

# Draft GSAP

## *Draft Geothermal Sustainability Assessment Protocol Operation Stage*

September 2019

Draft GSAP – Operation Stage prepared by:

**Orkustofnun**, National Energy Authority, Iceland

**Landsvirkjun**, National Power Company, Iceland

**Orkuveita Reykjavíkur**, Reykjavík Energy, Iceland

**HS Orka**, Iceland

**Umhverfisstofnun**, Environmental Agency of Iceland

Adapted from:

HSAP - Hydropower Sustainability Assessment Protocol

Published by **International Hydropower Association**

Governed by multi-stakeholder **Hydropower Sustainability Assessment Council**

Ref.: [www.hydro-sustainability.org](http://www.hydro-sustainability.org)

## Introduction

The Hydropower Sustainability Assessment Protocol, HSAP, was prepared at the initiative of the International Hydropower Association, IHA, and issued in November 2010. The Protocol is a product of a considerable effort by multi-stakeholder parties, representing the hydropower industry, several developing and developed countries, the finance sector and international environmental and social NGOs. The aim is to provide a tool to measure, guide and improve the performance in the industry for the key sustainability factors, social, environmental and economic. It enables the production of a sustainability profile for a project through the assessment of performance within important sustainability topics. Separate protocol documents were provided for project stages; Early Stage, Preparation, Implementation and Operation. The HSAP is governed by the multi-stakeholder Hydropower Sustainability Assessment Council and assessments are performed by accredited assessors. Comprehensive information is found on the Council webpage: [www.hydrosustainability.org](http://www.hydrosustainability.org) and the general approach is explained in the first part of the Assessment Protocol: **Background Document**.

Representatives from Iceland were active participants in the preparation of HSAP, including the multi-stakeholder Forum established for the Protocol. Also, Landsvirkjun, the National Power Company, has applied HSAP for assessments of several projects and operating facilities. These assessments were considered highly valuable and they initiated positive improvements of procedures and work methods. In addition to hydro, geothermal development has a long history in Iceland and is highly advanced, for electrical production, space heating and various industrial purposes. In this context, members of the Icelandic power sector proposed to adapt the internationally recognized and fully tested HSAP to geothermal plants.

Two governmental agencies and three power companies formed a Working Group for the GSAP initiative:

- **Orkustofnun**, National Energy Authority; Dr Gudni A Johannesson, Director General, *leads the working group*, Mr Jonas Ketilsson, Deputy Director General, Mr Kristinn Einarsson, Senior Advisor.
- **Landsvirkjun**, National Power Company; Mr Jon Ingimarsson, Manager Environmental Dept, Mrs Ragnheidur Olafsdottir, Environmental Manager, Mr Bjarni Palsson, Manager Geothermal Dept.
- **Orkuveita Reykjavíkur**, Reykjavik Energy; Mr Bjarni Bjarnason, CEO, Mrs Hildigunnur H Thorsteinsson, Managing Director Research and Development, Mrs Hólmfríður Sigurðardottir, Head of Environmental Affairs.
- **HS Orka**; Mr Asgeir Margeirsson, CEO, Mrs Kristin Vala Matthiasdottir, VP Resources.
- **Umhverfisstofnun**, Environmental Agency of Iceland; Mrs Kristin Linda Arnadottir, Director General, Mrs Adalbjorg Guttormsdottir, Team Leader Integration Dept.
- **Moderator/Project Manager** is Mr Sigurdur St. Arnalds, Engineering firm **Mannvit hf** in Iceland.

As a first step, a Draft GSAP Preparation Stage was prepared in 2016 and a subsequent test assessment performed for the Theistareykir 90 MWe geothermal project in Northeast Iceland, under construction by Landsvirkjun at the time. The resulting assessment report was published on the [www.landsvirkjun.com](http://www.landsvirkjun.com) website, News archive, date 15.6.2017. As a next step a Draft GSAP Operation Stage was prepared in 2017 and a subsequent test assessment performed for the Hellisheidi 300 MWe/130 MWth geothermal plant in Southwest Iceland, owned and operated by ON Power, a subsidiary of Orkuveita Reykjavíkur (OR), Reykjavik Energy. The resulting assessment report was published on the [www.or.is](http://www.or.is) website, *UTGEFID EFNI* (published material), 22.06.2018. In 2019, a newly added HSAP assessment Topic on Climate Change Mitigation and Resilience was adapted and added to the Draft GSAP.

The required adaption changes from HSAP to GSAP have been kept to a minimum with the aim to maintain as much as possible the international recognition and multi-stakeholder consensus obtained for the HSAP. Further modifications and streamlining remain to be addressed, preferably in co-operation with a prospective wider participation. In short, the test assessments illustrate the applicability of such an adapted GSAP, obstacles were not found in the process related to the fact that the plants were geothermal and not hydro. The products provide a good illustration of this method for sustainability assessment of a geothermal project.

# Contents

O-1	Communications & Consultation .....	2
O-2	Governance.....	4
O-3	Environmental & Social Issues Management.....	6
O-4	Geothermal Resource Management .....	8
O-5	Asset Reliability & Efficiency.....	10
O-6	Public Health and Safety .....	12
O-7	Financial Viability .....	14
O-8	Project Benefits.....	16
O-9	Project-Affected Communities & Livelihoods .....	18
O-10	Resettlement .....	20
O-11	Indigenous Peoples.....	22
O-12	Labour & Working Conditions .....	24
O-13	Cultural Heritage .....	26
O-14	Biodiversity & Invasive Species .....	28
O-15	Induced Seismicity and Subsidence .....	30
O-16	Air and Water Quality .....	32
O-17	Climate Change Mitigation and Resilience.....	34

## O-1 Communications & Consultation

This topic addresses ongoing engagement with project stakeholders, both within the company as well as between the company and external stakeholders (e.g. affected communities, governments, key institutions, partners, contractors, geothermal area residents, etc).

The intent is that stakeholders are identified and engaged in the issues of interest to them, and communication and consultation processes maintain good stakeholder relations throughout the project life.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Ongoing or emerging issues relating to geothermal facility communications and consultation have been identified; requirements and approaches are determined through a periodically updated assessment process involving stakeholder mapping; and effectiveness is monitored.

**Management:** Communications and consultation plans and processes, including an appropriate grievance mechanism, are in place to manage communications and engagement with stakeholders; these outline communication and consultation needs and approaches for various stakeholder groups and topics.

**Stakeholder Engagement:** The operation stage involves appropriately timed and scoped, and often two-way, engagement with directly affected stakeholders; engagement is undertaken in good faith; ongoing processes are in place for stakeholders to raise issues and get feedback.

**Conformance/Compliance:** Processes and objectives relating to communications and consultation have been and are on track to be met with no major non-compliances or non-conformances, and communications related commitments have been or are on track to be met.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, the stakeholder mapping takes broad considerations into account.

**Management:** In addition, communication and consultation plans and processes show a high level of sensitivity to communication and consultation needs and approaches for various stakeholder groups and topics; and processes are in place to anticipate and respond to emerging risks and opportunities.

**Stakeholder Engagement:** In addition, engagement is inclusive and participatory; negotiations are undertaken in good faith; and feedback on how issues raised have been taken into consideration has been thorough and timely.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

## Assessment Guidance:

**Stakeholders** are those who are interested in, involved in or affected by the geothermal project and associated activities.

**Stakeholder mapping** refers to identification and grouping of stakeholders in a meaningful way, for example based on stakeholder rights, risks and responsibilities. An example of "rights" would be land rights.

**Directly Affected Stakeholders** are those stakeholders with substantial rights, risks and responsibilities in relation to the issue. These may be inside the project affected area (e.g. project affected communities) or outside the project-affected area (e.g. government regulators, finance institution representatives, or investment partners).

**Grievance mechanisms** refer to the processes by which stakeholders are able to raise concerns, grievances and legitimate complaints, as well as the project procedures to track and respond to any grievances.

**Needs and approaches for stakeholder groups** could be with respect to, for example: cultural norms, gender, literacy level, vulnerable social groups, disabilities, logistical constraints, etc.

**Good faith engagement** is engagement that is undertaken with an honest intent to reach a mutually satisfactory understanding on the issues of concern.

**Processes in place for stakeholders to raise issues** could include, for example: a contact person on the company website, public meetings, periodic public briefings or question/answer opportunities, etc.

**Feedback on stakeholder issues** could be demonstrated by means such as, for example: emails, records of telephone conversations, written correspondence, meeting minutes, media releases, provision of responses to frequently asked questions on company website, etc.

**Broad considerations** could be with respect to, for example: the geographic or compositional extent of stakeholder groups identified and considered, the interrelationships amongst stakeholder groups, the level of consideration of rights, risks and responsibilities, etc.

**Good faith negotiation** involves (i) willingness to engage in a process; (ii) provision of information necessary for informed negotiation; (iii) exploration of key areas of importance; (iv) mutually acceptable procedures for negotiation; (v) willingness to modify position; (vi) provision of sufficient time to both parties for decision-making; (vii) agreements on proposed compensation framework, mitigation measures, and development interventions.

**Potential interviewees:** station or company communications or public relations staff; stakeholder representatives; project affected community representatives

**Examples of evidence:** project stakeholder mapping document; project communications and/ or consultation plans; communications protocols; grievance mechanisms; monitoring reports.

