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Progressing with the GSAP to Advance and Support Sustainable Geothermal Development

Katrín Ragnarsdóttir[1]*, Joerg Hartmann, Bjarni Pálsson[2], Marit Brommer[3], Álfheiður Bjarnadóttir1, Kristín Steinunnardóttir1, Sandra Rán Ásgrímsdóttir1

COWI[1]*, Landsvirkjun[2], IGA[3]

katrr@cowi.com

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INTRODUCTION

Geothermal energy is a renewable resource with strong climate mitigation potential. Unlike fossil fuels, geothermal energy typically produces minimal greenhouse gas emissions while providing consistent baseload power, making it a critical component in the low-carbon energy transition. As countries seek to expand clean energy portfolios worldwide, geothermal development is increasingly recognized for its ability to reduce carbon footprints while supporting energy security and economic growth.

However, ensuring the long-term sustainability of geothermal projects requires rigorous management of environmental, social, economic, and technical factors. The rapid expansion of geothermal infrastructure invites challenges such as resource depletion, land use concerns, community impacts, and governance issues. Addressing these challenges systematically is essential to maximize benefits while minimizing negative impacts.

The Geothermal Sustainability Assessment Protocol (GSAP) was developed by a working group of Icelandic power companies and government agencies as an evidence-based framework to evaluate and advance the sustainability of geothermal projects. Finalized in Reykjavik in October 2022, the GSAP builds upon the foundation established by the Hydropower Sustainability Assessment Protocol (HSAP), launched in 2010, defining a global consensus on good and best sustainability practices across a range of issues. The GSAP adapts this comprehensive approach specifically for geothermal energy by incorporating criteria addressing induced seismicity, air emissions, and sustainable management of geothermal resources, while removing criteria related to river flows and sediment management in reservoirs.

By generating evidence-based sustainability profiles, the GSAP supports continuous improvement in project performance across the entire geothermal project lifecycle, from exploration and development to operation and decommissioning, integrating stakeholder involvement and promoting transparent decision-making. (Johannesson et al., 2021)

1 OVERVIEW OF GSAP APPLICATIONS

The GSAP has been applied to several geothermal projects. The first test of the GSAP was a preparation stage assessment performed for the Theistareykir 90 MWe geothermal power plant operated by Landsvirkjun in 2017, which was under construction at the time, see Figure 1. (Landsvirkjun, 2017) The following year a GSAP operation stage assessment was carried out for Hellisheidi 330 MWe and 130 MWth geothermal power plant operated by ON Power, a subsidiary of Reykjavík Energy (OR), where independent assessors reviewed 16 topics and found the project met proven best practice in six topics and exceeded basic good practice in six more, see Figure 2. (Adalsteinsdottir et al., 2021) Both of these assessment reports were published. In addition to these Icelandic projects, a partial test GSAP assessments have been conducted for geothermal projects in Ethiopia (Adem et al., 2021), Kenya (Mathenge, 2021) and Alaska (Pletnikoff, 2022), and early discussions with project developers in Indonesia, China and other countries, have further demonstrated the protocol's versatility.

