Environmental Due Diligence (EDD)

Of Renewable Energy Projects

GUIDELINES

for

Small-Scale Hydroelectric Energy Systems

Release 1.0

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BASE

Environmental Due Diligence (EDD) process for Small-Scale Hydroelectric 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

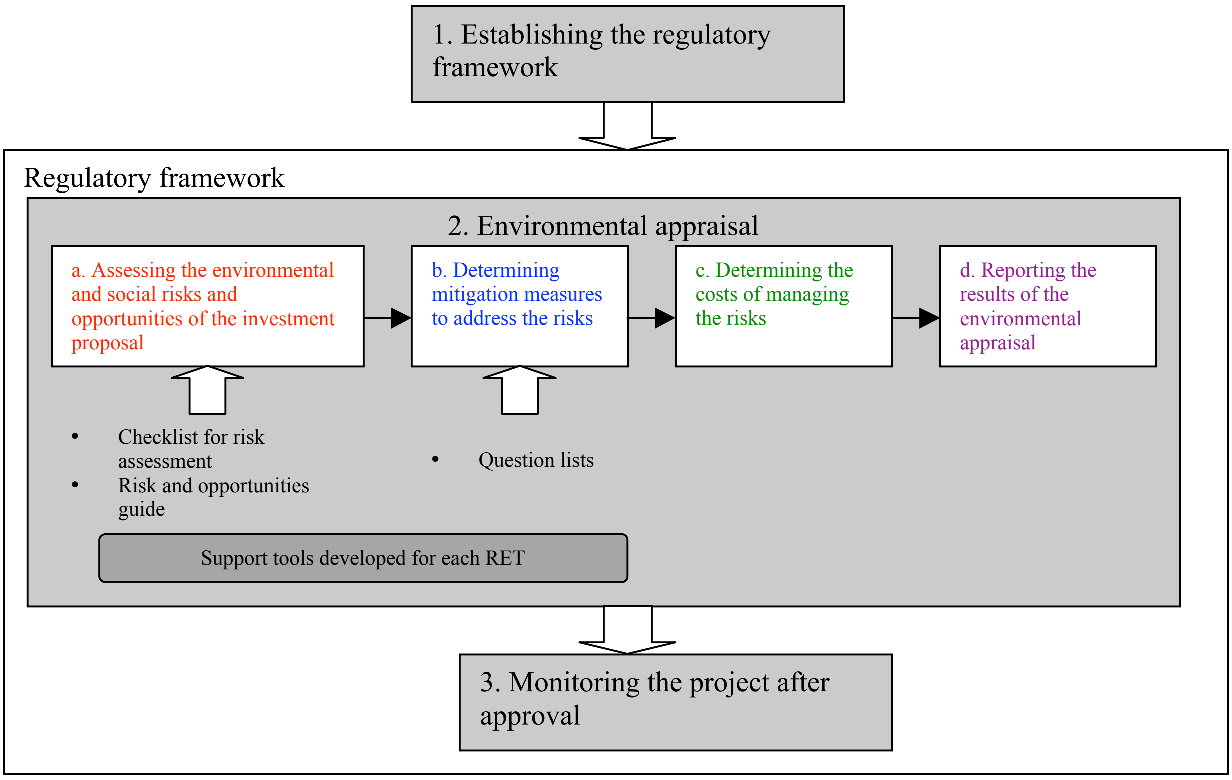

Figure 1: Procedure for environmental due diligence of RET projects

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 Small-scale Hydroelectric Energy Projects

The guidelines for EDD of small-scale hydroelectric 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 small-scale hydroelectric 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 small-scale hydroelectric 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 small-scale hydroelectric 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: Estimated 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 small-scale hydroelectric system

