Power's second large geothermal plant, after the Nesjavellir plant commissioned in 1990 on the northern side of the volcano, 11 km north of Hellisheidi. Like Nesjavellir, Hellisheidi is a cogeneration plant for heat and power, and was built up in modular units.

Research drilling started in 2001 by drilling two wells. Environmental impact assessment was carried out in two steps; initially for a 120 MWe power generation and 400 MWth thermal production design (finalized in 2003); and afterwards for a 303 MWe and 133 MWth design (finalized in 2005).

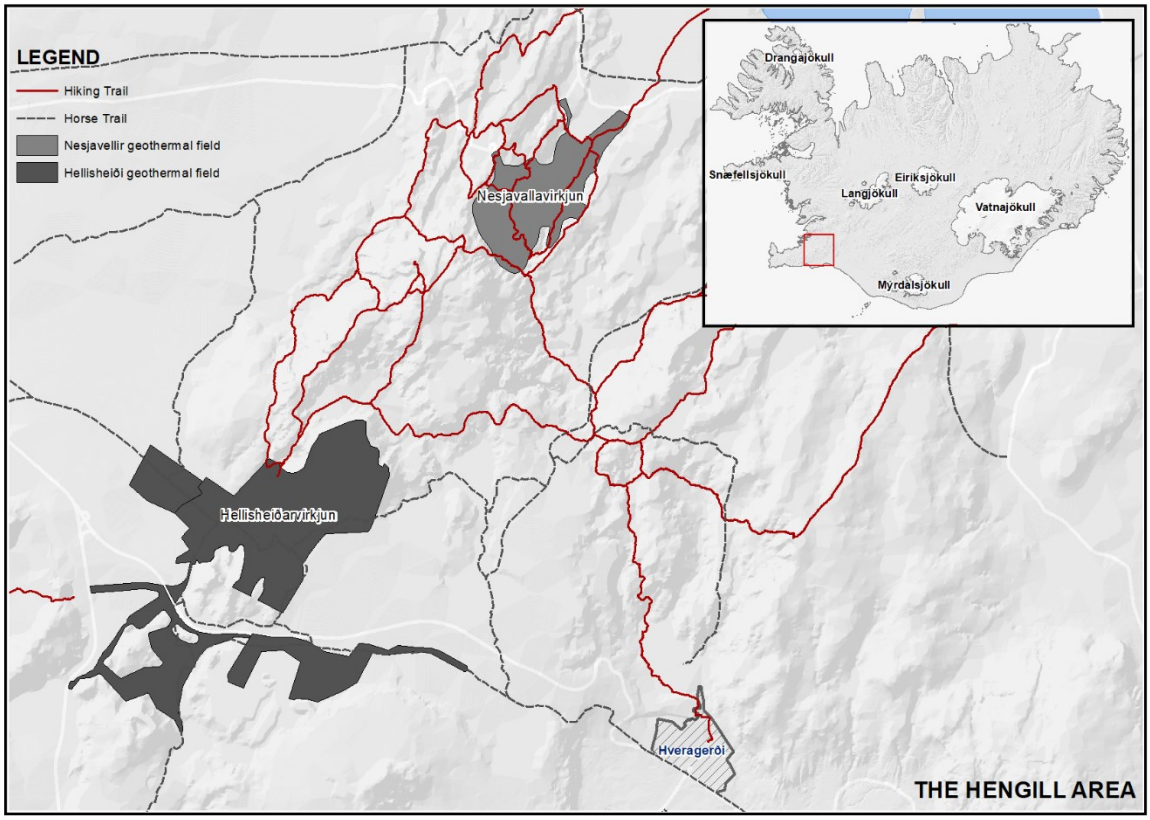


**Figure 1: Geothermal production area at Hengill. Nesjavellir on the north side of Hengill and Hellisheidi on the south side.**

The geothermal field supplying the plant consists of three main areas with a total footprint of approximately 820 ha. Construction started in early 2005, and the first two turbine units were commissioned in late 2006. The annual output increased steadily in the coming years as more turbines were added. At the end of 2010, the thermal station began operations and in October 2011 the final phase of electricity production began, in a separate powerhouse called Sleggja, just north of the main powerhouse.

