Environmental Due Diligence (EDD)

Of Renewable Energy Projects

GUIDELINES

for

Geothermal Energy Systems

Release 1.0

UNEP
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BASE

Environmental Due Diligence (EDD) process for Geothermal Energy Systems

Definition and background

Environmental Due Diligence (EDD) is the collection and assessment of data relative to environmental conditions or impacts prior to a transaction to identify and quantify environment-related financial, legal, and reputational risks.

Banks have put in place a number of instruments to manage risk. One of these instruments is commonly termed a **Due Diligence** review. This term, as well as its practice, originates from the U.S. and refers to the background work (investigation, analysis, and verification) done by a prudent entrepreneur, owner, executive, or lender when making a decision. The general intention of a due diligence review is to ensure that a projected investment does not carry financial, legal, or environmental liabilities beyond those that are clearly defined in an investment proposal. The environmental component of the due diligence procedure is referred to as environmental due diligence (EDD). Originally, lenders or investors used EDD to manage environmental risks and liabilities stemming from an investment decision. Recently, it has become a way for financial institutions to incorporate environmental and social considerations in their investment review process.

EDD has become largely standardised for many sectors, but not for all. There is a growing realisation in energy and environmental policy and research circles that procedures for environmental due diligence of Renewable Energy Technologies (RETs) are poorly defined and financiers must often adopt *ad hoc* procedures for environmental review. Although most renewable energy technologies are environmentally sound in theory, all of them can have negative impacts on the environment if poorly planned.

The Environmental Due Diligence process

The process consists of three stages (Figure 1)