## O-2 Governance

This topic addresses corporate and external governance considerations for the operating geothermal facility.

The intent is that the owner/operator has sound corporate business structures, policies and practices; addresses transparency, integrity and accountability issues; can manage external governance issues (e.g. institutional capacity shortfalls, political risks including transboundary issues, public sector corruption risks); and can ensure compliance.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Ongoing or emerging political and public sector governance issues, and corporate governance requirements and issues have been identified, and monitoring is being undertaken to assess if corporate governance measures are effective.

**Management:** Processes are in place to manage corporate, political and public sector risks, compliance, social and environmental responsibility, procurement of goods and services, grievance mechanisms, ethical business practices and transparency; policies and processes are communicated internally and externally as appropriate; in case of capacity shortfalls, appropriate external expertise is contracted for additional support.

**Stakeholder Engagement:** The business interacts with a range of directly affected stakeholders to understand issues of interest to them; and the business makes significant project reports publicly available, and publicly reports on project performance, in some sustainability areas.

**Outcomes:** There are no significant unresolved corporate and external governance issues identified.

**Conformance/Compliance:** The project has no significant non-compliances.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, there are no significant opportunities for improvement in the assessment of political and public sector governance issues and corporate governance requirements and issues.

**Management:** In addition, contractors are required to meet or have consistent policies as the developer; procurement processes include anti-corruption measures as well as sustainability and anti-corruption criteria specified in pre-qualification screening; and processes are in place to anticipate and respond to emerging risks and opportunities.

**Stakeholder Engagement:** In addition, the business makes significant project reports publicly available and publicly reports on project performance in sustainability areas of high interest to its stakeholders.

**Outcomes:** In addition, there are no unresolved corporate and external governance issues identified.

**Conformance/Compliance:** The project has no non-compliances.

## Assessment Guidance:

**Governance** broadly refers to the combination of processes and structures that inform, direct, manage and monitor the activities of the project toward the achievement of its objectives.

**Corporate governance** is a term that refers broadly to the rules, processes, or laws by which businesses are operated, regulated, and controlled.

**Corporate governance requirements** may include, for example: business administration, policies and processes, risk management, corporate social responsibility, ethical business practices, accountability and stakeholder relations, compliance, etc.

**Corporate governance issues** may relate to, for example: lack of capacity in key external institutional structures, policies and processes important to the project; public sector corruption risks; political risks; internal corruption risks; compliance; management of project risks; etc.

**External governance considerations** include legal, judicial, and institutional structures, processes and policies relevant to the project. Examples include: the executive, the legislature, political parties, anticorruption organizations, judiciary, grievance addressing mechanisms (e.g. the Ombudsman), specific civil service/public sector agencies, law enforcement agencies, Freedom of Information, media, local and national government, civil society, private sector, international institutions (e.g. some provide peer review of anti-corruption efforts), audit/oversight institutions, public contracting system, etc.

**Political risk** is a risk of financial loss or inability to conduct business faced by investors, corporations, and governments due to government policy changes, government action preventing entry of goods, expropriation or confiscation, currency inconvertibility, politically-motivated interference, government instability, or war.

**Transboundary issues** would take into account institutional arrangements that could address the management of impacts of the project and sharing of resources.

**Corruption risks** may be within the business such as with how finances are managed, or within the public sector such as not addressing licence or permit violations. **Public sector corruption risks** during project preparation may include, for example, limited options considered, shortcutting of assessment / preparation requirements, or non-transparent approvals; and at the project implementation and operation may include, for example, a blind eye to licence and permit violations.

**Processes to ensure ethical business practices** could include, for example: a business Code of Ethics, an employee Code of Conduct, a business Integrity Pact, anti-bribery or anti-corruption policies and procedures for reporting and investigation, (such as Transparency International's Business Principles for Countering Bribery (BPCB), a whistle-blowing arrangement, etc.

**Procurement plans and processes** should address provision of a procurement policy, pre-qualification screening, bidding, awarding of contracts, anticorruption measures, and mechanisms to respond to bidder complaints. Screening could be for, by way of example, quality, reputation, cost, contractor prior performance on meeting contractual obligations (time, cost, specifications), etc.

**Compliance** is with respect to all relevant laws, policies, permits, agreements, codes of practice and publicly stated commitments.

**Anti-corruption measures** examples include: open bidding contracting processes to be above a low threshold, contracting authority and its employees commit to an anti-corruption policy, project integrity pacts, mechanisms to report corruption and protect whistle blowers, confidentiality limited to legally protected information, etc.

**Screening based on sustainability criteria** might encompass additional criteria which could include, by way of example, social, environmental, ethics, human rights, health and safety performance, preference and support to local suppliers where they meet other criteria, etc.

**Screening to address anti-corruption** might specify, by way of example, that companies tendering must have a code of conduct addressing anti-corruption.

**Potential interviewees:** a Board member; the operating facility manager; business managers for corporate governance, compliance, internal audit, business risk; experts on public sector governance; other relevant third parties such as anti-corruption civil society organisations

**Examples of evidence:** business internal website and external website for vision, values, policies, structure, procedures, annual reports; assessment of public sector governance issues; internal audit reports; regulatory requirements; project compliance plan; reports to Board on ethical business practices and compliance; log of ethical business practices grievance; third party review reports; relevant documentation on public sector governance issues such as reports of Transparency International on National Integrity Systems (NIS) and the Corruption Perceptions Index (CPI)

## O-3 Environmental & Social Issues Management

This topic addresses the plans and processes for environmental and social issues management.

The intent is that negative environmental and social impacts associated with the geothermal facility are managed; avoidance, minimisation, mitigation, compensation and enhancement measures are implemented; and environmental and social commitments are fulfilled.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Systematic processes are in place to identify any ongoing or emerging environmental and social issues associated with the operating geothermal facility, utilising appropriate expertise; and monitoring programs are in place for identified issues.

**Management:** An environmental and social management system is in place to manage measures to address identified environmental and social issues, and is implemented utilising appropriate expertise (internal and external).

**Stakeholder Engagement:** Ongoing processes are in place for stakeholders to raise issues and get feedback.

**Conformance/Compliance:** Processes and objectives in environmental and social management plans have been and are on track to be met with no major non-compliances or non-conformances, and environmental and social commitments and regulatory requirements have been or are on track to be met.

**Outcomes:** Negative environmental and social impacts associated with geothermal facility operations are avoided, minimised and mitigated with no significant gaps; and land disturbance associated with development of the geothermal project is rehabilitated or mitigated.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, processes to identify ongoing and emerging environmental and social issues take broad considerations into account, and both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities; and plans and processes are embedded within an internationally recognised environmental management system which is third party verified, such as ISO 14001.

**Stakeholder Engagement:** In addition, feedback on how issues raised have been taken into consideration has been thorough and timely.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, negative environmental and social impacts associated with geothermal facility operations are avoided, minimised, mitigated and compensated with no identified gaps.



## Assessment Guidance:

**Environmental and social issues** may include, for example: aquatic and terrestrial biodiversity, threatened species, critical habitats, ecosystem integrity and connectivity issues, gas emissions and air quality, geothermal fluid discharge, water quality, induced seismic activity, ground subsidence, visual impact of plumes, noise, vibrations and solid waste disposal, project-affected communities, tourism, indigenous peoples, ethnic minorities, resettlement, cultural heritage (both physical and non-physical), and public health. For operating geothermal facilities, the baseline is understood to be the existing condition and risks are assessed against this condition; exceptions may be for topics where there was very good documentation of the pre-project condition and commitments were made for changes that would be measured against this pre-project baseline (e.g. resettles experiencing improved living standards). Environmental and social issues associated with the operating geothermal facility that extend beyond the jurisdictional boundaries in which the facility is located would need to have been identified and included in management plans.

**Ongoing issues** are issues that have been of concern repeatedly for a given area over a longer period of time, and may relate to legacy issues.

**Legacy issue** refers to impacts of previous projects that are unmitigated or not compensated with a similar good or service, or long-standing issues with a present (existing) project, or pre-existing issues in the present location of a new project.

**Emerging issues** may relate to on-site changes (e.g. maintenance construction and modifications or erosion exposing cultural heritage artefacts or impacting on land-use or livelihood activities) or to broader circumstances (e.g. policy changes, changes in relevant legislation or standards, trends in emerging practice, changing community expectations, etc). Furthermore, these might relate to additional usage of the resource and facility.

**Processes in place for stakeholders to raise issues** could include, for example: a contact person on the company website, public meetings, periodic public briefings or question/answer opportunities, etc.

**Feedback on stakeholder issues** could be demonstrated by means such as, for example: emails, records of telephone conversations, written correspondence, meeting minutes, media releases, provision of responses to frequently asked questions on company website, etc. Where identified or ongoing issues have been resolved through a mediation, legal, approval or licensing process, facility owner/operators would need to have some clear communication on the issue and the resolution, so stakeholders understand the issue was recognised, evaluated and resolved.

**Land rehabilitation** is the process of returning project-affected land to some degree of its former state after disturbance or damage associated with project implementation.