Aspect	Information to look for
Effluent emissions, on-site contamination, hazardous materials issues	
1. Contamination of surface water with dust, construction materials, oil, grease, hydraulic fluids, etc.	• Construction permits and licences • Status of compliance with relevant environmental laws, regulations, and codes of practice: integration of rules, regulations and codes of practice into tender documents • Type of system: Low-head schemes typically require greater quantities of materials and construction activity than high-head schemes. In addition, the construction of entirely new facilities of either type will require greater material and construction activity inputs than facilities developed using existing structures (e.g. dams used for river or lake water level control or dams used for irrigation schemes). • Construction practices on site: use of best management practices to preserve water quality during construction activities, including good housekeeping (e.g. provision of silt traps, stockpiling of construction material away from riverbanks, maintaining as much as possible of riparian vegetation, etc.) and appropriate scheduling of activities (planning construction activities during dry season to minimize erosion, scheduling the placement of sediment capturing devices and key runoff control measures before major land disturbing activities, such as clearing and excavation, etc.) to minimise sediment release
2. Emissions of pollutants due to O&M practices onsite.	• Compliance with regulated pollutant emission levels of liquid effluents and water quality standards. • Operation practices on site: Use of biodegradable compounds for pipe/tunnel cleaning, wastewater treatment, etc.
Biodiversity protection issues	
3. Eutrophication of water ways downstream from construction site	• Construction practices on site: use of best management practices to preserve water quality during construction activities, including good housekeeping (e.g. provision of silt traps, stockpiling of construction material away from riverbanks, maintaining as much as possible of riparian vegetation, etc.) and appropriate scheduling of activities (planning construction activities during dry season to minimize erosion, scheduling the placement of sediment capturing devices and key runoff control measures before major land disturbing activities, such as clearing and excavation, etc.) to minimise sediment release
4. Loss of fauna and flora attributable to construction of hydro facility	• Site location: e.g. proximity to sensitive or valuable ecosystems such as wetlands or peat bogs, valuable forests, or areas with archaeological or recreational value (e.g. Natura 2000 areas). • Inventories of fauna and flora on site: e.g. rare or endangered species, indigenous vegetation, etc. • Compliance with legal requirements for protection of species considered rare, vulnerable or endangered • Compliance with best construction practices: Noise mitigation, erosion control, scheduling of activities (avoidance or reduction of construction activities during breeding or spawning seasons of sensitive species) • Mitigation measures for minimizing possible loss of biodiversity during and after construction: e.g. clean-up activities; replanting and seeding affected sites, borrow pits, camp sites, etc; landscaping; creation of breeding programs for rare or endangered species affected by hydro project, etc.

5. Creation of barriers to fish migration	• Inventory of migratory fish species affected by construction of dams and diversion works • Design features incorporated to mitigate fish migration effects: provision of fish passes (ladders) to aid upstream migration; screens or grids to prevent fish from entering turbines and to divert descending molts away from intakes • Management of flow regime or spillway during downstream movement of migratory fish
6. Alteration (change, degradation, loss) of aquatic habitats due to construction of instream barriers	• Site location: e.g. proximity to sensitive or valuable ecosystems such as wetlands or peat bogs, valuable forests, or areas with archaeological or recreational value (e.g. Natura 2000 areas). • Value of affected habitats: economic, ecological, recreational, cultural, etc. (this can be determined through consultation processes with stakeholders) • Mitigation and/or compensation measures planned or carried out: proper site location and design of installations, recreation of affected habitats, restocking of species, creation and protection of new habitats (e.g. creation of small islands on the reservoir area with semi aquatics and willows planted in combination with grasses and weeds to provide breeding habitats for migratory waterfowl), aquatic fauna and flora management plans: incorporation of aquaculture schemes within facility, creation of spawning areas in the reservoir and in tributaries, replanting and seeding, watershed management including stakeholder participation, etc.
7. Impacts on fauna and flora due to construction of transmission lines and access roads	• Site location: access to site, distance from site to grid or load centre, location of sensitive or valuable ecosystems such as wetlands or peat bogs, valuable forests, or areas with archaeological or recreational value (e.g. Natura 2000 areas) in pathway from site to grid or load centre. • Mitigation measures planned or carried out: transmission line route planning to reflect preservation of existing parks and reserves, establishing protection perimeters around major animal habitats and/or sensitive or valuable ecosystems such as peat bogs, marshlands, and valuable forests, where no construction activities are allowed, marking of power lines or guard wires, installation of anti-roosting devices or nesting platforms to persuade birds to nest in safest possible locations, etc.
8. Loss of aquatic, wetland and/or terrestrial habitat due to flooding	• Type of scheme: Since run-of-river facilities typically have low dams that allow no or limited storage capabilities, they produce none or minimal flooding. • Site selection: selection process taking into account value of area to be flooded by reservoir impoundment (economic, ecological, recreational, cultural, etc.), alternative locations, etc. in order to locate project in area that has less impact on habitats, specific inventories and studies about fauna, flora and habitats within reservoir impoundment zone. • Mitigation and/or compensation measures planned or carried out: Avoid flooding sensitive or valuable ecosystems, plan reservoir filling to minimize impacts (e.g. slow filling, schedule filling avoiding reproduction periods), management of reservoir water levels, creation and protection of new habitats (e.g. creation of small islands on the reservoir area with semi aquatics and willows planted in combination with grasses and weeds to provide breeding habitats for migratory waterfowl, and of spawning areas for indigenous fish) within reservoir, establishment and maintenance of minimum levels of water flow, enhance reduced habitat elsewhere, give reserve status to another area with similar characteristics as the one flooded.