1. Establishing the regulatory framework
2. Environmental appraisal
3. Monitoring the project after approval

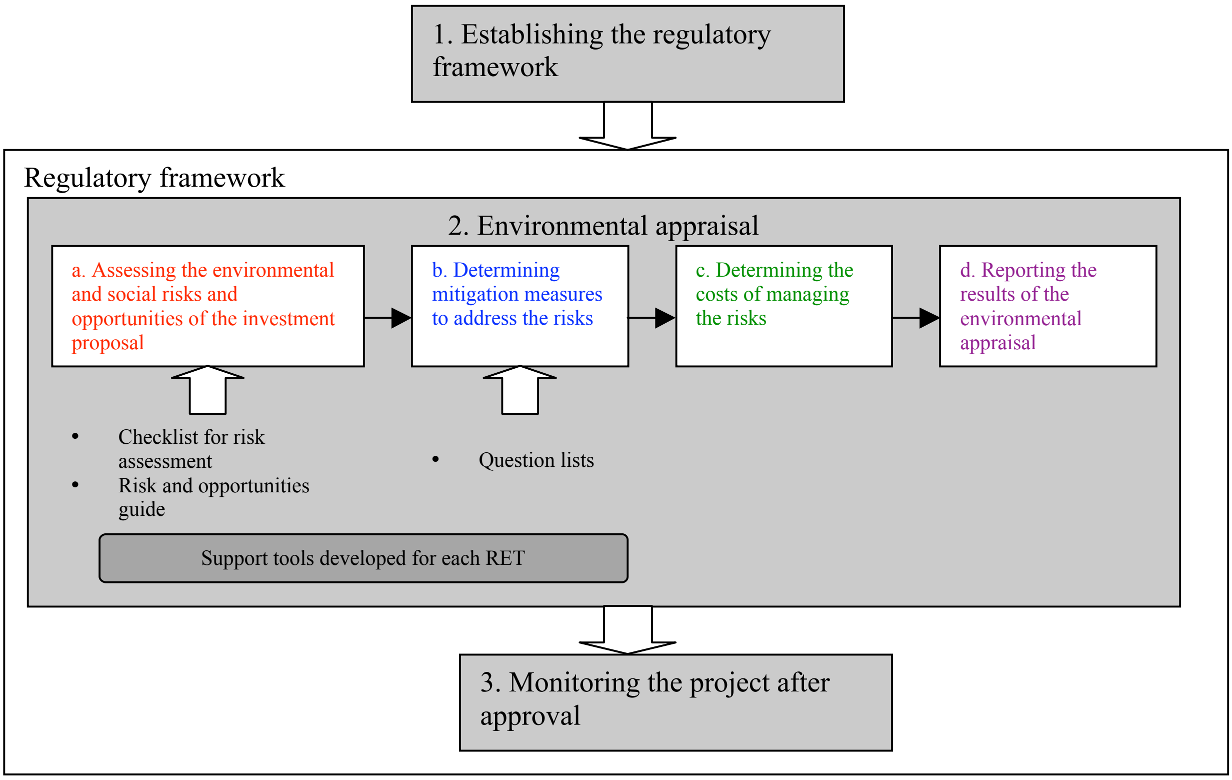

Figure 1: Procedure for environmental due diligence of RET projects

1. The first stage of the procedure is establishing the relevant regulatory framework for the project, including national regulations, international standards, and good practice guidelines.

The environmental laws provide the background for determining the main issues that should be considered during the environmental appraisal process. Environmental regulations, standards, and guidelines provide practical information concerning emission limits, permitting requirements, pollution abatement and control techniques and equipment, best management and operational practices, etc., against which the investment proposal should be benchmarked. Two timeframes must be considered for this process: first, that of existing laws and regulations that currently affect the project, and second, that of anticipated laws and regulations (e.g. in process of development, discussion, or approval) that may change the conditions under which the project must operate.

2. The second stage is the core of the entire process. It comprises four main steps: a) assessing the environmental risk; b) determining mitigation measures; c) estimating the cost of risk management; and d) reporting the results.

To facilitate the first two steps of this stage, a number of new EDD tools are proposed. These tools are intended to complement, not replace, any EDD tools currently used for environmental review procedures. In addition, it is important to note that since these tools are intended for general use, they may not reflect all the possible environmental and/or social issues related to a particular investment. The analyst should incorporate additional issues as needed.

3. The third stage is the monitoring and environmental evaluation of the project. This procedure serves two main purposes: a) to ensure that the project sponsor complies with the applicable environmental standards and various environmental components of operations included in legal agreements; b) to keep track of ongoing environmental impacts associated with project operations and of the effectiveness of any mitigation measures.

EDD Guidelines for Geothermal Energy Projects

The guidelines for EDD of geothermal energy follow **the three stages** shown in Figure 1.

1. Regulatory framework for the project

The regulatory framework for the guidelines consists of the current and anticipated national and regional laws, international standards, and best practice guidelines[1].

2. Environmental appraisal of the project

This stage comprises **four main steps:** a) assessing the environmental risk, b) determining mitigation measures, c) estimating the cost of risk management, and d) reporting the results.

a) Assessing the environmental and social risks and opportunities of the project

The objective of this task is to provide an initial evaluation of the environmental risks and the opportunities presented by a particular geothermal project. The expected outcome of this step is a matrix that provides the analyst with an estimate of the risk potential of a project with respect to a number of potential environmental issues.

Two tools have been developed to aid the investment analyst in this task.

Table 1 provides a list of potential environmental issues that may be associated with a geothermal project. The issues have been divided into four categories: effluent emissions, on-site contamination and hazardous materials issues; biodiversity protection issues; worker health and safety issues; and environmental issues sensitive to public perception. The table provides a checklist of information that an analyst may use to determine the risk potential of each issue for the project in review. This information may be contained in the documentation provided by the project developer, for example, in an EIA or other type of environmental assessment report that may accompany the proposal; or it may be ascertained during on-site field visits, stakeholder meetings, etc. Other possible sources of information include media reports, telephone conversations, electronic or post mail, etc. In any case, the responsibility for providing relevant information to the satisfaction of the analyst rests ultimately with the project developer/sponsor.

In some cases, the table also provides best practices and/or mitigation measures that could be planned, proposed, or carried out on-site to manage a particular issue. It is important to note, however, that these best practices/measures are generic and therefore only meant for illustrative purposes.

Other important information to be used to assess the risk potential of a geothermal energy system include:
- impending environmental legislation that may affect the project;
- the environmental liability regime of the host country; and
- project sponsor characteristics including previous compliance problems and history of accidents.

The risk potential of each issue is to be rated using the following key:

[1] (e.g. as provided by the International Finance Corporation (IFC): Environmental, health and safety guidelines, available under: www.ifc.org/enviro/enviro/pollution/guidelines.htm).