**Appropriate expertise** refers to specialists with experience in the key identifiable topical areas of the assessment and management plans, giving particular attention to the differences between environmental areas and social impact areas. These specialists could be internal or external to the project developer; internal expertise in managing environmental and social issues is of particular importance with respect to this topic.

**Avoid, minimise, mitigate and compensate** is a concise expression for what is understood to be a sequential process. Measures to avoid or prevent negative or adverse impacts are always prioritised and where avoidance is not practicable, then minimisation of adverse impacts is sought. Where avoidance and minimisation are not practicable, then mitigation and compensation measures are identified and undertaken commensurate with the project's risks and impacts.

**Broad considerations** might be exhibited by, for example: a broad view of the project affected area; a broad view of relevant issues; a broad interpretation of important concepts such as livelihoods or living standards; a broad range of approaches considered; a broad view of stakeholder perspectives on the various issues; a focus on interrelationships amongst issues; legacy issues; cumulative impacts; etc.

**Commitments** would be those of the present owner/operator (or predecessor entity where those commitments are transferred to the new owner), or other agency with the primary responsibility for delivery. If there are disputes about the currency of historical commitments, these should be treated as an ongoing issue and measures put in place to address the issue. In many cases changes incurred due to project development may not be able to be remediated, so measures may need to take the form of new initiatives that recognise the importance of the changes that occurred in the past and make some other form of contribution or recognition of this.

**Potential interviewees:** station or company managers responsible for environmental and social issues assessment and management; government representatives responsible for environmental and social issues; stakeholder representatives; project affected community representatives; external experts.

**Examples of evidence:** regulatory requirements for EIA / SIA; EIA / SIA and associated reports; environmental and social management plans; records of consultation and stakeholder involvement; records of response to stakeholder issues; third party review report; qualifications of experts utilised; evidence of appropriate separate expertise used for environmental and social issues recognising that in many cases single experts may not have sufficient breadth of expertise to cover both aspects.

## O-4 Geothermal Resource Management

This topic addresses the level of understanding of the geothermal resource and the assessment of the geothermal production capacity. Also, predicted and actual response to the planned production and generation efficiency based on the assessed geothermal conditions and utilization strategy.

The intent is that energy generation planning and operations take into account a good understanding of the geothermal resource availability, renewability and reliability in the short- and long-term, as well as efficient utilization of the geothermal resource.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Monitoring is being undertaken of geothermal resource production capacity and reliability, and ongoing or emerging issues have been identified; inputs include field measurements, testing of wells, appropriate statistical indicators and geothermal reservoir models, issues which may impact geothermal availability or reliability have been identified and factored into the geothermal models.

**Management:** Measures are in place to guide generation operations that are based on analysis of the geothermal production capacity, a range of scientific and technical considerations, an understanding of power system opportunities and constraints, and social, environmental and economic considerations.

**Conformance/Compliance:** Objectives for operating regulatory requirements for the geothermal resource have been and are on track to be met with no significant non-compliances or non-conformances.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, issues that may impact on steam and fluid availability, renewability and reliability have been comprehensively identified; and scenarios, uncertainties and risks including reservoir drawdown, average well production decline and geothermal system response are routinely and extensively evaluated over the short- and long-term.

**Management:** In addition, generation operations planning has a long-term perspective; shows exemplary energy efficiency and comprehensive monitoring of the effect of operation on the resource is performed and conceptual and numerical models are well maintained to ensure that geothermal fluid and energy balance can be achieved in the long run and goals of sustainable yield will be met, e.g. with reinjection as applicable. Predictions are presented with quantified and well supported uncertainty boundaries.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances with operating regulatory requirements for the geothermal resource.

## Assessment Guidance:

At the operation stage the capacity of the resource needs to be continually evaluated scientifically and technically on the basis of chemical, geological and geophysical monitoring as well as testing of wells. For the project to be within the limits of sustainable yield, the production needs to be within the limits that can sustain long-term steady energy production from the system. Re-injection of geothermal fluid into the geothermal reservoir can support long-term utilization. Models for re-assessment of production capacity are maintained on the basis of continuous data obtained during operation. Operation of the geothermal resource may be conditioned by regulatory requirements.

If the operating geothermal facility is reliant on geothermal resources that can have an effect beyond the jurisdictional boundaries in which the facility is located, the implications of this would need to be fully considered.

### **Technical considerations for generation operations**

examples include: geothermal reservoir characteristics; turbine type, number and characteristics, safety issues, adherence to acceptable limitations to pressure drawdown and cooling in the geothermal reservoir, monitoring for changes in physical characteristics and updating of reservoir assessment models, maintenance of wells and make-up well requirements, re-injection of geothermal fluid if applicable, location of make-up wells and maintenance and adaption of steam supply system, etc.

**Energy system opportunities and constraints** examples include: patterns of demand for energy (e.g. base vs peak load), energy prices, other generators and their capacities and constraints, transmission issues, etc.

**Fully optimise and maximise efficiency of the geothermal resource** means that the plan is to maximize the utilization of the available geothermal energy given the opportunities and constraints relating to scientific, technical, social, economic, environmental, financial considerations and is based on an iterative and consultative process. Efficiency can be directly related to the technical installations, e.g. efficiency of geothermal supply system and turbines. Efficiency can be estimated by assessment of the exergy efficiency and primary energy efficiency. Multiple use and/or cascaded use and re-injection into the reservoir affects this assessment.

**Potential interviewees:** company, government and/or independent geothermal scientists; regulatory authorities, energy system planners; stakeholder representatives; project affected community representatives; ecosystem specialists; neighbouring stakeholders in a transboundary context;

**Examples of evidence:** testing, monitoring and generation data; monitoring program and data sources; geothermal model reports; compliance documentation on regulatory and licencing requirements as applicable; analyses of energy system and market opportunities; simulation and optimisation model scenarios and outputs; systems operations plan for the project;

## O-5 Asset Reliability & Efficiency

This topic addresses the reliability and efficiency of the geothermal facility and associated network assets.

The intent is that assets are maintained to deliver optimal performance in the short- and long-term in accordance with the overall energy generation and supply strategy of the owner/operator.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Routine monitoring of asset condition, availability and reliability is being undertaken to identify risks and assess the effectiveness of management measures; and ongoing or emerging asset maintenance and management issues have been identified.

**Management:** Measures are in place to address routine monitoring and maintenance requirements of the operating facility in accordance with the overall energy generation and supply strategy of the owner/operator.

**Conformance/Compliance:** Processes and objectives relating to asset maintenance and management have been and are on track to be met with no major non-compliances or non-conformances, and any asset related commitments have been or are on track to be met.

**Outcomes:** Asset reliability and efficiency performance is in line with the objectives of the owner/operator and any asset performance guarantees with only minor gaps.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging asset maintenance and management issues takes into account both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities; and asset maintenance management plans include a long-term program for efficiency improvements and asset upgrades.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** Asset reliability and efficiency performance is fully in line with the objectives of the owner/operator and any asset performance guarantees.

## Assessment Guidance:

**Asset** refers to the infrastructure, plant and equipment on which the geothermal facility generation operations are reliant.

**Asset maintenance requirements** could include, for example: changing of lubricants or filters, replacement of parts, remedial measures for chemical scaling, painting, cleaning, etc.

**Asset reliability and efficiency issues** could include, for example: normal wear and tear, reduced efficiency due to chemical scaling of steam supply system and power production machinery, abrasion of parts, changes to machinery configuration over time which reduces efficiency, difficulties with valves due to lack of use, rust, corrosion, etc.

**Asset related opportunities** could include, for example: new technologies, market opportunities for replacement parts, R&D opportunities, partnerships with universities or research institutions for tests of trials, etc.

**Potential interviewees:** station manager; station operator; generation manager; steam supply manager; asset maintenance program manager.

**Examples of evidence:** maintenance programs; record of asset performance; facility asset management strategies and program; asset performance guarantees; asset reliability assessment and monitoring program; program of asset upgrades; information on asset efficiency; information on comparative equipment and system performance; information on practicability of constraint removal; information on the operational efficiency of the individual facility or groups of facilities in the context of the broader system and relevant market arrangements; facility revenues for generation and for availability; operational efficiency identification, measurement and assessment process; machine specifications; monitoring data.

## O-6 Public Health and Safety

This topic addresses management of hazardous and polluting impacts from geothermal operations and other health and safety issues for the public and neighbouring communities.

The intent is that life, property and the environment are protected from the consequences of the geothermal energy harnessing and facility operation and other associated health and safety risks.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Routine monitoring of health and safety issues related to the operating facility and other infrastructure is being undertaken to identify risks and assess the effectiveness of management measures; and ongoing or emerging health and safety issues have been identified.

**Management:** Hazardous and polluting geothermal impact and other health and safety management plans and processes have been developed in conjunction with relevant regulatory and local authorities with no significant gaps, and provide for communication of public health and safety measures; emergency response plans and processes include awareness and training programs and emergency response simulations.

**Conformance/Compliance:** Processes and objectives relating to public health and safety have been and are on track to be met with no major non-compliances or non-conformances, and health and safety related commitments have been or are on track to be met.

