BARCLAYS

Environmental and Social Risk Briefing

Power Generation

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Table of Contents

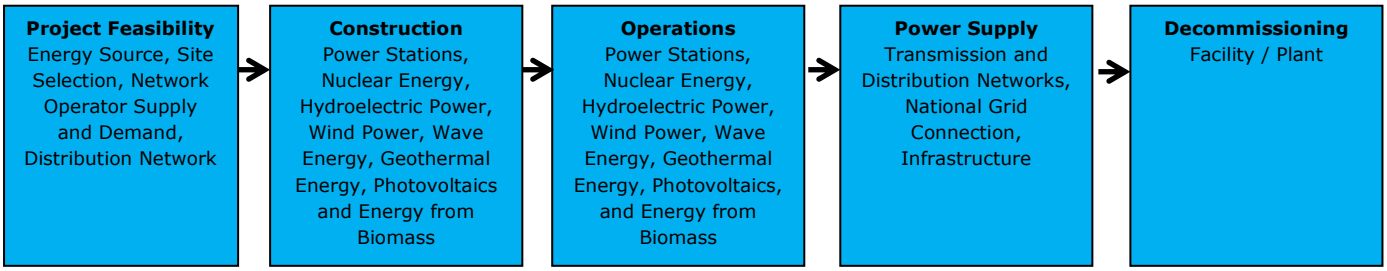
1. Introduction

This Environmental and Social Risk Briefing (ESRB) covers the power generation industry and includes power stations and the use of fossil fuels, nuclear power and renewable energy sources: such as hydroelectric power, wind farms, geothermal energy, photovoltaics and energy generation from biomass and waste.

Although unique in terms of the way energy is produced, a standard life cycle can be applied to each power generation sector. The life cycle can be divided into project feasibility and planning, construction, operations, power supply and facility / plant decommissioning, as illustrated below.

Further information on each 'phase' of the life cycle, along with a more detailed description of the different energy

Power Generation and Distribution Life Cycle



2. Project Feasibility and Planning

A feasibility assessment is a technical assessment and a business plan and is the first stage in reducing the technical, financial, environmental and socio-economic risks of a potential project.

Each of the energy technologies comes with its own set of technical questions, which could potentially have an impact on project economics. The technical evaluation should focus on the recommended project that has been the result of the technical alternatives considered and should be combined with a robust analysis of the economic and financial aspects of the project.

Feasibility assessments should also focus on interface issues, such as connecting to the existing electric power system, evaluating the match between resource and technology (particularly important when investigating biomass options), and identifying environmental concerns and site constraints.

In summary, a feasibility assessment should consider the energy resource availability (e.g. wind strength), site accessibility, available technology, land rights, connection to existing grids, sales, supply and demand, construction, operations and maintenance issues.

3. Construction and Operation

Power generation projects can be onshore or offshore or a combination of both at a variety of scales and may transect international boundaries.

The following subsections provide a more detailed description of each of the sectors covered in this ESRB.

3.1 Thermal Power Stations

Conventional steam producing thermal power stations generate electricity through a series of energy conversion stages: firstly fuel is burnt in boilers to convert water into high pressure steam, which is then used to drive a turbine to generate electricity.

In coal fired power stations the coal is pulverised (to enhance combustion efficiency), then fed into the combustion chamber of a boiler and burned. Electricity is generated from oil using similar methods.

Combined cycle power stations burn fuel in a combustion chamber and the exhaust gases are used to drive the turbine. Waste heat boilers capture energy from the exhaust gases for the production of steam, which is then used to drive another turbine; this process is generally more efficient than conventional systems.

Advanced coal utilisation technology (e.g. fluidised bed combustion) tends to be more efficient than conventional and combined cycle systems. Integrated Coal Gasification Combined Cycle (IGCC) power plant is the most environmentally friendly coal-fired power generation technology. Most importantly, coal gasification offers the immediate opportunity to generate power with near zero greenhouse gas emissions and the pathway to a future hydrogen economy.

IGCC uses a combined cycle format with a gas turbine driven by the combusted syngas (gas from coal combustion or high energy waste gases from refineries), while the exhaust gases are heat exchanged with water/steam to generate superheated steam to drive a turbine.
Engine-driven power stations have shorter building periods, higher overall efficiency (low fuel consumption per unit of output) and moderate investment costs.

There is increasing focus on the greenhouse gas (GHG) emissions from power stations, particularly those that are coal fired. Impact assessments for these developments should include discussion of alternative fuel sources, and in circumstances where there are limited alternatives to coal, technology should be installed to minimise emissions as much as possible.

3.2 Nuclear Energy

Nuclear power is generated from the controlled use of nuclear reactions to yield energy (electricity and heat). Nuclear energy is produced when the natural radioactive decay of material, such as uranium, is accelerated to produce heat, which is used to boil water, which in turn generates steam which is used to drive turbines. Nuclear power provides 11% of global electricity generation.