Risk rating key:

Key	Definition	Characteristics
L	Low/no risk potential.	Information availability: Excellent (the issue is well documented) Environmental impact: Little to no negative environmental impact in case of occurrence Probability of occurrence: Low to non-existent Mitigation/compensation measures: readily available and considered in proposal
L-M	Low to moderate risk potential.	Information availability: Excellent to good (the issue is adequately documented) Environmental impact: Temporary/reversible damage in case of occurrence Probability of occurrence: Low (estimated at less than 20%) Mitigation/compensation measures: readily available and considered in proposal
M	Moderate risk potential	Information availability: Good (documentation is adequate, but may require improvement (e.g. clarification, addition)) Environmental impact: Temporary/reversible damage in case of occurrence Probability of occurrence: Estimated between 20-40% Mitigation/compensation measures: Readily available, but not considered in proposal
M-H	Moderate to high risk potential	Information availability: Requires improvement (there is little or no documentation pertaining to the issue, or the information requires clarification or addition) Environmental impact: Potential for adverse impacts, although to a lesser degree than **H** issues (e.g. impacts may be site-specific, mostly reversible, or with readily available mitigation measures). Probability of occurrence: Estimated between 20-60% Mitigation/compensation measures: Available, not considered in proposal
H	High risk potential	Information availability: Requires improvement (there is little or no documentation pertaining to the issue, or the information requires clarification or addition). Environmental impact: Potential for adverse impacts (the issue may become critical if not managed, e.g. it could affect more than the project site, pose irreversible environmental damages, affect sensitive flora, fauna, human communities, etc.) Probability of occurrence: Higher than 40% Mitigation/compensation measures: Not available from technical/logistical/financial/legal perspective/ or available, but not considered in proposal

The second table, **Table 2**, is a matrix in which the user can enter the appropriate letter (i.e. L, L-M, M, M-H, H) according to his/her estimation of the risk each issue presents for the project in review. The purpose of the table is simply to provide a snapshot of the environmental and social risks of a particular project and their corresponding risk rating at a particular point in time. This risk rating can help the investment analyst decide further actions in the EDD process.

Table 2 also presents a column of potential environmental opportunities of a project to present a more balanced view of the environmental impact (both positive and negative) that may be attributed to a particular project.

The assessment of a certain risk potential will depend on the results of the review of relevant information, as well as on the analyst's experience and common sense.

How to use the tables:

Table 1 contains a list of potential risks as well as information to help estimate the risk potential. Once the analyst makes this estimation, the appropriate letter is filled in Table 2.

Template of Table 1: Checklist for environmental risk assessment

Risk	Information to look for
1. Risk 1	Information 1
2. Risk 2	Information 2
3. ...	...
...	

Risk rating
L, M, H
to be entered here

Template of Table 2 (Matrix):

Activity	Environmental and social risks					Environmental opportunities
	Issue 1	Issue 2	Issue 3	Issue 4	Issue 5	
	1. **H**	**L**				
	2. **M**	**M-H**				

Table 1: Checklist for environmental and social risk assessment of a geothermal energy system