The effluent water from the plant has been pumped back into the geothermal reservoir to ensure the sustainable status of the project and to protect the groundwater. The groundwater is monitored in over 40 wells, to measure the effects of the power plant on the environment. Construction of the power plant has mostly been completed, and the focus has shifted to the restoration of the surroundings and of the local vegetation.

Procedures for pumping water back into the system have been reviewed and revised, following earthquakes that occurred when reinjection began in a new area near Húsmúli in late 2011. The regularity of the tremors has gradually been reduced. The development of geothermal energy production in the Hengill area has resulted in an increase in gas emissions, relatively close to urban areas. Reykjavik Energy has in recent years worked to find a solution to deal with the greenhouse gas carbon dioxide ($CO_2$), and the pollutant hydrogen sulphide ($H_2S$), which can be toxic in high concentrations. Work is in progress to reduce gas emissions through the SulFix and CarbFix projects, by reinjecting the geothermal gases back deep into the rock layers, where they mineralize.

The main objectives for the Hellisheidi test assessment were:

- To identify areas for improvement of the Hellisheidi project, and other OR/ON geothermal projects
- To facilitate a discussion within Reykjavik Energy/ON Power, with stakeholders, and with other working group members about sustainability in geothermal projects
- To test the Operations tool of the draft Geothermal Sustainability Assessment Protocol

## 3. THE ASSESSMENT

The Hellisheidi assessment was carried out over a 7-month period, with a planning visit in September 2017, an on-site assessment in January 2018, and a workshop in March 2018. The on-site assessment was conducted in January 2018 by two accredited assessors for the Hydropower Sustainability Assessment Protocol. It involved one week of site visits and 48 interviews with 39 internal and 31 external stakeholders in Reykjavík and at the project site in Hellisheidi. Furthermore, the assessment as based on 505 documented evidences. Lead assessor was Dr. Joerg Hartmann and Co-Assessor was Dr. Bernt Rydgren. Project manager was Gísli Sveinsson at ON Power.

The assessment covers 16 topics that were adapted from the HSAP. The topics cover key environmental, social and economic factors that are deemed essential for assessing the profile of sustainability at operational stage of the project's life cycle. The topics are assessed based on up to 6 criteria, namely: Assessment; Management; Stakeholder Engagement; Stakeholder Support; Outcomes and Conformance/Compliance. The approach of the GSAP for operation's stage is similar to that of ISO 14001, in that the existing

condition is taken as the baseline, and risks are assessed against that condition. The Assessment criterion looks in many cases to see if any ongoing or emerging issues have been identified. The 16 topics subject to assessment are enlisted in table 1.

**Table 1: GSAP cover 16 topics assessing key environmental, social and economic factors.**

| GSAP topics 1-8 | GSAP topics 9-16 |
|---|---|
| 1. Communications &Consultation | 9. Project-Affected Communities & Livelihoods |
| 2. Governance | 10. Resettlement |
| 3. Environmental & Social Issues Management | 11. Indigenous Peoples |
| 4. Geothermal Resource Management | 12. Labour & Working Conditions |
| 5. Asset Reliability & Efficiency | 13. Cultural Heritage |
| 6. Public Health and Safety | 14. Biodiversity & Invasive Species |
| 7. Financial Viability | 15. Induced Seismicity and Subsidence |
| 8. Project Benefits | 16. Air and Water Quality |

Applying the GSAP to a project delivers an evidence-based assessment of performance in each topic, with a set of scores providing an indication of performance in relation to basic good practice and proven best practice. The scoring system runs from level 1 to level 5, level 5 defines proven best practice and level 3 defines basic good practice. Level 4 represents one significant gap against proven best practices. Level 2 represents one significant gap against basic good practice and level 1 two significant gaps against basic good practice. The scoring system is explained in table 2.