**Outcomes:** Health and safety risks have been avoided, minimised and mitigated with no significant gaps.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging health and safety issues for the public and neighbouring communities takes into account consideration of a broad range of scenarios and both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities; and public health and safety measures are widely communicated in a timely and accessible manner.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, health and safety risks have been avoided, minimised and mitigated with no identified gaps; and health and safety issues have been addressed beyond those risks caused by the operating facility itself.

## Assessment Guidance:

**Health and safety risks** examples include: vector borne diseases; communicable and non-communicable diseases, malnutrition, psychological disorders, social well-being; loss or contamination of traditional resources; mercury or heavy metal bioaccumulation; effect of high concentration of hazardous gas emission from the geothermal operation, seismic and volcanic risk, extreme noise, contamination of drinking water sources by geothermal effluent fluid, electric shock, injury from hot water or steam, road accidents, accidents arising from community interactions with project activities, etc.

**Measures to address public health issues** could include, for example: measures to reduce mosquito-borne disease risks; storing of medical supplies and immunisations; educational, awareness and disease prevention training; water and air quality testing; etc.

**Health needs, issues and risks for different community groups** could be with respect to, for example: gender, age, ethnicity, use of and access to traditional medicines, etc.

**Safety management measures** examples include: HSE Plan for public health and safety risks, signage, exclusion zones, emergency preparedness, monitoring, inspections, training, incident response, communication, allocation of responsibilities, etc.

**Communication of public safety measures** could be, for example, through public signage, documentation appropriately lodged with local authorities, awareness raising through various types of community engagements, verbal communication by on-site patrolmen or other similar mechanisms, etc

**Emergency response simulations** may be undertaken, for example, through training or workshop exercises for company staff, regional authorities, etc.

**Avoid, minimise, mitigate and compensate** is a concise expression for what is understood to be a sequential process. Measures to avoid or prevent negative or adverse impacts are always prioritised, and where avoidance is not practicable, then minimisation of adverse impacts is sought. Where avoidance and minimisation are not practicable, then mitigation and compensation measures are identified and undertaken commensurate with the project's risks and impacts.

**Public health opportunities** could include, for example: improved access to electricity and heat, clean water and sanitation; development or upgrading of public health facilities; provision of equipment, training, health education, immunisations; new service providers; new medical technologies; new vaccinations or approaches to public health issues, etc.

**Contributions to safety issues beyond project risks** might include, for example, improving the safety of some existing roads or traffic infrastructure, signage in public places about suitable and safe track routes, etc.

**Potential interviewees:** station or company safety manager and social issues manager; government authorities on health and safety; independent expert; stakeholder representatives; project affected community representatives

**Examples of evidence:** health and safety risk and opportunities assessments; health and safety management plans; emergency preparedness plans; monitoring reports; independent reviews; national and international standards; regional statistics before and after project.

## O-7 Financial Viability

This topic addresses financial management of the operating geothermal facility, including funding of measures aimed at ensuring project sustainability, and the ability of the project to generate the required financial returns to meet funding requirements as well as to optimise its financial opportunities.

The intent is that the operations of the geothermal facility are proceeding on a sound financial basis that covers all funding requirements including social and environmental measures and commitments, and that it is aware of and responding to market trends which may influence its long-term viability.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Routine monitoring of the operating geothermal facility's finances is being undertaken to identify risks including decline of yield over time and assess the effectiveness of management measures; and ongoing or emerging financial management issues have been identified.

**Management:** Measures are in place for financial management of the operating geothermal facility.

**Conformance/Compliance:** Processes and objectives relating to financial management have been and are on track to be met with no major non-compliances or non-conformances, and funding commitments have been or are on track to be met.

**Outcomes:** The operating geothermal facility or the corporate entity to which it belongs can manage financial issues under a range of scenarios, can service its debt, and can pay for all plans and commitments including social and environmental.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging financial management issues takes into account both risks and opportunities including confirmation of resource capacity based on monitoring and resource modelling as well as factors and trends that might influence future demand for electricity and ancillary services.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities; and financial contingency measures can be implemented for environmental and social management plans if required.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, the operating geothermal facility or the corporate entity to which it belongs can manage financial issues under a range of scenarios, and has optimised or is on track to optimise its market position with respect to supply and demand for energy and ancillary services.



## Assessment Guidance:

**Financial viability** is the ability of an entity to continue to achieve its operating objectives and fulfil its mission from a financial perspective over the long term. Some operating facilities may be multi-purpose, e.g. combined electricity and warm water production or even further utilization of excess geothermal heat and possible bi-products from the geothermal fluid. For some operating facilities the financial contribution is measured from the perspective of the system within which it operates; for example dependency on variable load for power and heat if applicable,

**Financial issues and risks** examples include: very high operating costs; cost of drilling of make-up wells, decline of geothermal yield over time, inability to meet required costs; uncertainties with respect to revenue streams; currency exchange instability; difficulties in access to finance; access to renewable incentive schemes; regional pricing; market stability; market access; likelihood of major inflation or depreciation; financial viability of the principal off-takers etc.

**Market** refers to the situation of supply and demand for electricity, heat if applicable and ancillary services in which the geothermal project operates.

**Opportunities** may include, for example: integrated use of the geothermal resource; development or upgrade of transmission lines to enter new markets; changing customer, pricing and contract strategies; refurbishments and upgrades; changing operational patterns to meet higher priced electricity demand, renewable developments in synergy with geothermal power to provide grid stability and attract renewable energy certificates; enhancement of social and environmental benefit linked to corporate reputation and brand linked to customer attraction strategies; etc.

**Optimises** in this context means best market position that the facility is able to achieve, once all considerations have been factored in.

Some **financial information** may have a high degree of commercial sensitivity, and evidence for this topic may need to be viewed under a confidentiality agreement.

**Potential interviewees:** Company financial officers; principal financing institution representative; independent financial expert; company representative from business development, marketing, consulting, trading, strategy, policy; company generation manager and regulatory authorities.

**Examples of evidence:** analysis of financing options; financial modelling reports; financial risk analysis; financial plans; financial status reports; reports on geothermal resource viability; third party review reports; annual financial reports for company, project, and principal off-taker(s); market research; research and development program; evidence of application of new solutions; awards and external recognition for innovation and/or research and development program; examples of new products; examples of expansion into new markets; examples of response to market demands.

## O-8 Project Benefits

This topic addresses the benefits that were committed to alongside the development of the geothermal facility and subsequent emerging opportunities for beneficial utilization,

The intent is that commitments to additional benefits and benefit sharing strategies made during development of the geothermal facility are fulfilled, and that communities affected by the geothermal development have benefitted.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Monitoring is being undertaken to assess if commitments to project benefits have been delivered and if management measures are effective; and ongoing or emerging issues relating to delivery of project benefits have been identified.

**Management:** Measures are in place to deliver commitments to project benefits, and to manage any identified issues relating to these commitments; and commitments to project benefits are publicly disclosed.

**Conformance/Compliance:** Processes and objectives in place to manage project benefits have been and are on track to be met with no significant non-compliances or non-conformances, and commitments have been or are on track to be met.

**Outcomes:** Communities directly affected by the development of the geothermal facility and any other identified beneficiary of the facility have received or are on track to receive benefits.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging issues relating to project benefits takes into account both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to risks and opportunities.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, benefits are significant and sustained for communities affected by the project.

## Assessment Guidance:

**Benefits** may take the form of additional benefits, or benefit-sharing strategies.

**Additional benefits** refers to benefits that can be leveraged from the project; examples include: capacity building, training and local employment; infrastructure such as bridges and access roads; improved services such as for health and education; support for other geothermal usages or benefits associated with further utilization of the geothermal resource or excess heat like for spa resort, food production and processing, chemical production, etc.

**Benefit sharing** is distinct from one-time compensation payments or resettlement support; examples include:

- equitable access to energy services and, if applicable other multiple use – project affected communities are among the first to be able to access the benefits of energy services from the project, subject to contextual constraints (e.g. power safety, preference);
- non-monetary entitlements to enhance resource access – project affected communities receive enhanced local access to natural resources;
- revenue sharing – project affected communities share the direct monetary benefits of geothermal energy installations according to an approach defined in regulations; this goes beyond a one-time compensation payment or short-term resettlement support; and trust funds.

**Commitments** to additional benefits or benefit sharing may be the responsibility of a third party and not the owner/operator.

**Potential interviewees:** relevant station or company manager; government representative (e.g. department of economic development); stakeholder representatives; project affected community representatives.

**Examples of evidence:** pre-project analysis of relevant development indicators; pre-project analysis of potential project benefits; pre-project analysis of benefit sharing options and opportunities; pre-project meeting minutes or reports demonstrating stakeholder input and involvement; benefit sharing plan; commitments to project benefits; monitoring reports on delivery and status of project benefits.

## O-9 Project-Affected Communities & Livelihoods

This topic addresses how impacts of development and operation of the geothermal facility on project affected communities have been addressed.

The intent is that livelihoods and living standards impacted by the project have been improved relative to pre-project conditions for project affected communities with the aim of self-sufficiency in the long-term, and that commitments to project affected communities have been fully fulfilled.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Monitoring is being undertaken to assess if commitments to project affected communities have been delivered and if management measures are effective; and ongoing or emerging issues that affect project affected communities have been identified.