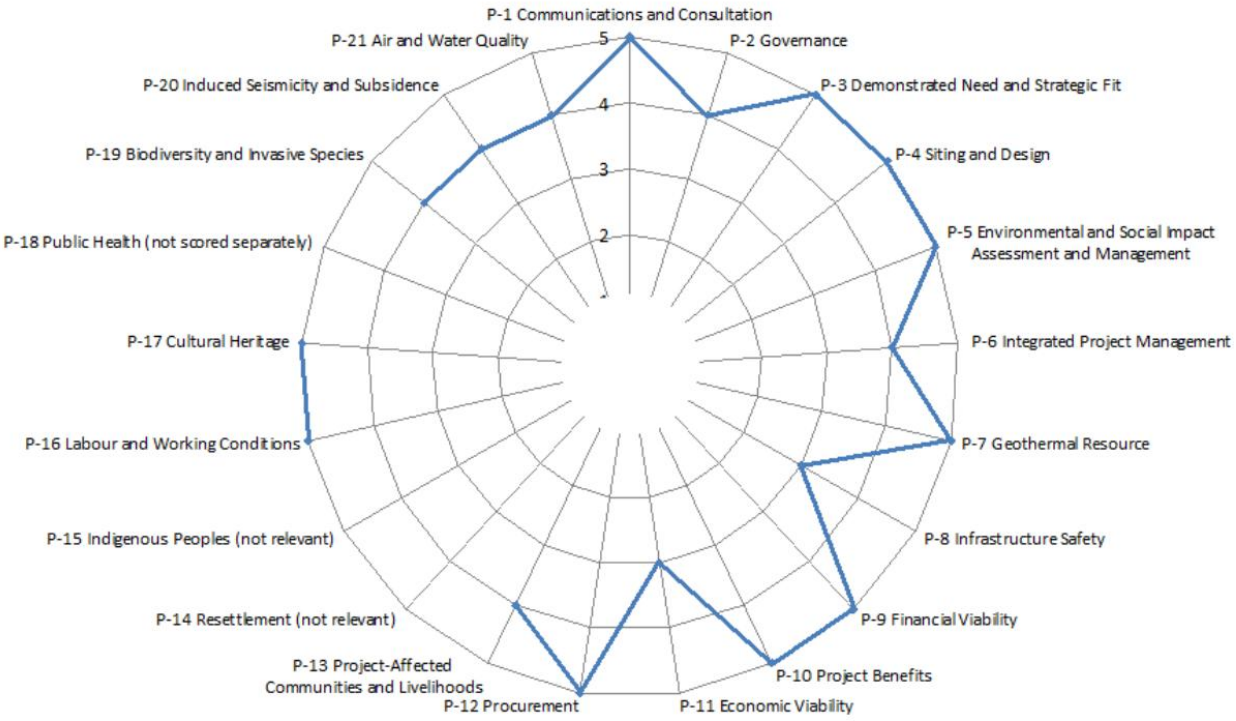


Figure 1. Sustainability profile for Theistareykir 90 MWe geothermal power plant preparation stage assessment. (Landsvirkjun, 2017)

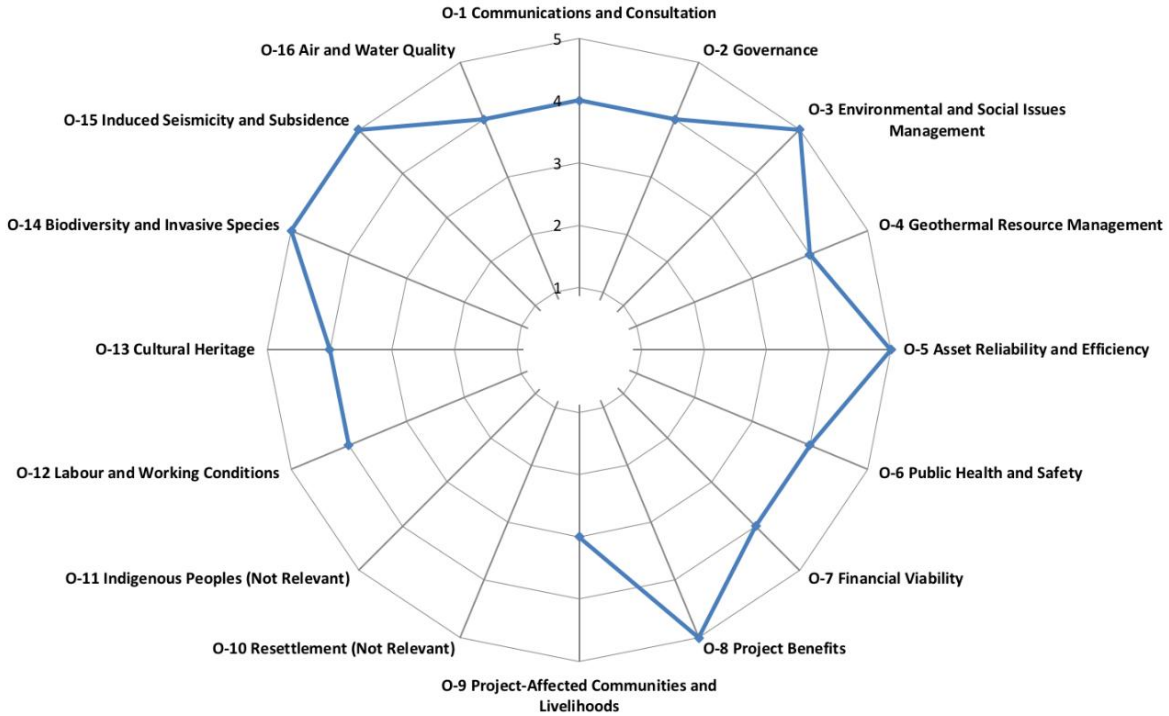


Figure 2. Sustainability profile for Hellisheidi 330 MWe (electric) and 130 MWth geothermal power plant operation stage assessment. (Adalsteinsdottir et al., 2021)

For Theistareykir 90 MWe geothermal power plant the preparation stage GSAP assessment identified key areas for improvement to advance sustainability performance prior to project completion. From the operation stage GSAP assessment the results indicated strong management and positive sustainability outcomes in operation.