**Table 2, GSAP Scoring System**

| | |
|---|---|
| 5 | Meets basic good practice and proven best practice. |
| 4 | Meets basic good practice with one significant gap against proven best practice. |
| 3 | Meets basic good practice with more than one significant gap against proven best practice. |
| 2 | One significant gap against basic good practice. |
| 1 | More than one significant gap against basic good practice. |

Assessments rely on objective evidence to support a score for each topic that is factual, reproducible, objective and verifiable. The scoring system has been devised to ensure that the application of the GSAP cannot provide an overall 'pass' or 'fail' mark for a project, nor can it be used to 'certify' a project as sustainable. The GSAP provides an effective mechanism to continuously improve sustainability performance because results identify gaps that can be addressed, and the findings provide a consistent basis for dialogue with stakeholders.

## 4. DISCUSSION

The results of the assessment show that Hellisheidi has low adverse environmental and social impacts, and important positive socio-economic effects, primarily by supplying clean and low-cost power to the national electricity grid and hot water to serve heat demand in the capital area of Reykjavík and neighbouring communities. District heating in particular makes an important contribution to the quality of life in Iceland.

These issues are reflected in the findings of this assessment, and in a range of high scores that summarize the findings. Hellisheidi meets Proven Best Practice on six topics: O-3 Environmental and Social Issues Management, O-5 Asset Reliability and Efficiency, O-8 Project Benefits, O-14 Biodiversity and Invasive Species, O-15 Induced Seismicity and Subsidence, and O-16 Air and Water Quality.

The project exceeds Basic Good Practice on six topics, each of these with one significant gap against Proven Best Practice: O-1 Communications and Consultation, O-2 Governance, O-6 Public Health and Safety, O-7 Financial Viability, O-12 Labour and Working Conditions, and O-13 Cultural Heritage.

The project meets Basic Good Practice on two topics: O-4 Geothermal Resource Management, and O-9 Project-Affected Communities and Livelihoods.

Two topics, Resettlement and Indigenous Peoples, are Not Relevant to Hellisheidi. The scores for all topics are summarized in the following Sustainability Profile and Table of Significant Gaps.

The results are shown in a spider diagram, giving a a good visual reference of the overall sustainability profile of the project's operational stage.