**Management:** Measures are in place to deliver commitments to project affected communities, and to manage any identified issues relating to these commitments; and if there are any formal agreements with project affected communities these are publicly disclosed.

**Stakeholder Engagement:** Ongoing processes are in place for project affected communities to raise issues and get feedback.

**Conformance/Compliance:** Processes and objectives in place to manage delivery of commitments to project affected communities have been and are on track to be met with no significant non-compliances or non-conformances, and commitments have been or are on track to be met.

**Outcomes:** Livelihoods and living standards impacted by the project have been or are on track to be improved; and economic displacement has been fairly compensated, preferably through provision of comparable goods, property or services.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging issues for project affected communities takes into consideration both risks and opportunities, and interrelationships amongst issues.

**Management:** In addition, processes are in place to anticipate and respond to risks and opportunities.

**Stakeholder Engagement:** In addition, feedback on how issues raised are taken into consideration is thorough and timely, and project affected communities have been involved in decision-making around relevant issues and options.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, the measures put in place to improve livelihoods and living standards are on track to become self-sustaining in the long-term.

## Assessment Guidance:

**Project affected communities** are the interacting population of various kinds of individuals in the area surrounding the geothermal project who have been affected either positively or negatively by the geothermal facility development and its associated infrastructure.

**Issues that affect project affected communities** may include, for example: loss or constraints on livelihoods, lowering of living standards, or economic displacement brought about due to changes associated with the project. Specific examples could include: impacts on cultural practices; impacts on lands and forest; loss of agricultural lands, loss of hot springs and tourist attractions, loss of access to sacred sites, to community forest etc. In cases the impacts may result in project affected communities needing to move, but they may not be considered part of the resettlement community because the physical resettlement was a secondary impact and not a primary impact of the project.

**Livelihood** refers to the capabilities, assets (stores, resources, claims and access) and activities required for a means of living. **Improvement of livelihoods** refers to compensatory measures taken to address impacts of the project on pre-project livelihoods so that those affected are able to move forward with viable livelihoods with improved capabilities or assets relative to the pre-project conditions; for example supporting farmers to continue to be able to farm or to pursue alternatives, accompanied by sufficient support mechanisms that not only enable any changes to livelihoods to be well-established but also so that they have increased capabilities or access to the necessary resources (including training, information, materials, access, supplies etc).

**Living standards** refer to the level of material comfort as measured by the goods, services, and luxuries available to an individual, group, or nation; indicators of household well-being examples include: consumption, income, savings, employment, health, education, nutrition, housing, and access to electricity, hot water, clean water, sanitation, health services, educational services, transport, etc. Improvement in living standards would be demonstrated by improvement in the indicators of the level of material comfort.

**Economic displacement** refers to the loss of assets, access to assets, or income sources or means of livelihoods as a result of (i) acquisition of land, (ii) changes in land use or access to land, (iii) restriction on land use or access to natural resources including water resources, legally designated parks, protected areas or restricted access areas such as reservoir catchments and (iv) changes in environment leading to health concerns or impacts on livelihoods. Economic displacement applies whether such losses and restrictions are full or partial, and permanent or temporary.

**Measures to address project affected communities** issues may include, for example: improved traffic infrastructure and access to communications; access agreements to project lands to enable continued access to sacred sites, community forest, traditional medicinal plants; support for new industries, e.g. related to further use of the geothermal resource; protection of sacred sites; etc.

**Opportunities for project-affected communities** may include, for example: training and capacity building; education; health services; employment; transportation; contributions to provide for cultural traditions or events, etc.

**Potential interviewees:** representatives of project affected communities; station or company social issues manager; government expert; independent experts

**Examples of evidence:** assessment report on project affected communities and livelihoods; gender analysis; human rights issues analysis; records of consultation and project affected community involvement; records of response to project affected community issues; third party review report; report on compensation measures; agreements on compensation measures; assessments and agreements on cultural sensitive areas and customs.

## O-10 Resettlement

This topic addresses how the physical displacement arising from development and operation of the geothermal facility has been addressed.

The intent is that the dignity and human rights of those physically displaced have been respected; that these matters have been dealt with in a fair and equitable manner; that livelihoods and standards of living for resettlees and host communities have been improved; and that commitments made to resettlees and host communities have been fully fulfilled.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Monitoring is being undertaken to assess if commitments made to resettlees and host communities have been delivered and if management measures are effective; and ongoing or emerging issues relating to resettlement have been identified.

**Management:** Measures to address resettlement are documented in a Resettlement Action Plan; measures are in place to deliver commitments to resettlees and host communities, and to manage any issues relating to resettlement, including provision of grievance mechanisms; and formal agreements with resettlees and host communities are publicly disclosed.

**Stakeholder Engagement:** Ongoing processes are in place for resettlees and host communities to raise issues and get feedback.

**Conformance/Compliance:** Processes and objectives in the Resettlement Action Plan have been and are on track to be met with no major non-compliances or non-conformances, and any resettlement related commitments have been or are on track to be met.

**Outcomes:** Resettlement has been and is being treated in a fair and equitable manner, and resettlees and host communities have experienced or are on track to experience a timely improvement in livelihoods and living standards relative to the pre-project baseline.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging resettlement issues takes into account both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities.

**Stakeholder Engagement:** In addition, feedback on how issues raised have been taken into consideration has been thorough and timely, and resettlees and host communities have been involved in decision-making around relevant issues and options.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, the measures put in place to improve livelihoods and living standards are on track to become self-sustaining in the long-term.

## Assessment Guidance:

**Resettlement** is the process of moving people to a different place to live, because due to the project they are no longer allowed to stay in the area where they used to live.

**Livelihood** refers to the capabilities, assets (stores, resources, claims and access) and activities required for a means of living. **Improvement of livelihoods** refers to compensatory measures taken to address impacts of the project on pre-project livelihoods so that those affected are able to move forward with viable livelihoods with improved capabilities or assets relative to the pre-project conditions; for example supporting farmers to continue to be able to farm or to pursue alternatives, accompanied by sufficient support mechanisms that not only enable any changes to livelihoods to be well-established but also so that they have increased capabilities or access to the necessary resources (including training, information, materials, access, supplies etc).

**Living standards** refer to the level of material comfort as measured by the goods, services, and luxuries available to an individual, group, or nation; indicators of household well-being examples include: consumption, income, savings, employment, health, education, nutrition, housing, and access to electricity, clean water, sanitation, health services, educational services, transport, etc.

**Resettlees** are those people who are required to be resettled, and including those who have formal legal rights, customary or traditional rights, as well as those who have no recognizable rights to the land.

**Host communities** refers to the communities to which resettlees are relocated.

**Resettlement Action Plan** refers to a document or set of documents specifically developed to identify the actions that will be taken to address resettlement. It would typically

include identification of those being resettled; the socioeconomic baseline for the resettlees; the measures to be implemented as part of the resettlement process including those relating to resettlement assistance and livelihood support; the legal and compensation frameworks; organisational roles and responsibilities; budget allocation and financial management; the timeframe, objectives and targets; grievance redress mechanisms; monitoring, reporting and review provisions; and understandings around consultation, participation and information exchange. In cases where resettlees' livelihoods have been land-based, and where consistent with resettlees' preferences, strong consideration may be given to land-for-land compensation.

**Grievance mechanisms** refer to the processes by which stakeholders are able to raise concerns, grievances and legitimate complaints, as well as the project procedures to track and respond to any grievances.

**Potential interviewees:** community representatives affected by resettlement and land acquisition; representatives from resettlement host communities; station or company social issues manager; representative from the responsible governmental authority, independent reviewer.

**Examples of evidence:** assessment report on resettlement and land acquisition; records of consultation and affected stakeholder involvement; records of response to resettlement and land acquisition issues; third party review report; resettlement action plans; land acquisition plans; compensation agreements; agreements on resettlement action plan; baseline social conditions report; livelihood analysis; impoverishment risk analysis; mitigation, resettlement and development action plans, including project benefit sharing mechanisms; NGO reports; monitoring reports.

## O-11 Indigenous Peoples

This topic addresses the rights, risks and opportunities of indigenous peoples with respect to the geothermal facility, recognising that as social groups with identities distinct from dominant groups in national societies, they are often the most marginalized and vulnerable segments of the population.

The intent is that the operating facility respects the dignity, human rights, aspirations, culture, lands, knowledge, practices and natural resource-based livelihoods of indigenous peoples in an ongoing manner throughout the project life.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Ongoing or emerging issues relating to the operating geothermal facility that may affect indigenous peoples have been identified, and if management measures are required then monitoring is being undertaken to assess if management measures are effective.

**Management:** Measures are in place to manage identified issues; and formal agreements with indigenous peoples are publicly disclosed.

**Stakeholder Engagement:** Ongoing and mutually agreed processes are in place for indigenous peoples to raise issues and get feedback.

**Conformance/Compliance:** Processes and objectives in place to manage issues that may affect indigenous peoples have been and are on track to be met with no significant non-compliances or non-conformances, and commitments made to indigenous peoples have been or are on track to be met.