1.1 Update since WGC 2020+1

Since 2021, the International Geothermal Association (IGA) has managed the GSAP. However, its adoption within the geothermal industry remains limited. To address this, a task force was established within the IGA board of directors, which engaged Elín Hallgrímsdóttir from World Bank (now Landsvirkjun), Marit Brommer from IGA, and Kolbrún Ragna Ragnarsdóttir from IRENA to serve as the core team supporting the GSAP's development and implementation.

In May 2022, a three-day course on the GSAP was held in Costa Rica, facilitated by the IGA, the national power utility (Instituto Costarricense de Electricidad), and GIZ, targeting countries in the region. The course covered the protocol's structure, application and benefits, aiming to promote understanding and encourage wider adoption.

In 2025, the IGA, in collaboration with Sinopec, launched the International Geothermal Standard Committee (IGSC) to develop harmonized global geothermal standards that enhance confidence, comparability, and investment. The priorities of IGSC's 2025-2027 work are to establish a foundational glossary and develop recommended practices covering geothermal resource evaluation, ground source heat pump standards, geothermal power generation benchmarks with sustainability metrics and framework for geothermal heating and cooling systems. These efforts directly support the GSAP's goals by providing standardized methodologies and metrics that enhance comparability, transparency, and investment confidence in geothermal sustainability assessments worldwide.

2 PRACTICAL INSIGHT INTO THE GSAP

The HSAP was initiated by the International Hydropower Association (IHA) and developed through broad stakeholder collaboration, including industry representatives, governments, financial institutions, and NGOs. Its primary objective is to provide a practical, internationally recognized tool to assess, guide, and improve hydropower sustainability performance. Additionally, it can serve as a benchmarking system aligned with sustainability criteria set forth by major financial entities such as the KfW Development Bank and the World Bank, helping developers meet rigorous environmental and social standards. (Johannesson et al., 2021) The HSAP has evolved over time, incorporating criteria addressing climate change mitigation and adaptation, Indigenous Peoples' consent, and has been complemented by detailed guidelines and converted into a rapid Environmental, Social, and Governance (ESG) gap assessment tool. In 2021, these criteria formed the basis for the Hydropower Sustainability Standard (HSS) and a certification scheme managed by the Hydropower Sustainability Alliance (HSA), which also developed HydroSelect — a tool to identify risks and opportunities at early project stages.

Johannesson et al. (2021) explains that the GSAP adapts the HSAP framework to geothermal energy with minimal modifications, ensuring it retains the original's international recognition and multi-stakeholder consensus. According to Adalsteinsdottir et al. (2021), this approach has been effective across various contexts, though further testing in diverse countries is advisable. Separate protocol documents were developed for the four project stages; Early Stage, Preparation, Implementation and Operation, that reflect the different issues and levels of information available at each stage in the project cycle.

2.1 Benefits

Increasing the use of GSAP requires motivation driven by ambition and understanding its value as a practical audit tool that can ease permitting processes, attract investment, unlock financing opportunities, and build social acceptance for geothermal projects. A key strength of the GSAP lies in its emphasis on inclusive stakeholder engagement and transparent decision-making processes, which are essential for building trust and achieving long-term sustainability.

In a world that needs to rapidly expand all sources of renewable energy, public acceptance in particular is a key enabling factor. Hydropower was the first renewable energy sector to develop its own sustainability framework because of increasing conflicts and resulting difficulties in obtaining permits and finance, in a growing number of countries. Other renewables, including geothermal, are now starting to face similar conflicts. If these issues are not managed through better siting, design, operations and mitigation at the project level, they risk damaging the reputation of individual companies and indeed, of the whole industry. Each project acts as an ambassador for the sector, for better or worse. A mixed or negative reputation tends to lead to tougher community relations, more hurdles in permitting, governments being less willing to encourage geothermal investments, greater caution from investors and lenders, and challenges in attracting and keeping skilled staff. Interestingly, one

added benefit of applying best sustainability practices and having them independently reviewed is staff motivation, as people often express pride in working for a company or a project that stands out in its industry.

Internally, applying protocols like the GSAP helps identify gaps and priorities for ESG investments, focusing efforts where they are most critical and cost-effective. Companies can learn from their peers in the industry about modern approaches, either through studying published assessment reports and guidelines, or by working with the independent assessors who are exposed to many different projects in different contexts. Regulators, in turn, can benchmark their expectations against internationally recognized good and best practices.

For companies managing multiple projects across jurisdictions, the GSAP aids in harmonizing procedures, ensuring consistent ESG performance across their portfolios. Furthermore, systematic ESG documentation facilitates regulatory reporting, due diligence, and negotiations with lenders or insurers. Independent ESG assessments are increasingly viewed by stakeholders as indicators of reduced project risk. This should be particularly valuable in the geothermal sector, where challenges such as delays in securing exploration licenses, difficulties in raising counterpart financing, challenges in finalizing power purchase agreements (PPAs) and meeting complex environmental and social safeguards are common. GSAP's capacity to identify early red flags and propose solutions addresses many of these risks, helping to overcome major barriers in geothermal project development.