Risks	Information to look for
Effluent emissions, on-site contamination, hazardous materials issues	
1. Atmospheric emissions	• Construction and drilling permits and licences • Compliance with local, national, or international air quality standards during construction and drilling phases
2. Disposal of drilling effluents	• Disposal methods of drilling effluents planned or carried on at plant site (e.g. soaking ponds for containment of drilling effluents, removal of drilling effluents, etc.) • Design, O&M of containment facilities: e.g. impermeable linings in evaporation or sedimentation ponds, availability of secondary containment such as dikes
3. Emissions of CO_2 through stack	• Concentration of in non-condensable gases (NCGs) present in the geothermal fluid (level of CO_2 present in geothermal fluid should be monitored throughout the life of the generating plant). • Method used or planned for treatment of CO_2 present in NCGs: e.g. reinjection of CO_2 through wet or dry gas methods • Compliance with local, national, and/or international air quality standards
4. Emissions of H2S and other NCGs through stack	• Conversion technology used: Closed loop systems have the potential for lower emissions of H2S and other NCGs through the stack than open-loop system • Composition of NCGs • Concentration of H2S and other NCGs present in air emissions • Method used or planned for treatment (removal) of H2S and other NCGs from air emissions released through stack: e.g. the Stretford process or the combustion of hydrogen sulphide to produce sulphur dioxide. • Compliance with legislated or recommended permissible levels of H2S in air emissions.
5. Contamination of surface water due to wastewater disposal	• Studies concerning environmental impact of wastewater on local watershed • Characteristics of geothermal reservoir: a) Type: In general, exploitation of water-dominated reservoirs generates more wastewater than the exploitation of steam-dominated ones. b) Temperature: The temperature of the disposal water will depend partly on the initial temperature of the reservoir fluid. c) Chemical content of the reservoir fluid: this also influences the toxicity of the disposal water. • Conversion technology used (e.g. the disposal water from single flash systems is likely to be at higher temperature than that of double flash systems). • Chemical composition of wastewater and compliance with local, national or international regulations concerning admissible or recommended concentrations of existing NCGs in wastewater discharge. • Effluent treatment techniques used or planned to remove or reduce concentrations of contaminants from disposal water: e.g. wastewater treatment facilities on site, sedimentation, biological treatments, evaporation, cooling etc. • Disposal methods used or planned for wastewater: e.g. collection and reinjection of wastewater vs. discharge in local streams.
Biodiversity protection issues	
6. Destruction of flora and fauna at plant site.	• Studies concerning flora and fauna at plant site and adjoining areas • Re-vegetation and flora and fauna management plans on-site
7. Disruption of local watersheds due to	• Studies concerning impact on local watersheds of drilling activities

water take for irrigation purposes	• Schedule of drilling activity (e.g. is drilling activity to take place during winter or summer? etc.) • Water-take plans for drilling activity: flow rates of streams used for water take purposes (high flow rate, low flow rate), local community usage of streams intended for water take, water management plans for drilling and construction activities, plans for construction of temporary reservoirs
8. Destruction of flora and fauna due to generation activities (e.g. wastewater disposal, migration of steaming ground)	• Studies concerning flora at plant site and adjoining areas • Re-vegetation and flora and fauna management plans on-site
Worker health and safety issues	
9. Accidents during plant drilling or construction activities	• Compliance with international, local, and national health and safety regulations • Training of personnel • Emergency plans in place • Outstanding worker compensation claims • Drilling procedures and blowout prevention equipment on site
10. Accidents during plant generation activity	• Compliance with international, local, and national health and safety regulations • Training of personnel • Emergency plans in place • Outstanding worker compensation claims
11. Induced seismicity, hydrothermal eruptions and/or landslides	• Preventative and response measures for catastrophic events: Studies of topographical and geological characteristics on plant site, reinjection pressures on site (keeping pressures at lowest operational levels may prevent induced seismicity), earthquake resistance of on site facilities, stability of reinjection pressures, slope stabilisation practices, etc.
Environmental issues sensitive to public opinion	
12. Lack of awareness of cultural and social significance of geothermal reservoir	• Attitudes of local and indigenous communities concerning geothermal reservoir • Registered complaints or protests against proposed development
13. Degradation of natural geothermal features	• Resource assessment of geothermal reservoir: Studies (e.g. simulations) to determine long term reservoir performance at different exploitation capacities, studies supporting the proposed installed capacity of power station(s) for reservoir exploitation (conservatively sizing the rate of heat extraction in comparison to estimated resource capacity may mitigate the risk of pressure decline over time). • Resource management: maintaining adequate balance between geothermal fluid withdrawal and the recharge of disposal fluids. • Disposal in a way that does not cause contamination on aquifers used (or likely to be used) for potable water or irrigation, and in a way that does not cause an unduly rapid decline of the resource.
14. Ground subsidence	• Studies of geological composition of plant site: areas where rock formations are highly compressible (e.g. clay or fine sediment) are more vulnerable to ground subsidence due to geothermal exploitation • Type of geothermal reservoir: liquid-dominated reservoirs are more vulnerable to ground subsidence that steam-dominated ones • Resource management: maintaining adequate balance between geothermal fluid withdrawal and the recharge of disposal fluids