9. Changes in fish communities	• Effects of reservoir impoundment on fish species valued for commercial, sporting or subsistence fishing: the creation of reservoirs, which approximate calm water conditions such as those existing in lakes, may detrimentally affect fast water fish (salmonidae, trout) while favouring calm water species such as bream. • Design features incorporated to mitigate fish migration effects: provision of fish passes (ladders) to aid upstream migration; screens or grids to prevent fish from entering turbines and to divert descending molts away from intakes • Mitigation and/or compensation measures planned or carried out: creation of spawning and rearing habitats, stocking of adults or fries of commercial species that are well adapted to reservoirs • construction of weirs and basins in certain reaches of the river in order to preserve lacustrine zones and thus original habitats for indigenous species.
10. Detrimental effects on downstream aquatic ecosystems due to the release of anoxic water and/or increase in suspended solids	• Site location: Catchment size and characteristic (gradient, shape, vegetation), hydrology (climate, rainfall, runoff) and topography (river path), studies on long-term sediment inflow characteristics to the reservoir and other factors determining erosion and sediment loads • Mitigation and/or compensation measures planned or carried out: adequate bank protection in the catchment area to prevent erosion (replanting and maintenance of vegetation), extraction of coarse material from the river bed, use of sediment trapping devices, forced aeration of water, release of oxygenated surface water over spillway, establishment and maintenance of minimum levels of water flow
11. Changes to aquatic habitats or ecosystems, particularly habitat and species loss or depletion due to regulated (altered) water flow	• Type of scheme: Run-of-river facilities that do not impact the amount or pattern of water flow that normally exists in the river or stream will not produce these types of effects. • Value of affected habitats: economic, ecological, recreational, cultural, etc. (this can be determined through consultation processes with stakeholders) • Mitigation and/or compensation measures planned or carried out: Establishment and maintenance of minimum levels of water flow (the amount of water needed to maintain ecological values downstream of diversion structures), application of bank restoration techniques including planting and seeding, fish habitat restoration programmes and programmes for protection of coastal habitats
12. Changes in terrestrial habitats due to increased erosion of river banks	• Type of scheme: Run-of-river facilities that do not impact the amount or pattern of water flow that normally exists in the river or stream will not produce these types of effects • Mitigation measures planned or carried out: Establishment and maintenance of minimum levels of water flow (the amount of water needed to maintain ecological values downstream of diversion structures), application of bank restoration techniques including planting and seeding, maintenance and promotion of vegetation growth on exposed banks, installation of weirs in reduced flow sections to mitigate erosion phenomena, etc.
Environmental issues sensitive to public opinion	
13. Visual impact of earthworks	• 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 • Incorporation of conditions to minimize visual impact of schemes in tender documents and status of compliance with these conditions (e.g. restoration of land surface, tree screening, etc.)