**Outcomes:** The rights of indigenous peoples affected by the operating geothermal facility are respected in an ongoing manner.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of issues that may affect indigenous peoples is undertaken with the free, prior and informed participation of indigenous peoples; and takes into account both risks and opportunities.

**Management:** In addition, measures to address ongoing or emerging issues that may affect indigenous peoples have been developed with the free, prior and informed participation of indigenous peoples; and processes are in place to anticipate and respond to emerging risks and opportunities.

**Stakeholder Engagement:** In addition, feedback on how issues raised have been taken into consideration has been thorough and timely; and directly affected indigenous peoples have been involved in decision-making around relevant issues and options.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, where opportunities have been identified, measures to address issues that may affect indigenous peoples beyond those impacts caused by the operating geothermal facility have been or are on track to be achieved.



## Assessment Guidance:

**Topic relevance:** This topic will not be relevant if credible evidence provided shows that there are no indigenous peoples in the area affected by the operating geothermal facility.

**Indigenous peoples** refers to a distinct social and cultural group possessing the following characteristics in varying degrees: self-identification as members of a distinct indigenous cultural group and recognition of this identity by others; collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories; customary cultural, economic, social or political institutions that are separate from those of the dominant society or culture; an indigenous language, often different from the official language of the country or part of the country in which they reside. In some countries, interactions with indigenous peoples may be required to be conducted through a specific government agency.

**Issues that may affect indigenous peoples** are ideally self-identified, and may include, for example: impacts of the operating geothermal facility activities and infrastructure on cultural practices, direct or indirect impacts to traditional lands, impacts to community cohesion, public health risks, disturbance of customary practices, and impeded access to natural resource-based livelihoods, potential land use conflicts.

**Measures to address issues that may affect indigenous peoples** are ideally self-identified, and may include, for example: avoidance measures, protection of cultural practices, land entitlement and protection, health assistance, scheduling of activities of the operating geothermal facility to not disturb customary practices, support for festivals or traditions, improved or more secure access to natural resource-based livelihoods, etc.

**Potential interviewees:** representatives of project affected indigenous communities; station or company social issues manager; representative from the responsible governmental authority, independent reviewer

**Examples of evidence:** assessment report on indigenous peoples; records of consultation and project affected community involvement; records of response to issues that may affect indigenous peoples; third party review report; indigenous peoples management plans; agreements on measures for indigenous peoples; monitoring reports

## O-12 Labour & Working Conditions

This topic addresses labour and working conditions, including employee and contractor opportunity, equity, diversity, health and safety.

The intent is that workers are treated fairly and protected.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** A periodically updated assessment has been undertaken of human resource and labour management requirements for the operating facility, including occupational health and safety (OH&S) issues, risks, and management measures, with no significant gaps; monitoring is being undertaken to assess if management measures are effective; and ongoing or emerging labour management issues have been identified.

**Management:** Human resource and labour management policies, plans and processes are in place to address all labour management planning components, including those of contractors, subcontractors, and intermediaries, with no significant gaps.

**Stakeholder Engagement:** Ongoing processes are in place for employees and contractors to raise human resources and labour management issues and get feedback.

**Conformance/Compliance:** Processes and objectives relating to human resource and labour management have been and are on track to be met with no major non-compliances or non-conformances, and any labour related commitments have been or are on track to be met.

**Outcomes:** There are no identified inconsistencies of labour management policies, plans and practices with internationally recognised labour rights.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging labour management issues takes broad considerations into account, and both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities.

**Stakeholder Engagement:** In addition, feedback on how issues raised have been taken into consideration has been thorough and timely.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, labour management policies, plans and practices are demonstrated to be consistent with internationally recognised labour rights.

## Assessment Guidance:

**Labour management planning components** include: human resources policies, staff and workforce planning, occupational health and safety, equal opportunity, staff development and training, grievance mechanisms, and (where appropriate) collective bargaining mechanisms.

**Occupational health and safety** is about protecting the safety, health and welfare of people engaged in work or employment, for example through preventing disease or injury that might arise as a direct result of the workplace activities.

**Intermediaries** are workers engaged through third parties who are either performing work directly related to the functions essential for the project for a substantial duration, or who are geographically working at the project location.

**Broad considerations** might be exhibited by, for example: a broad view of relevant issues; a broad approach to types of data collection and important indicators; a focus on interrelationships amongst issues; a broad analysis of trends, approaches and existing and emerging standards relating to labour and working conditions; understanding of relevant human rights; etc.

**Internationally recognised labour rights** are documented in places such as the IFC Performance Standard 2, the International Labour Organisation standards, and the Human

Rights Council 2008 Report of John Ruggie “Protect, Respect and Remedy: a Framework for Business and Human Rights”. They include freedom of association, right to equal pay for equal work, right to organize and participate in collective bargaining, right to equality at work, right to non-discrimination, right to just and favourable remuneration, abolition of slavery and forced labour, right to a safe work environment, abolition of child labour, right to rest and leisure, right to work, right to family life. Evidence of no inconsistencies would be no policies, plans or practices that show workers are prevented from the ability to exercise these rights; evidence of consistency could be for example an analysis of alignment.

**Potential interviewees:** station or company human resources staff; contracted workforce manager, station or company safety officer; staff or contractor representatives; external experts; unions and shop stewards; female workers.

**Examples of evidence:** policies, plans and programs relating to human resources, employees, contractors, equity, occupational health & safety, workforce planning, and grievance mechanisms; national and international standards for labour and OH&S.

## O-13 Cultural Heritage

This topic addresses cultural heritage, with specific reference to physical cultural resources, associated with the geothermal facility.

The intent is that physical cultural resources are identified, their importance is understood, and measures are in place to address those identified to be of high importance.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Ongoing or emerging cultural heritage issues with respect to physical cultural resources have been identified, and if management measures are required then monitoring is being undertaken to assess if management measures are effective.

**Management:** Measures are in place to manage identified cultural heritage issues.

**Conformance/Compliance:** Processes and objectives in place to manage cultural heritage issues have been and are on track to be met with no significant non-compliances or non-conformances, and cultural heritage related commitments have been or are on track to be met.

**Outcomes:** Negative cultural heritage impacts arising from activities of the operating geothermal facility are avoided, minimised, mitigated and compensated with no significant gaps.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging cultural heritage issues takes broad considerations into account, and both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, where opportunities have been identified, measures to address cultural heritage issues beyond those impacts caused by the facility have been or are on track to be achieved.

## Assessment Guidance:

**Topic relevance:** This topic will not be relevant if credible evidence provided shows that there were no physical cultural resources identified in the project-affected area, and that there are no physical cultural resources identified in the area affected by the operating geothermal facility.

**Cultural heritage** refers to the legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations.

**Physical cultural resources** refer to movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings, and may be above or below ground, or under water. Their cultural interest may be at the local, provincial or national level, or within the international community.

**Non-physical cultural heritage** examples include: traditions, festivals, rituals, folklore, storytelling, drama, etc. If of relevance, these should be addressed under Topic O-3 Environmental & Social Issues Management in this Protocol assessment.

**Cultural heritage issues** may be ongoing issues that arose during project development and have not been resolved, such as for example: damage or destruction to important sites or artefacts due to drilling and construction activities; loss of access to important sites due to changes to access routes (e.g. pipelines or linear infrastructure with barrier fencing, major roads); disturbance of spirits associated with special sites; etc; or they may be emerging issues such as further maintenance or upgrading construction exposing new artefacts, or developments in policies, legislation or standards changing expectations on how cultural heritage issues will be addressed.

**Measures to address cultural heritage issues** may include, for example: documentation and recordkeeping; relocation; creation of protected areas; new access routes; appeasement ceremonies; etc.

**Avoid, minimise, mitigate and compensate** is a concise expression for what is understood to be a sequential process. Measures to avoid or prevent negative or adverse impacts are always prioritised, and where avoidance is not practicable, then minimisation of adverse impacts is sought. Where avoidance and minimisation are not practicable, then mitigation and compensation measures are identified and undertaken commensurate with the project's risks and impacts.

**Protection** means to keep in safety and protect from harm, decay, loss, damage or destruction.

**Broad considerations** might be exhibited by, for example: a broad view of relevant issues; a broad approach to types of data collection; a focus on interrelationships amongst issues; a broad analysis of trends, approaches and existing and emerging standards relating to cultural heritage; a broad perspective with respect to the assessment of significance of heritage finds; etc.

**Cultural heritage** opportunities may include, for example: partnerships with heritage organisations; establishment of initiatives recognising heritage values such as festivals, museums or visiting experts; programmes to preserve traditional activities; access to special grants for heritage protection works; exhibits; educational initiatives; etc.

**Potential interviewees:** station or company environmental and social issues manager, local cultural heritage expert, representative from relevant government department (e.g. heritage or environment); external experts; project affected community representatives.

**Examples of evidence:** cultural heritage impact statements; conservation plans; records of consultation and response to stakeholder issues; heritage plans and agreements; national and international standards; monitoring and inspection reports.

## O-14 Biodiversity & Invasive Species

This topic addresses ecosystem values, habitat, species and specific issues such as threatened species in the geothermal development areas and surrounding, as well as potential impacts arising from pest and invasive species associated with the operating geothermal facility.