2.2 Limitations

Wider adoption of the GSAP faces notable barriers, primarily due to limited awareness and the costs associated with applying the protocol. These costs include both the direct costs of an assessment team, the internal staff costs of organizing an assessment, and potential expenses related to corrective actions needed to meet the GSAP criteria. The hydropower industry has been able to mobilize financial support from donors, development banks and large power companies to overcome some of these barriers. For instance, initiatives to promote the HSAP and Hydropower Sector Sustainability (HSS) framework include training programs in multiple countries and a fund that subsidizes up to 50% of assessment costs in developing nations. The geothermal sector would similarly benefit from dedicated support mechanisms to facilitate broader GSAP uptake.

Beyond financial and awareness constraints, data availability remains a significant challenge, especially at early or pre-feasibility stages of geothermal projects. Adem et al. (2021), assessing the development of Abaya geothermal project in Ethiopia, highlighted limited data at these stages as a notable limitation of the GSAP's application. Limited data availability is a common challenge at this stage but early identification of sustainability-related red flags is critical for project continuation decisions, guiding design and siting adjustments during feasibility stage. Pletnikoff (2022) further identified key limitations of the draft GSAP , including its insufficient flexibility to adequately address projects of varying scale and ownership models. Additionally, Pletnikoff noted a potential methodological issue involving double-counting significant gaps within overlapping GSAP criteria, which could affect assessment accuracy.

Together, these challenges underscore the necessity for enhanced support systems and protocol refinement to strengthen GSAP's practical implementation and foster its wider acceptance in the geothermal sector.

3 FURTHER DEVELOPMENT

Boosting the adoption and effectiveness of the GSAP offers the geothermal sector a chance to set the standard for sustainability and inclusive growth, while also strengthening opportunities for expansion. The protocol can help geothermal projects meet rising sustainability expectations and support responsible growth aligned with the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (clean energy), SDG 13 (climate action) and SDG 9 (industry, innovation, and infrastructure). Now is the time for the geothermal sector to lead by example, embedding sustainability at the core of every project and ensuring that no community is left behind.

Building on these pathways, the geothermal sector now benefits from two new mechanisms within the IGA that can accelerate adoption and effectiveness of the GSAP. The newly launched International Geothermal Standards Committee (IGSC) will play a central role in aligning sustainability assessments with emerging global geothermal standards including resource classification, heat pump systems, and geothermal power generation benchmarks. At the same time, the IGA Operators Club (launching under the IGA in 2026) provides a trusted platform for developers and utilities to exchange best practices, test new methodologies, publish case studies, and collectively advance sustainability standards. Together, these two initiatives can transform the GSAP from a promising framework into a widely adopted global standard anchored in shared learning, operational reality, and international consensus.

From a collaborative perspective, one additional pathway for the geothermal industry is to continue building on the experience with the hydropower sector, whose sustainability framework is further evolved and tested. This could include conducting more trial assessments, updating the GSAP, training assessors, and eventually moving toward a formal standard and certification scheme, as has been done for hydropower. Early discussions have also taken place with solar and wind industry associations about developing common sustainability approaches.

The sector can also start by focusing on a less formal, knowledge-sharing approach to gradually build consensus and familiarity with the protocol among geothermal stakeholders. The published GSAP documents should be easily accessible and available for practitioners and developers. (International Geothermal Association, 2025) This will enhance awareness and understanding of the protocol's potential, facilitating wider adoption and more informed application within the geothermal community.

4 CONCLUSIONS

As geothermal energy plays an increasingly vital role in delivering clean, reliable power, frameworks like the GSAP will be indispensable in ensuring these developments contribute positively to climate goals and community wellbeing. The implementation of the GSAP can enhance public acceptance, accelerate the development of new projects, and make geothermal energy more attractive to end users and investors alike. By offering a transparent, measurable, and internationally recognized standard for sustainability, the GSAP underpins the responsible and inclusive growth of the geothermal sector globally.

Independent assessments play a key role in elevating the quality, credibility and reputation of individual projects, companies, and the geothermal sector as a whole. They demonstrate a clear commitment to best practices and transparent stakeholder engagement. Furthermore, publishing the results of such assessments signals openness and a proactive willingness to learn and continuously improve.

With the IGSC driving global alignment on standards and the IGA Operators Club supporting shared learning and real-world testing, the geothermal sector now benefits from a comprehensive and collaborative ecosystem. Together, these initiatives strengthen the GSAP's potential to evolve into a widely adopted global standard that firmly embeds sustainability at the core of every geothermal project.

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