	• Mitigation measures planned or carried out: employment of amelioration techniques such as traditional design of buildings, use of natural and local materials, vegetation screens, and non-reflective colours.
14. Disruption of sites with historic/cultural/religious significance	• Site location: proximity to areas with historic/cultural/religious significance • Local community participation in siting decisions • Registered complaints or protests against proposed development • Mitigation measures planned or carried out: avoidance of sites with historic/cultural/religious significance, consultation process with stakeholders (including local community) carried out since the planning stages of the project, stakeholder involvement in site selection
15. Noise	• Compliance with statutory (e.g. local or national regulations) or recommended (e.g. international guidelines) noise emission levels • Site location: proximity to populated areas, topographical characteristics that could affect noise emission • Compliance with best construction practices for sound mitigations: restrict work to daylight hours, use of hydraulic rather that pneumatic drills, installing mufflers on internal combustion engines used in large earth-moving equipment, maintenance of vehicles in good operating conditions • Neighbour complaints
16. Threat to human life and property in case of dam failure	• Type of scheme: For most small-scale hydro systems, the potential impact from dam failure will be small, and it is generally only an issue to be considered by large low-head schemes. • Compliance with best construction practices: use of quality materials, proper design, safety inspection after construction, regular maintenance of works • Mitigation measures planned or carried out: project follow-up by an expert panel, preparation and implementation of operation and emergency plans
17. Visual impact of instream barriers (dams and diversion works)	• 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 • Incorporation of conditions to minimize visual impact of schemes in tender documents and status of compliance with these conditions (e.g. restoration of land surface, tree screening, cosmetic engineering to preserve or enhance appearance of valued waterfalls on the diverted section of water, protection of other outstanding natural features and landscapes, etc.) • Mitigation measures planned or carried out: siting of turbine houses to minimise length of the tailrace, partial burial and/or screening of pipes, controlled water spilling to protect valuable waterfalls, landscaping, etc.
18. Land use conflicts due to construction of transmission lines and access roads	• Site location: access to site, distance from site to grid or load centre, location of sensitive or valuable ecosystems such as wetlands or peat bogs, valuable forests, areas with archaeological or recreational value (e.g. Natura 2000 areas), and/or agricultural or other economically productive areas in pathway from site to grid or load centre. • Project status regarding the obtainment of access rights to all land involved in project, including land on, over, or beneath which project components are to be located. • Mitigation and/or compensation measures planned or carried out: transmission line route planning to reflect preservation of existing parks and reserves, avoiding the obstruction of paths for recreational or tourist activities, promoting multiple uses in right-of-ways (gardening, green spaces, public infrastructures, recreational areas), public consultation with

	stakeholders when developing access to right-of-way in sensitive land such as agricultural areas, protection of identified archaeological sites, avoiding key agricultural or pasture zones, compensation for loss of agricultural or other economically productive land, etc.
19. Visual impact of transmission lines and access roads	• Site location: access to site, distance from site to grid or load centre, location of sensitive or valuable ecosystems such as wetlands or peat bogs, valuable forests, areas with archaeological or recreational value (e.g. Natura 2000 areas), and/or agricultural or other economically productive areas in pathway from site to grid or load centre. • Stakeholder participation in transmission line routing decisions and access road paths. • Employment of visual impact considerations in siting and design (e.g. arrangement of towers in such a way as to prevent their being too visible from communication paths, use of vegetation for screening, etc.)
20. Increased concentration of methyl-mercury in fish due to reservoir impoundment	• Compliance with best practices for reservoir design and impoundment: minimization of flooded areas on the basis of technical, economical and environmental concerns, removal and controlled burning of vegetation prior to impoundment (Note: this measure is only partially effective), monitoring of mercury concentrations in fish species in the reservoir and adjacent bodies of water. • Mitigation and/or compensation measures planned or carried out: establishment of family and community fishing programmes to reduce health risks associated with the consumption of fish species that may have accumulated methyl mercury (e.g. by reorienting fishing efforts towards fish species that present less risk, or by facilitating fishing and hunting in other bodies of water), setting up disease vector control programmes, etc.
21. Loss of land with agricultural/historic/cultural/ scenic value due to reservoir impoundment	• Type of scheme: Since run-of-river facilities typically have low dams that allow no or limited storage capabilities, they produce none or minimal flooding. • Site selection: selection process taking into account value of area to be flooded by reservoir impoundment (economic, ecological, recreational, cultural, etc.), community involvement in project planning including reservoir siting decisions • Project status regarding the obtainment of access rights to all land involved in project, including land on, over, or beneath which project components are to be located, including reservoir. • Compliance with best practice design and impoundment: minimization of flooded areas on the basis of technical, economical and environmental concerns • Protests about the development • Mitigation and/or compensation measures planned or carried out: avoiding flooding of land with agricultural/historic/cultural/scenic value, replacement of valuable resources (agricultural areas, pasture, etc.) flooded in the impoundment zone where feasible
22. Changes in water quality due to changes in natural sediment loads	• Site location: Catchment size and characteristic (gradient, shape, vegetation), hydrology (climate, rainfall, runoff) and topography (river path), studies on long-term sediment inflow characteristics to the reservoir and other factors determining erosion and sediment loads • Water quality classification before and after reservoir impoundment • Compliance with statutory drinking water quality requirements • Mitigation and/or compensation measures planned or carried out: adequate bank protection in the catchment area to prevent erosion (replanting and maintenance of vegetation), extraction of coarse material from the river bed,