The intent is that there are healthy, functional and viable aquatic and terrestrial ecosystems in the area that are sustainable over the long-term; that biodiversity impacts arising from the operating geothermal facility are managed responsibly; that ongoing or emerging biodiversity issues are identified and addressed as required; and that commitments to implement biodiversity and invasive species measures are fulfilled.

### Scoring:

- 1 *There are significant gaps relative to basic good practice.*
- 2 *Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*
- 3 **Assessment:** Ongoing or emerging biodiversity issues have been identified, and if management measures are required then monitoring is being undertaken to assess if management measures are effective.  
**Management:** Measures are in place to manage identified biodiversity issues.  
**Conformance/Compliance:** Processes and objectives in place to manage biodiversity issues have been and are on track to be met with no significant non-compliances or non-conformances, and biodiversity related commitments have been or are on track to be met.  
**Outcomes:** Negative biodiversity impacts arising from activities of the operating facility are avoided, minimised, mitigated, and compensated with no significant gaps
- 4 *All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*
- 5 **Assessment:** In addition, identification of ongoing or emerging biodiversity issues takes into account both risks and opportunities.  
**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities.  
**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.  
**Outcomes:** In addition, there are healthy, functional and viable aquatic and terrestrial ecosystems in the area affected by the geothermal facility that are sustained over the long-term; or the facility has contributed or is on track to contribute to addressing biodiversity issues beyond those impacts caused by the operating geothermal facility.

## Assessment Guidance:

**Biodiversity issues** may include, for example: loss of habitat; loss of habitat connectivity; loss of thermophilic biodiversity, loss or declines in important food chain species; loss of wetlands; poaching, hunting or over-exploitation of significant species; introduction of weed or pest species; etc.

**Measures to address biodiversity** may include, for example: creation of reserves, habitat conservation and improvement, species management plans, translocations, habitat rehabilitation, new habitat creation, etc. Measures to address invasive species may include, for example: physical barriers to pest species passage, pollution control, physical removal or containment, chemical treatment, etc.

**Avoid, minimise, mitigate and compensate** is a concise expression for what is understood to be a sequential process. Measures to avoid or prevent negative or adverse impacts are always prioritised, and where avoidance is not practicable, then minimisation of adverse impacts is sought. Where avoidance and minimisation are not practicable, then mitigation and compensation measures are identified and undertaken commensurate with the project's risks and impacts.

**Compensate** in the context of biodiversity impacts in cases may be in the form of establishing or supporting offset programs. Offsets are measurable conservation outcomes resulting from actions designed to compensate for significant adverse biodiversity impacts arising from project development and persisting after appropriate avoidance, minimization, and restoration measures have been taken. These can be outside the project site.

**Biodiversity opportunities** may include, for example, forming partnerships with wildlife protection groups; geothermal development area management committees and projects; joint research ventures around volcanic features; employing or working with local communities to act as wardens for protected areas; capacity building and educational initiatives, eco-tourism ventures, creation of geothermal habitat sanctuaries, wetland protection, etc.

**Potential interviewees:** station or company environmental manager; aquatic and terrestrial ecologists; representatives of relevant government departments (e.g. thermophilic flora and fauna, wildlife, environment); representatives of local communities; independent experts.

**Examples of evidence:** assessment of terrestrial and aquatic biodiversity; third party review reports; biodiversity management plans; invasive species management plans; commitments and agreements; economic and livelihood valuation from local communities; monitoring reports.

## O-15 Induced Seismicity and Subsidence

This topic addresses the management of induced seismicity and subsidence associated with the operating geothermal facility.

The intent is that physical impacts such as induced seismicity and subsidence caused by the operating geothermal facility are managed responsibly and do not present problems with respect to other social, environmental and economic objectives; that these impacts are recognised and managed; and that commitments to implement measures to address these impacts are fulfilled.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Ongoing or emerging induced seismicity and subsidence issues have been identified, and if management measures are required then monitoring is being undertaken to assess if management measures are effective.

**Management:** Measures are in place to manage identified induced seismicity and subsidence issues.

**Conformance/Compliance:** Processes and objectives in place to manage induced seismicity and subsidence issues and regulatory requirements, if applicable, have been and are on track to be met with no significant non-compliances or non-conformances, and induced seismicity and subsidence related commitments have been or are on track to be met.

**Stakeholder Engagement:** The induced seismicity and subsidence issues, as relevant, have been explained and discussed with directly affected stakeholders; ongoing processes are in place for stakeholders to raise issues and get feedback.

**Outcomes:** Induced seismicity and subsidence issues are avoided, minimised and mitigated with no significant gaps.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging induced seismicity and subsidence issues takes into account both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Stakeholder Engagement:** In addition, engagement with directly affected stakeholders has been inclusive, and participatory; and feedback on how issues raised have been taken into consideration has been thorough and timely.

**Outcomes:** In addition, induced seismicity and subsidence associated with operating facility do not present ongoing problems for environmental, social and economic objectives of the facility or the project affected areas.



## Assessment Guidance:

**Induced seismicity issues** that may be caused by the operation of the geothermal facility are related to injection of fluid into wells. The purpose of the injection can be: environmental disposal; maintaining of pressure and fluid in the aquifer/bedrock; a requirement of the operating permit or regulation; well stimulation by hydraulic pressure to enhance yield of existing or new wells. In the case of EGS systems (Enhanced Geothermal Systems) the purpose of the injection is to enhance bedrock permeability by hydraulic shearing or fracking and to facilitate circulation of fluid through the reservoir for operation.

**Subsidence issues** that may be caused by the project are related to the exploitation of the geothermal field. The withdrawal of geothermal fluid and the resulting lowering of pressure can result in localized subsidence in the area of the well fields, mostly vertical and, to a lesser extent, horizontal displacements. The countermeasure applied is re-injection of fluid.

**Issues that may impact on the operating geothermal facility** itself are ground movements (seismicity and subsidence) that can affect stability and integrity of project structures and operation and durability of equipment.

**Assessment** of geological and geophysical conditions to address induced seismicity and subsidence risks includes natural seismic and induced seismic potential and geological conditions that can result in subsidence.

**Measures to address induced seismicity and subsidence** issues might include, for example: monitoring networks for seismic measurements and topographic surface ground displacements; risk assessment and mitigating strategies and plans for different degrees of seismic or topographic movements; procedures for evaluation and remedy of eventual inconvenience or damage of property; plans for dialogue with regional authorities, education of stakeholders and the general public and interaction with stakeholders; etc.

**Avoid, minimise, mitigate and compensate** is a concise expression for what is understood to be a sequential process. Measures to avoid or prevent negative or adverse impacts are always prioritised, and where avoidance is not practicable, then minimisation of adverse impacts is sought. Where avoidance and minimisation are not practicable, then mitigation and compensation measures are identified and undertaken commensurate with the project's risks and impacts.

**Potential interviewees:** station or company environmental manager; geological or/and geophysical experts; independent expert; project communications staff; local and regulatory authorities; stakeholder representatives; project affected community representatives.

**Examples of evidence:** Induced seismicity and subsidence assessment reports; induced seismicity and subsidence management plans; monitoring reports.

## O-16 Air and Water Quality

This topic addresses the management of air and water quality issues associated with the operating geothermal facility.

The intent is that air and water quality in the vicinity of the operating geothermal facility is not adversely impacted by activities of the operator; that ongoing or emerging air and water quality issues are identified and addressed as required; and commitments to implement measures to address air and water quality are fulfilled.

### Scoring:

1

*There are significant gaps relative to basic good practice.*

2

*Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3

**Assessment:** Ongoing or emerging air and water quality issues have been identified, and if management measures are required then monitoring is being undertaken to assess if management measures are effective.

**Management:** Measures are in place to manage identified air and water quality issues.

**Conformance/Compliance:** Processes and objectives in place to manage air and water quality issues have been and are on track to be met with no significant non-compliances or non-conformances, and air and water quality related commitments and regulatory requirements as relevant have been or are on track to be met.

**Outcomes:** Negative air and water quality impacts arising from activities of the operating geothermal facility are avoided, minimised and mitigated with no significant gaps.

4

*All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5

**Assessment:** In addition, identification of ongoing or emerging air and water quality issues takes into account both risks and opportunities.

**Management:** In addition, processes are in place to anticipate and respond to emerging risks and opportunities.

**Conformance/Compliance:** In addition, there are no non-compliances or non-conformances.

**Outcomes:** In addition, air and water quality in the area affected by the operating geothermal facility is of a high quality; or the facility has contributed or is on track to contribute to addressing air and water quality issues beyond those impacts caused by the operating geothermal facility.

## Assessment Guidance:

Air and water quality issues examples at the operation stage include: contamination of streams, lakes and groundwater aquifers by geothermal fluid discharge, air pollution by various geothermal gas emissions and fluid and airborne emissions from operational and service equipment, chemical or waste spills, etc.

Main geothermal pollutants are non-condensable gases (NCG) such as CO<sub>2</sub> and H<sub>2</sub>S and chemical elements such as Rn, Hg and As; drilling of make-up wells involves discharge of fluids and gases.