Interest in nuclear energy production had been increasing in recent years, particularly in Asia. However, the tsunami and subsequent nuclear incident at Fukushima in Japan have led to some countries (including Germany) to halt or slow nuclear expansion plans. There is also increased focus on nuclear safety, which is increasing operating costs.

The use of nuclear power is controversial because of the problem of storing radioactive waste for indefinite periods, the potential for possibly severe radioactive contamination by accident or sabotage, and the possibility that its use in some countries could enable the development of nuclear weapons.

Renewables

Although renewable forms of electricity generation have expanded over the past decade – and are forecast to continue growing over the next 25 years – they will still account collectively for less than a quarter of global electricity production by 2040. The renewables industry has suffered comparatively little disruption from social opposition and NGO reputational campaigns. However, renewable energy sources are not immune to the reputational risk of association with exacerbating poverty when resourced from land or water upon which impoverished community livelihoods depend, or when imported from energy poor regions.

3.3 Hydroelectric Power

Hydroelectric power stations can produce a great deal of power very cheaply. Either a dam is built to trap water, usually in a valley where there is an existing lake, or a smaller run-of-river installation can be used. Dams are frequently located upstream of major population centers. Water is allowed to flow through tunnels in the dam, to turn turbines and thus drive generators and so produce electricity. After passing through the turbine, the water re-enters the river on the downstream side of the dam.

While producing low emission power, hydro schemes can cause significant environmental and social impacts. Dam construction can mean significant land-take, and can cause largescale resettlement of communities and reduction in the availability of productive land. Changes in water flow downstream can also reduce the water available for existing use, affecting livelihoods (fishing, agriculture, industry) and lifestyle. It is often a highly political issue, particularly where the dammed river crosses international boundaries.

3.4 Wind Power

Wind drives the propeller, which turns a generator to produce electricity. In addition to the actual wind farm, other project features associated with wind conversion systems include: construction camps; maintenance facilities; substations and transmission lines; and access roads.

The construction of wind turbines can attract considerable protest from local communities, particularly in the UK. This relates to noise, visual intrusion and effect on birds.

3.5 Wave Power

Wave power refers to the energy of ocean surface waves. Existing wave power devices are categorised by the method used to capture the energy of the waves, by the intended location, and by the potential power generation. Systems include oscillating water column, articulated pontoon, wave pump, anchored buoy, and fixed buoy.

Wave power systems currently include:

- A pontoon lying in the water which is driven by wave action to push or pull a generator;
- Wave action which compresses air in a tunnel and drives a generator; and
- Waves overtop the side of a reservoir, and the water in the reservoir runs hydroelectric generators.

3.6 Geothermal Power

Mining the Earth's heat generates geothermal power. In areas with high temperature ground water at shallow depths, wells are drilled into natural fractures in basement rock or into permeable sedimentary rocks. Hot water or steam flows up through the wells either by pumping or through boiling (flashing) flow.

Three types of power plants are used to generate power from geothermal energy:

- Dry steam plants take steam out of fractures in the ground and use it to directly drive a turbine that spins a generator.
- Flash plants take hot water, usually at temperatures over 200 °C, out of the ground, and allow it to boil in steam separators and then run the steam through a turbine.
- In binary plants, the hot water flows through heat exchangers, boiling an organic fluid that spins the turbine.

The condensed steam and remaining geothermal fluid from all three types of plants are injected back into the hot rock to pick up more heat.

Geothermal power generation can only be used in some areas around the world, where the crust is thin and hot rocks are near the surface. Sometimes the hot water that is pumped to the surface contains pollutants such as sulphur.

3.7 Photovoltaics/Solar power

Solar photovoltaic (PV) and concentrating solar power (CSP) are the two main types of solar energy . PV power involves the absorption of the sun's energy using photovoltaic cells made of semiconductor material. These cells are connected together to form a solar panel. Sunlight on the cells forms an electric field across the layers of the panel to produce a direct electrical current. Using an inverter, direct current is then transformed into alternating current which can be used by a commercial or residential property or exported into electricity grids. CSP absorbs sunlight heating into a receiver. The receiver in turn adapts the sunlight into mechanical energy through turbines, forming solar thermal electricity.

The high cost of generating electrical power using PVcells compared to conventional coal-, gas-, and nuclear-powered generators has kept PV power generation from being in widespread use. Less than 1% of electricity is generated by PV. There are a few applications, however, in which PV power is economical e.g. developing countries that lack a power distribution infrastructure, and remote or rugged areas where running distribution lines is not practical. As the cost of PV systems drops, more applications become economically feasible. The non-polluting aspect of PV power can make it an attractive choice even when conventional generating systems are more economical.