	use of sediment trapping devices, establishment and maintenance of minimum levels of water flow to minimize erosion, monitoring of drinking water quality
23. Visual impact due to reservoir impoundment	• Site location: e.g. proximity to populated areas, or areas with high scenic or recreational value • Local community participation during siting of reservoir decision process • Compliance with best practices for reservoir design and impoundment: minimization of flooded areas on the basis of technical, economical and environmental concerns • Incorporation of conditions to minimize visual impact of schemes in tender documents and status of compliance with these conditions • Protests about development
24. Public health risks (e.g. dengue, malaria, schistosomiasis) due to increase of disease vectors such as flies, mosquitoes and other pests, due to reservoir.	• Assessment of health issues related to disease vectors (e.g. flies, mosquitoes, snails). Although this is an issue of particular importance in tropical countries, studies regarding: the adequacy of the location of the reservoir with respect to nearby communities (e.g. distance to reservoir, wind conditions, etc.); the vectors species whose populations could increase due to the reservoir; health plans should be included if the threat of spreading diseases via insects is a risk in the area. • Management practices for the control of vectors planned or carried out, which may include: - Environmental Information systems and GIS - to determine the area of insect vector concentrations in order to implement the most effective control measures; - Advanced weather forecasting systems - sing remote sensing to determine when the vectors are at their most vulnerable state so as to manage their populations; - Safe and sustainable use of chemical pesticides - without compromising the destruction of beneficial predators and parasites; - Avoiding the development of resistance in the target pest - programs include insecticide resistance management, advice and training for safe and effective handling and application of pesticides, pesticide legislation and residue analysis and integrated vector management; - In the USA, the American Mosquito Control Association advocates control methods such as larviciding, adulticiding, biological control, research and education
25. Insufficient flow for downstream and instream users (farming, fishing, irrigation, and other economic uses of water, and recreation uses such as canoeing and rafting)	• Type of scheme: Run-of-river facilities that do not impact the amount or pattern of water flow that normally exists in the river or stream will not produce these types of effects • Site selection and design taking into account downstream and instream uses of water (existing and planned): farming, fishing and industrial operations, recreational uses, irrigation, etc. • Compliance with best operation practices: management of reservoir levels and periodic releases in order to maintain pre-existing conditions downstream of the hydropower system, establishment and maintenance of minimum levels of water flow • Stakeholder involvement in the establishment of a minimum flow value for the project