Air quality **management measures** involve NGC gas distribution monitoring program and prediction modelling to find the impacts on local air quality, based on meteorological data etc. and plans for mitigation measures. Water quality management measures involve monitoring programs and modelling of the disposal of geothermal fluid to surface, groundwater and the geothermal reservoir. Management processes for air and water quality may be built into other plans and processes, e.g. visual inspections undertaken for operational purposes.

Measures to address air and water quality at the operation stage may include, for example: special discharge and emission measures including eventual re-injection; vegetation and soil management to address surface disturbance and effects of discharge and emission; addressing pollutants from non-project activities such as sewage, wastes, contaminated sites, etc. Monitoring programs.

**Avoid, minimise, mitigate and compensate** is a concise expression for what is understood to be a sequential process. Measures to avoid or prevent negative or adverse impacts are always prioritised, and where avoidance is not practicable, then minimisation of adverse impacts is sought. Where avoidance and minimisation are not practicable, then mitigation and compensation measures are identified and undertaken commensurate with the project's risks and impacts.

**Air and water quality opportunities** may include, for example: reduction of greenhouse gas emissions, addressing pollutants from non-project activities such as sewage, wastes, contaminated sites; new technologies; new service providers; participating in or forming local community management groups to address water quality issues at the local community level; etc.

**Potential interviewees:** station or company environmental manager; government and municipal representative (e.g. from environment departments), representatives of local communities; independent expert.

**Examples of evidence:** air and water quality monitoring reports; air and water quality management plans.

## O-17 Climate Change Mitigation and Resilience

This topic addresses the estimation and management of the project's greenhouse gas (GHG) emissions, analysis and management of potential risks of climate change for the project, and the project's role in climate change adaptation. The intent is that the project's GHG emissions are consistent with low carbon power and heat generation, the project is resilient to the effects of climate change, and the project contributes to wider adaptation to climate change.

### Scoring:

1 *There are significant gaps relative to basic good practice.*

2 *Most relevant elements of basic good practice have been undertaken, but there is one significant gap.*

3 **Assessment:**

For climate mitigation: if estimates of net GHG emissions (gCO<sub>2</sub>e) of energy generation (electricity plus heat) are calculated and independently verified, and periodically updated; if estimated emissions are above 100 gCO<sub>2</sub>e/kWh, a site-specific assessment of GHG emissions is undertaken and periodically updated.

For climate resilience: an assessment of the project's resilience to climate change is undertaken and periodically updated; this assessment of project resilience incorporates an assessment of plausible climate change, identifies a range of resulting climatological conditions at the project site, and applies these conditions in a documented risk assessment or stress test, other infrastructural resilience, environmental and social risks, and power and heat generation availability.

**Management:**

For climate mitigation: if GHG emissions estimates assume management measures, these measures are in place.

For climate resilience: measures are in place to avoid or reduce identified climate risks.

**Stakeholder Engagement:**

For climate mitigation: estimated GHG emissions and / or the results of a site-specific assessment are publicly disclosed.

For climate resilience: ongoing processes are in place for stakeholders to raise issues and get feedback on the management of climate risks.

**Conformance/Compliance:**

Processes and objectives relating to climate change mitigation and resilience have been and are on track to be met with no significant non-compliances or non-conformances, and any mitigation-related and resilience-related commitments have been or are on track to be met.

**Outcomes:**

For climate mitigation: the project's GHG emissions are demonstrated to be consistent with low carbon power and heat generation.

For climate resilience: findings of the climate change assessment indicate that the project is resilient to climate change.

4 *All relevant elements of basic good practice have been undertaken and in one or more cases exceeded, but there is one significant gap in the requirements for proven best practice.*

5 **Assessment:**

For climate mitigation: in addition, if a site-specific assessment is required, it incorporates a broad range of scenarios, uncertainties and risks.

For climate resilience: in addition, if a site-specific assessment of resilience is required, it can for example incorporate sensitivity analysis, project-specific modelling using recognized models, and the project's opportunities to provide adaptation services are considered on an ongoing basis.

**Management:**

For climate mitigation: management measures are in place to respond to risks and opportunities including offsetting emissions, for example by reinjecting the GHGs, use of GHGs for production of products; plans are in place to monitor parameters used in GHG emissions estimates or to monitor GHG stocks.

For climate resilience: in addition, measures take account of a broad range of risks and interrelationships, and processes are in place to respond to unanticipated climate change; and plans are in place to provide adaptation services if necessary.

**Stakeholder Engagement:**

In addition, the assessment of project resilience is publicly disclosed.

**Conformance/Compliance:**

In addition, there are no non-compliances or non-conformances.

**Outcomes:**

For climate mitigation: in addition, project net emissions are minimised or project operations facilitate system emissions reductions.

For climate resilience: in addition, the project is resilient under a broad range of scenarios; and the project will contribute to climate change adaptation at a local, regional or national levels.

## Assessment Guidance:

**Topic relevance:** This topic is always relevant, including for older projects that were developed without any consideration of climate change. The role of older projects in climate change mitigation and their resilience can be assessed and enhanced during operation.

**Climate change mitigation** is defined, by the Intergovernmental Panel on Climate Change (IPCC, Fifth Assessment Report, glossary), as a human intervention to reduce the sources or enhance the sinks of GHG and other substances which may contribute directly or indirectly to climate change.

**Resilience** is the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation (IPCC, Fifth Assessment Report, glossary).

**Climate Change adaptation** is defined by the Intergovernmental Panel on Climate Change (IPCC, Fifth Assessment Report, glossary) as the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

**Net GHG emissions estimates** should deliver an estimate of emissions in gCO<sub>2</sub>e per kWh, using recognized methods and site/reservoir specific calculations. For older projects, a comparison with current system emissions intensity has been made. Recognised tools or site and reservoir specific calculations should take into account pre-construction baseline emissions if available, chemical analysis of the fluid, emissions from construction and ongoing operational activities, the life cycle of the project (at least 30 years), and the allocation of emissions between electricity generation and other services provided by multipurpose projects as applicable.

For the purposes of the assessment, **system emissions** shall mean greenhouse gas emissions associated with the local, regional or national power grid and energy infrastructure to which the project is connected.

**Older projects** are defined as those commissioned prior to 2004.

The estimation of GHG emissions may be an **iterative process**. For projects with emissions estimated at more than 100 gCO<sub>2</sub>e per kWh, operational measures would be identified to lower emissions below this figure.

**A broad range of scenarios, uncertainties and risks in emissions assessment** would encompass potential changes of the content of GHGs in the geothermal fluid and if relevant, the injection rate.

**Operational measures** to manage emissions can include the capture of emissions, reinjection, use and/or storage.

Consideration has been given to use the residual heat; for example for heating or cooling.

**Measures to respond to risks of higher emissions than anticipated** may include design features or operational measures that can be instigated in response to emissions measurements.

**Opportunities concerning emissions reductions** include opportunities to increase the efficiency of the turbines, use the effluent heat and use the gases for production of products.

**Consistency with low carbon power/energy generation** may be demonstrated by alignment with national plans for mitigation, and: or net emissions intensity that is less than internationally recognised thresholds at the time of the assessment (such as less than 100 gCO<sub>2</sub>e/kWh); or in the case of older projects, current emissions intensity lower than current emissions intensity at the system level.

**A risk assessment or stress test** would be documented, for example in a risk register or matrix. This would set out the range of potential risks and hazards, assess the probability and magnitude of the impacts of each. It would identify and prioritise measures to avoid, minimise and mitigate the risks and impacts, and promote an approach of decision-making under uncertainty.

**Measures for project resilience** may not be only engineering measures. Non-engineering measures may include risk monitoring and risk management plans, disaster risk reduction and management plans, or other climate risk management plans.

**Sensitivity analysis** in the assessment of resilience refers to analysis of the increased probability and severity of impacts in relation to ranges of conditions.

**Risks and inter-relationships** in resilience refers to lower probability risks, and inter-relationships between issues, for example an increase in temperatures resulting in increased peak electricity demand which results in need for flexibility and in the case of combined heat and power (CHP) a changed balance in production.

**Environmental and social risks** refers to the increased risk for the local environment and communities that result from the project within a context of a changing climate.

Conversely, the project may have opportunities to provide **adaptation services** to the local environment and communities, above and beyond the risks created by the project.

**Public disclosure** of emissions calculations is important for credibility. Public disclosure refers to the disclosure of the details of the calculation, demonstrating how the calculation conforms to the emission criteria for power/energy production and public information on the project design.

In stakeholder engagement, it is important that plans for the management of environmental and social risks have been discussed with stakeholders, for example in the development of plans for emergency preparedness.

**Potential interviewees:** GHG emissions assessment researchers; verifier of GHG emissions assessment; geothermal reservoir specialists; environmental manager; social experts; regional and national climate scientists; designated national authorities (DNAs); disaster preparedness authorities; emergency response services.

**Examples of evidence:** register and methods used for sampling of fluids from the reservoir and geothermal field; chemical data for the geothermal fluids; tools and methods used for analysis of the samples; calculation of estimated emissions; climate change studies in the region; analysis of plausible climate change, and conditions at the project site;

risk assessment or stress tests; national and regional policies and plans on mitigation and adaptation; feasibility study; operational plans; environmental and social management plans; disaster preparedness and response plans; minutes of meetings with stakeholders; evidence of public disclosure, etc.