3.8 Energy from Biomass and Waste

Energy from biomass and/or waste, as an alternative to fossil fuels, provides a contribution towards the reduction in landfill disposal.

Organic matter, defined as "non-fossil biological materials" can be used as a source of biomass energy includes trees, timber waste, wood chips, corn, rice hulls, peanut shells, sugar cane, a variety of agricultural crops e.g. oilseed rape, sunflowers , wheat, soy beans, palm oil, and linseed, grass cuttings, leaves, manure, sewage, and municipal solid waste.

There are several ways of capturing the stored chemical energy in biomass: direct combustion (the burning of material by direct heat) is the simplest biomass technology and can be economically feasible/efficient if the biomass source is close by. Pyrolysis refers to the thermal degradation of biomass by heat in the absence of oxygen, resulting in the creation of gas, fuel oil and charcoal.

Other methods include anaerobic digestion, which involves the mixing of biomass such as sewage wastewater, manure or food processing waste without air to produce methane (natural gas) and carbon dioxide. Landfill gas is generated through the decay (anaerobic digestion) of buried waste in landfills. Landfill gas can consist of up to 50% methane (natural gas). The production of fuel alcohol through the conversion of starch to sugar, fermentation of the sugar to alcohol and then distillation (separation of the alcohol from the water) is known as alcohol fermentation.

It is now widely acknowledged that crop-based biofuel plantations that are grown purely with the intention to provide a fuel source exacerbates food insecurity and so is viewed less positively from an environmental perspective.

4. Decomissioning

Decommissioning refers to the closure of a power generation facility and removal of associated plant and infrastructure.

5. Key Sector Risks and Headline Issues

In power generation and distribution some critical issues of particular public concern may result in reputation or credit risk to a lender or an investor, these include:

- Public perception of the use of nuclear power - possibility of radioactive contamination/explosion;
- Nuclear waste storage- health risks terrorist implication - site security.
- Climate change - long term impact and phase out of greenhouse gases; pollution (burning coal, exhaust gases);
- Non-compliance with environmental permits and regulations;
- Health risks from pollution arising from power generation activities (burning coal);
- Potential health risk caused by electromagnetic fields - electricity distribution;

The following tables detail potential environmental and social risks associated with industry processes and appropriate control measures. These may include Environmental and Social Management Plans and may form part of a wider Environmental Social Management System.

6. Risks and Controls

6.1 Environmental Risks

6.1.1 Project Feasibility & Planning

Life Cycle Phase and Activity	Risks	Controls
	No Specific Risks	No specific controls required

6.1.2 Construction

Life Cycle Phase and Activity	Risks	Controls
All Power Generation Facilities	**Regulatory burden** – is likely to increase, due to pressure to reduce carbon emissions and also for renewables, as the regulatory framework expands as the sector develops. **Habitat depletion, fragmentation and degradation** • Land acquisition and clearance • Land disturbance and clearance, erosion, land stability • Use of remote sites that may have significant wilderness, scenic or recreation value **Strain on infrastructure and public nuisance** - strain on transport networks and local infrastructure	**Engagement with regulators and robust capex planning** **Environmental planning and management / Environmental Impact Assessment and Environmental Management System -** • Avoidance of populated area • Avoidance of sensitive areas/active marine areas • Land use, ecological management/habitat restoration, erosion control, and water quality, spill prevention and response, etc.) and that compliance is monitored by independent third party **Emissions management** - minimise unnecessary use /

Life Cycle Phase and Activity	Risks	Controls
	Impact on terrestrial and aquatic ecology - Infrastructure development e.g. access roads, opening up of natural habitat **Atmospheric emissions:** • Pollutants (VOC, NOX, SOX, PM10, CO, CO2, etc) • Greenhouse gas production • Dust and noise **Disruption and pollution to surface (hydrological) and groundwater (hydrogeological) systems and flows** - Impact to hydrological regime particularly hydroelectric power **Connection with grids** - Requirement for grid extensions **Subterranean/submarine utilities** – • Requirement for submarine cables (wave power, offshore wind farms and transmission links across bodies of water	movement of vehicles, plant and machinery **Hazardous waste, storage and disposal plans** - Employ appropriate health and safety measures for containment of chemicals **Minimize facility footprint** - wherever possible in environmental design **TV and radio reception screening assessment** - mitigation for residential properties affected (in particular wind farms and photovoltaics)
PV and wind	**Landscape scarring and visual impact**	**No specific controls required**