26. Changes in water quality due to regulated (altered) flow	• Site location: Catchment size and characteristic (gradient, shape, vegetation), hydrology (climate, rainfall, runoff) and topography (river path), studies on long-term sediment inflow characteristics to the reservoir and other factors determining erosion and sediment loads • Water quality classification before and after operation of hydro scheme • Compliance with statutory drinking water quality requirements • Mitigation and/or compensation measures planned or carried out: adequate bank protection in the catchment area to prevent erosion (replanting and maintenance of vegetation), extraction of coarse material from the river bed, use of sediment trapping devices, establishment and maintenance of minimum levels of water flow to minimize erosion, monitoring of drinking water quality
27. Threat to human life and property during sudden releases.	• Type of scheme: Run-of-river facilities that do not impact the amount or pattern of water flow that normally exists in the river or stream will not produce these types of effects. • Compliance with best operation practices: management of reservoir levels and periodic releases, preparation and implementation of operation and emergency plans.
28. Changes in water quality due to maintenance activities	• Compliance with regulated pollutant emission levels of liquid effluents and statutory drinking water quality requirements. • Operation practices on site: Use of biodegradable compounds for pipe/tunnel cleaning, wastewater treatment, etc.
Worker Health and Safety Issues	
29. Social consequences of increased migration to plant site: Insufficient and/or inadequate housing, public health problems, etc	• Planning of construction activities taking into account socio-economic consequences of development: involvement of and consultation with local community since early planning stages, design of new infrastructures associated with the project to serve resident population as well as population attracted by the project • Mitigation, compensation and/or enhancement measures planned or carried out: promote hiring of local manpower, promote housing development in existing communities rather than the creation of temporary settlements during construction period, establish information programs for non-local workforce regarding aboriginal communities, conflict management between workers and residents, implementation of public health measures, including prevention, education, and follow-up programmes, as well as clinical treatment, cooperation with existing local health programmes
30. Accidents during construction	• Compliance with international, local, and national health and safety regulations • Training of personnel • Emergency plans in place • Outstanding worker compensation claims
24. Public health risks (e.g. dengue, malaria, schistosomiasis) due to increase of disease vectors such as flies, mosquitoes and other pests, due to reservoir.	• Assessment of health issues related to disease vectors (e.g. flies, mosquitoes, snails). Although this is an issue of particular importance in tropical countries, studies regarding: the adequacy of the location of the reservoir with respect to nearby communities (e.g. distance to reservoir, wind conditions, etc.); the vectors species whose populations could increase due to the reservoir; health plans should be included if the threat of spreading diseases via insects is a risk in the area. • Management practices for the control of vectors planned or carried out, which may include: - Environmental Information systems and GIS - to determine the

	area of insect vector concentrations in order to implement the most effective control measures; - Advanced weather forecasting systems - sing remote sensing to determine when the vectors are at their most vulnerable state so as to manage their populations; - Safe and sustainable use of chemical pesticides - without compromising the destruction of beneficial predators and parasites; - Avoiding the development of resistance in the target pest - programs include insecticide resistance management, advice and training for safe and effective handling and application of pesticides, pesticide legislation and residue analysis and integrated vector management; - In the USA, the American Mosquito Control Association advocates control methods such as larviciding, adulticiding, biological control, research and education

Table 2: Environmental and social risks and opportunities guide for a small-scale hydroelectric system

Activity		Environmental and Social Risks: Effluent emission onsite contamination hazardous materials issues	Environmental and Social Risks: Biodiversity protection issues	Environmental and Social Risks: Environmental issues sensitive to public opinion	Environmental and Social Risks: Worker health and safety issues	Environmental opportunities
Construction	**Earthworks**	1. Contamination of surface water with dust, construction materials, oil, grease, hydraulic fluids, etc	3. Eutrophication of water ways downstream from construction site	13. Visual impact	29. Social consequences of increased migration to plant site: Insufficient and/or inadequate housing, public health problems, etc	Developmental opportunities: creation of infrastructure, employment opportunities, etc.
			4. Loss of fauna and flora	14. Disruption of sites with historic/cultural/religious significance		
				15. Noise		
	In stream barriers (dams and diversion works)	-	5. Creation of fish migration barriers	16. Threat to human life and property in case of dam failure	30. Occupational Accidents	
			6. Alteration (change, degradation, loss) of aquatic habitats	17. Visual impact		
	Transmission lines and access roads	-	7. Impacts on fauna and flora	18. Land use		
				19. Visual impact		

Table 2: Environmental and social risks and opportunities guide for a small-scale hydroelectric system (continued)