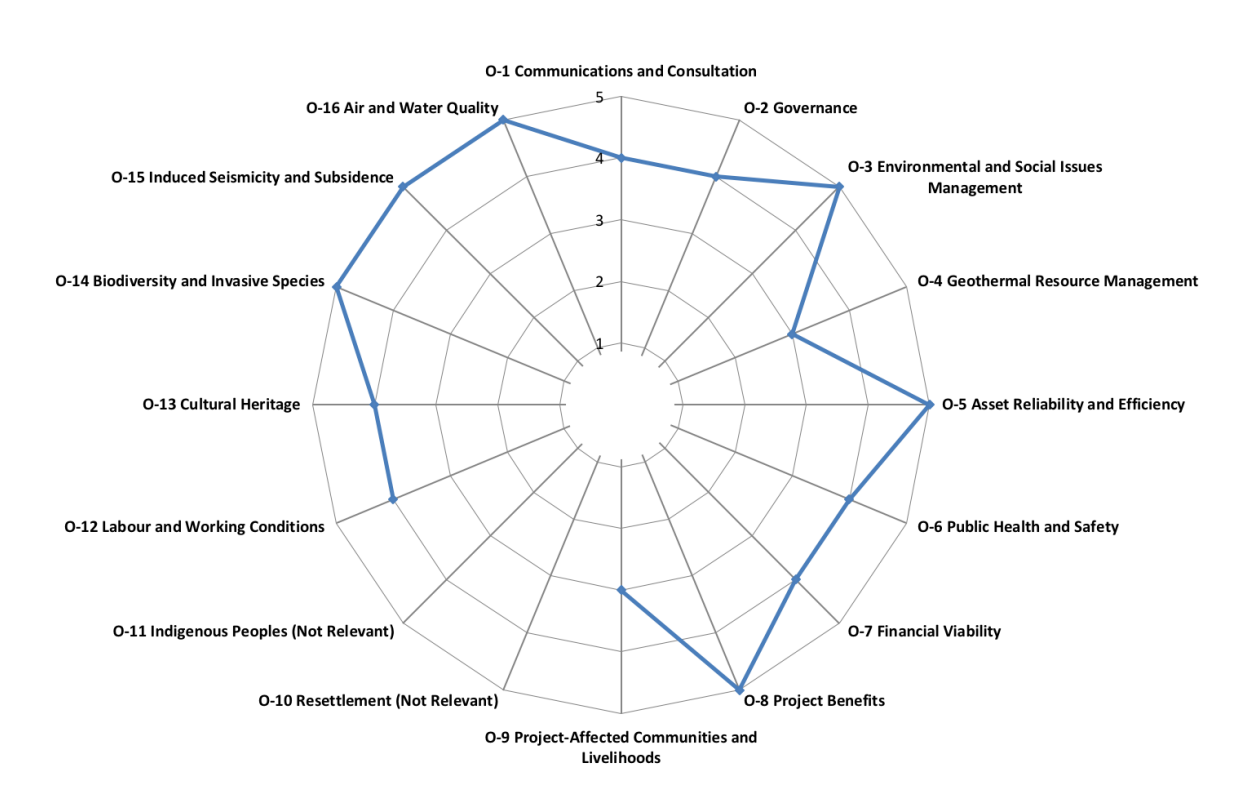


**Figure 2: Sustainability profile for Hellisheidi's operational stage in 2018.**

The Hellisheidi project has no significant gaps against basic good practice (level 3), but there are some significant gaps against proven best practices (level 5). It is both important and beneficial to identify those gaps as they provide opportunities for improvement. A description of identified gaps from level 5 are presented in table 3.

**Table 3: Identification of significant gaps against proven best practices.**

| | Level 3: Significant Gaps against Basic Good Practice | Level 5: Significant Gaps against Proven Best Practice |
|---|---|---|
| **Assessment** | No significant gaps | O-7: The original assessment of resource capacity and environmental impacts was subject to high uncertainties due to limited resource data, which was not taken sufficiently into account by management, has required substantial unforeseen and ongoing expenditure, and has contributed to relatively low returns on investment. |
| **Management** | No significant gaps | No significant gaps |
| **Stakeholder Engagement** | No significant gaps | O-1: There is a lack of personal and regular interaction with residents in the Hveragerdi community through proactive contacts and targeted information dissemination.<br><br>O-9: There is no effective process for involving project-affected communities in decision-making on relevant issues.<br><br>O-12: Feedback to workers before the process to change shift schedules started again in June 2017 was insufficient, which has contributed to some dissatisfaction and departures in the operations team. |

| | | |
|---|---|---|
| **Conformance/ Compliance** | No significant gaps | O-4: ON informed the National Energy Authority too late of a rapid pressure drop at a Hverahlíd well.<br><br>O-4: There are repeated non-compliances in relation to the utilization licence conditions on surface releases of geothermal water.<br><br>O-13: Damage to a protected historic stone wall by a contractor was notified to ON Power, but has not yet been rectified. |
| **Outcomes** | No significant gaps | O-2: Current governance arrangements do not support an equitable treatment of municipalities.<br><br>O-6: There is a lack of active promotion of research into $H_2S$ exposure-response relationships.<br><br>O-9: There are uncertainties around positive livelihood outcomes for parts of the community in Hveragerdi. |

## 5. CONCLUSION

The working group for the Hellisheidi test assessment agrees that the GSAP serves as a highly valuable and useful tool to assess the sustainability of a geothermal project. The adaption from HSAP to GSAP, with changes kept to a minimum, did not result in obstacles which is a good indication of its relevancy, although it is critical to put it to further testing in different context and preferably different countries.

The assessment was especially useful to identify gaps and provided ample opportunities for further improvements of procedures and work methods. Draft results were presented to both internal and external stakeholders at a workshop in Reykjavik in March 2018, where all stakeholders got an opportunity to give feedback on the draft report's content. When the final report was issued in June 2018 a stakeholder meeting was held where final results were presented along with a detailed action plan describing how ON Power will address and amend gaps identified in the assessment. The action plan is currently being followed up on and implemented.

*This paper is an extended abstract from Hellisheidi Geothermal Project GSAP report, prepared by Dr. Joerg Hartmann and Dr. Bernt Rydgren for ON Power. The full report is available for download at ON Power's website: www.on.is/gsap.*

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