15. Visual intrusion	• Site location: e.g. proximity to populated areas, or areas with high scenic or recreational value • Local community participation in siting decisions • Protests about development concerning its effect on the scenic or recreational value of site
16. Groundwater pollution	• Chemical composition of wastewater and compliance with local, national or international regulations concerning admissible or recommended concentrations of existing NCGs in wastewater discharge. • Effluent treatment techniques used or planned to remove or reduce concentrations of contaminants from disposal water: e.g. wastewater treatment facilities on site, sedimentation, biological treatments, evaporation, cooling etc. • Disposal methods used or planned for wastewater: e.g. collection and reinjection of wastewater vs. discharge in local streams. • Design, and O&M of wastewater treatment facilities (evaporation, sedimentation or cooling ponds) and reinjection wells: e.g. impermeable linings, maintenance of reinjection well casings, etc.
17. Noise emissions	• Compliance with statutory (e.g. local or national regulations) or recommended noise emission levels • Site location: proximity to populated areas, topographical characteristics that could affect noise emission • Neighbour complaints concerning noise levels

Table 2: Environmental and social risks and opportunities guide for a geothermal energy project

Activity	Environmental and social risks: Effluent emission, onsite contamination, hazardous materials issues	Environmental and social risks: Biodiversity protection issues	Environmental and social risks: Worker health and safety issues	Environmental and social risks: Environmental issues sensitive to public opinion	Environmental opportunities
Plant drilling and construction	1. Atmospheric emissions (CO_2, SO_2, NOx, particulates) ☐	6. Destruction of forests and other vegetation at plant site ☐	9. Accidents ☐	12. Unawareness of cultural and social significance of geothermal reservoir ☐	
	2. Contamination of surface or groundwater with drilling effluents ☐	7. Disruption of local watersheds due to water take for drilling purposes ☐			
Generation activity	1. Emissions of CO_2 through stack ☐	8. Destruction of flora and fauna due to generation activities (e.g. wastewater disposal, migration of steaming ground) ☐	10. Accidents ☐	13. Degradation of natural geothermal features ☐	**Avoided CO_2 and other air pollutant emissions from deployment**
	4. Emissions of H2S and other NCGs through stack ☐		11. Induced seismicity, hydrothermal eruptions, and/or landslides ☐	14. Ground subsidence ☐	
	5. Contamination of surface water due to wastewater disposal ☐			15. Visual intrusion ☐	
				16. Groundwater pollution ☐	
				17. Noise emissions ☐	

b. Identifying risk management measures

Once the environmental and social risks of the project have been assessed, the next step is to identify what measures would be needed to eliminate, reduce, or manage those risks. In the case that the project sponsor has recommended measures for managing potential risks, the analyst must decide whether the measures are acceptable. If no or only inadequate risk-mitigation measures have been recommended, the project developer must modify the project to ensure satisfactory risk management.

Risk management measures may be identified through industrial or sectoral best practices, international or other widely used/accepted standards, etc. As mentioned in the previous section, Table 1 includes some mitigation/compensation measures, although the measures included in the table should not be considered as complete or exhaustive, but merely indicative.

The following question list may provide some assistance in determining the extent of compliance of the project with regulations, standards, and best-practice guidelines and protocols for risk management. The question list has been constructed in a modular form, with the first module containing general questions that should be answered for all projects, while subsequent modules should be applied only if considered necessary or relevant.