Activity		Environmental and social risks				Environmental opportunities
		Effluent emission, onsite contamination, hazardous materials issues	**Biodiversity protection issues**	**Environmental issues sensitive to public opinion**	**Worker health and safety issues**	
Operation	**Reservoir impoundment**	-	8. Loss of aquatic, wetland and/or terrestrial habitat due to flooding	20. Increased con-centrations of methyl-mercury in fish species.	31. Public health risks (e.g. risk of dengue or malaria epidemics) due to increase of disease vectors, such as flies, mosquitoes and other pests, due to reservoir	Avoided CO_2 and other air pollutant emissions from deployment
			9. Changes in fish communities	21. Loss of land with agricultural/historic/cultural/ scenic value		
			10. Detrimental effects on downstream aquatic ecosystems due to the release of anoxic water and/or increase in suspended solids	22. Changes in water quality due to changes in natural sediment loads		Recreational opportunities
				23. Visual impact		
				24. Public health risks (e.g. risk of dengue, malaria epidemics) due to increase of disease vectors such as flies, mosquitoes and other pests, due to reservoir		

Table 2: Environmental and social risks and opportunities guide for a small-scale hydroelectric system (continued)

Activity		Environmental and social risks				Environmental opportunities
		Effluent emission, onsite contamination, hazardous materials issues	**Biodiversity protection issues**	**Environmental issues sensitive to public opinion**	**Worker health and safety issues**	
Operation (continued)	**Regulated (altered) flow**	–	11. Changes to aquatic habitats or ecosystems, particularly habitat and species loss or depletion	25. Insufficient flow for downstream and instream users (farming, fishing, irrigation, and other economic uses of water, and recreation uses such as canoeing and rafting)	–	Beneficial effects on ecology: e.g. reduced erosion of the river bank due to slower water flows; improved micro-climate from the additional moisture, raised water table
				26. Changes in water quality (higher pollutant concentrations, increase in suspended solids due to erosion of river banks and beds)		
			12. Changes in terrestrial habitats due to increased erosion of river banks	27. Threat to human life and property during sudden releases		
	Maintenance	2. Emissions of pollutants due to O&M practices onsite.	–	28. Changes in water quality (higher pollutant concentrations)		

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 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 lists for a small-scale hydroelectric system

Level	Question
LEVEL I: All projects	1. Has the project complied with all legislated requirements for operation, receiving all necessary licences and permits, including but not limited to the following: - Right of access permits to all land involved in project, including land on, over, or beneath which project components are to be located - In case of projects involving reservoir impoundment, right to inundate all land affected by reservoir (e.g. through land purchasing or leasing) - Permission to use resources (water, air, and land) from local, regional, and/or national authorities - Requirement to prepare and present an environmental assessment of the project - Requirement for public consultation - Construction permits - Operational permits for power production
	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, impacts on populated areas concerning noise or visual intrusion of the development, impacts on upstream, downstream, and instream users of the water resource and stakeholder inputs? Is there documentation about the site choosing process?
	3. Has the project planned/followed best construction practices to minimise visual intrusion and noise emissions?
	4. Has the project planned/followed best construction practices to minimise emissions to air, soil and water (e.g. good housekeeping, good outdoor behaviour, proper scheduling of activities, etc.)?
	5. Has the project planned/followed mitigation and/or compensation measures for the following impacts: - Impacts on water quality (aeration levels, sedimentation) - Impacts on aquatic environments (loss, degradation or change of habitats, barriers to fish migration, biodiversity effects, etc.) - Impacts on terrestrial environments (loss, degradation, or change of habitats, biodiversity effects, etc.) - Social and economic impacts (public health, housing, loss of economically/culturally valued land, insufficient flow for downstream and instream users)

	6. Has the project planned/followed stakeholder consultation processes during the planning of the following issues: - Project site in sensitive areas such as fragile ecosystems, areas with economic, cultural or recreational value - Siting of individual project components (powerhouse, reservoir) in sensitive areas such as fragile ecosystems, areas with economic, cultural or recreational value - Establishment of minimum flow (amount of water required to maintain ecological, productive and amenity values). - Other stakeholder concerns and issues
	7. Have all moderate and high risk issues identified in the previous stage, other than those that may have been covered in questions 1-6, been appraised and have mitigation measures been proposed?
Level II: Optional	8. Has a site visit been planned? Is one required?
	9. How can the environmental liability regime of the host country affect the financial institution?
	10. 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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