Table 3: Question list to determine level b for a geothermal energy system

Level	Questions
LEVEL I: All projects	1. Has the project complied with all legislated requirements for operation, receiving all necessary licences and permits? (Land use for geothermal development, plant operational permits, requirements from local and national governmental authorities, etc.)
	2. Has the project site been chosen giving due consideration to all potential environmental impacts of the development, including impacts on natural habitats and wild life disturbance, and impacts on populated areas concerning noise or visual intrusion? Is there documentation about the site choosing process?
	3. Are air emissions from the generation plant regulated and are these regulations complied with?
	3. Is reinjection of liquid effluents a feasible practice at the plant? If not, are liquid effluents disposed of in an environmentally acceptable way?
	4. Is the composition and temperature of the liquid effluents in compliance with statutory or recommended limits regarding temperature, pH, suspended solids and heavy metal levels?
	5. Are air emissions from the generation plant in compliance with statutory or recommended levels, specially concerning CO_2 and H2S limits?
	6. Are prevention and mitigation measures for worker health and safety considered at the generation plant? (Emergency plans, basic medical facilities on site, sanitary facilities, etc.)
	7. Are workers properly trained and equipped for carrying out their activities at the generation plant?
	8. Are there proper operation and maintenance routines at the generation plant?
	9. Have all moderate and high risk issues identified in the previous stage, other than those that may have been covered in questions 1-8, been appraised and have mitigation measures been proposed?
LEVEL II: Optional	12. Has an environmental impact assessment report, an environmental audit, or any similar environmental assessment been prepared with respect to the project? Is one required?
	13. Has a site visit been planned? Is one required?

	14. How can the environmental liability regime of the host country affect the financial institution?
	15. Have there been any protests or complaints about the project? If so, what have they focused on?
	16. What are the potential environmental benefits of the project? Is the general public aware of these environmental benefits?

c. Determining the costs of managing the risks

When the mitigation measures have been determined, the next step is to estimate the cost of the risks and their management. This includes both the real cost of the mitigation measure itself, as well as the potential costs associated with non-compliance (e.g. increased charges, fines and other penalties, the closure of an operation by environmental authorities, project delays due to permitting requirements, etc). Estimating such costs is important even if the financial institution or investor may not be directly responsible for them: first, any unforeseen costs can compromise the financial viability of the proposal; and secondly, the financial institution could be held liable under certain liability regimes. How exact the cost calculation should be and the level of detail is up to the analyst.

The analyst must also take into consideration any future liabilities that could occur as a result of changed environmental legislation, regulations, and standards.

Costs should be determined on a case-by-case basis, depending on the results of the previous step.

d. Reporting the results

The third step of the environmental appraisal stage is to present the key findings of the EDD review in a report that can be used during the investment decision process. The final report should include, at a minimum, the following information:

- Brief description of the project
- General information about the project sponsor
- Status of compliance with host-country regulations, international standards, best-practice guidelines
- Main environmental impacts and proposed mitigation measures (including an assessment of the adequacy of these mitigation measures if necessary or appropriate)
- An analysis of how the costs of the necessary mitigation measure affects the project's financial viability
- Environmental opportunities (potential benefits of the project)
- Any missing information that may be significant for the assessment of the environmental risks and opportunities of the project
- In the case of moderate and high-risk projects, the key findings should highlight high-risk potential issues and their mitigation measures, as well as the results of environmental assessment reports and site visits that may have been carried out during the review process.
- Further actions required by the financial institution or the project sponsor with respect to environmental issues

3. Monitoring the project

If the project has been approved, the final stage of EDD is the monitoring stage. For this purpose, specific provisions should be included in the legal documentation, for example, the requirement of annual environmental reports, independent environmental audits at specific intervals, site visits, etc. This is especially important for high-risk projects, for which the agreements between project sponsor and financial institution or investor should always include an environmental reporting and evaluation clause. In this case the monitoring should be carried out at regular intervals (e.g. annually or semi-annually), preferably including independent site visits or audits in addition to the project sponsor's environmental evaluation reports.

For low and moderate risk projects, environmental reports from the project sponsor on an annual or semi-annual basis should be sufficient.

Significant changes in the project (e.g. projected expansions, changes in technology), changes in the type of finance (e.g. from loan to equity), and/or foreclosures should **always** be preceded by a re-assessment of environmental risk. This is in order to determine whether the changed project carries environmental and social risks and opportunities that were not considered in the initial review. The environmental monitoring of the project should continue until the loan has been repaid, the financial institution or investor has divested its equity share in a company, or the operation has been cancelled.

Disclaimer

The UNEP Guidelines on Environmental Due Diligence of Renewable Energy Projects are intended to serve as a practical tool for identifying and managing environmental risks associated with renewable energy projects. They are not meant to supplant national or local environmental or permitting requirements. The EDD Guidelines are to be considered work in progress and UNEP and BASE will continue to improve and refine the Guidelines to make them as suitable and useful as possible for reviewing renewable energy projects.

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