6.1.3 Operation

Life Cycle Phase and Activity	Risks	Controls
Power Stations	**Regulatory burden** – is likely to increase, due to pressure to reduce carbon emissions and also for renewables, as the regulatory framework expands as the sector develops. **Pressure on natural resources** - high water use in water cooled condensers **Liquid waste (production and disposal)** - hot water discharges **Solid waste (production and disposal**) - ash residues (from combustions process) and sludge (from cooling process) **Atmospheric emissions:** • Pollutants (VOC, NOX, SOX, PM10, CO, CO2, etc) • Greenhouse gas production • Dust and noise **Employee Health and Safety -** operational noise, odour, nuisance, **Landscape scarring and visual impact** **Coal fired Power Stations - coal pile runoff and**	**Engagement with regulators and robust capex planning** **Water management** - securing of a sustainable water supply, recycling and reuse wastewater **Waste management –** • On-site effluent treatment and discharge quality monitoring • Appropriate waste handling, storage and disposal procedures **Emissions management** - air quality monitoring and management including Air Quality Management Plan **Use of Best Available Technology Not Entailing Excessive Cost (BATNEEC)** **Emergency preparedness and spill response plans** - protect / avoid water resources

Life Cycle Phase and Activity	Risks	Controls
	leachate **Oil Fired Power Stations** - bulk oil storage tanks	
Nuclear Energy	**Atmospheric emissions:** • Pollutants (VOC, NOX, SOX, PM10, CO, CO2, etc) • Greenhouse gas production • Dust and noise **Hazardous waste disposal** - long term radioactive waste storage and disposal **Site Security and careful waste disposal** - waste materials that can be used to develop nuclear weapons and the resulting proliferation of nuclear weapons **Natural hazards and risks - catastrophic reactor accident** - massive environmental and human health implications	**Emissions management** - air quality monitoring and management including Air Quality Management Plan **Use of Best Available Technology Not Entailing Excessive Cost (BATNEEC)** **Emergency preparedness and spill response plans** **Radioactive Waste Management Plans** – appropriate waste disposal including characterization and siting of repositories **Site security - terrorism risk** **Visible and transparent nuclear regulatory regime**
Hydroelectric Power	**Natural hazards and risks - Dam failure** **Habitat depletion, fragmentation and degradation and Impact on terrestrial and aquatic ecology** - e.g. disrupted salmon (fish) migration **Habitat depletion, fragmentation and degradation** - water quality	**Ecological management plan** - installation of fish passes, **Water management and water quality monitoring** - securing of a sustainable water supply, recycling and reuse wastewater **Emergency preparedness and spill response plans** **Climate resilience should be factored into ESIAs**

Life Cycle Phase and Activity	Risks	Controls
	Accidental/Unplanned Events - transformer/equipment failure/oil leaks **Climate change** - Hydroelectric power generation is dependant on water resource availability, impacts affecting river flows, such as variation in rainfall, accelerated glacial retreat, and prolonged drought, can present risks to the success of the project	
Wind Power	**Landscape scarring and visual impact scarring** - visual impact, **Community Health and Safety** - noise, odor, vibration, dust creation **Natural hazards and risks** - turbine failure during adverse weather conditions, reliance on energy output due to erratic nature of the wind environment **Natural hazards and risk** - interference with functions on agricultural land **Risk to avian populations** – if sites are located in key migratory routes or habitats. May necessitate use of radar and/or pre-emptive shutdowns, which affect productivity. **Natural hazards and risks** - Onshore and Offshore -	**Use of Best Available Technology Not Entailing Excessive Cost (BATNEEC)** - to minimise noise and vibrations **Community engagement** **Land Use Management Plan** **Sustainable forestry (land clearing) and biodiversity management** **Instigation of safety buffer zone** – especially around land clearing operations **Minimise facility footprint -** Location of wind farm away from bird migration routes , away from open water

Life Cycle Phase and Activity	Risks	Controls
	interference with aircraft, military activity zones (drop zones for parachutists) **Offshore** - interference with shipping lanes, dredging areas, fishing areas, wrecks, pipelines **Site security** - security wind farm security	
Wave Power	**Natural hazards and risks** - failure during adverse weather conditions - storm damage **Natural hazards and risks** - long-term persistent damage to equipment due to saltwater corrosion	**Robust operations and maintenance procedures**
Geothermal Energy	**Employee Health and Safety** - exposure to high heat, volatile/toxic gases and work in seismically active areas **Pressure on natural resources** - water injection and heat depletion - both water and energy **Geothermal fluids** **Atmospheric emissions:** Pollutants (VOC, NOX, SOX, PM10, CO, CO2, etc) • Greenhouse gas production - gas emissions and production of highly visible steam plumes • Dust and noise **Disruption and pollution to groundwater**	**Emissions management** - air quality monitoring and management including Air Quality Management Plan **Use of Best Available Technology Not Entailing Excessive Cost (BATNEEC)** - to minimise noise and vibrations **Use of low impact geothermal fluids where alternatives exist**

Life Cycle Phase and Activity	Risks	Controls
	(hydrogeological) systems and flows - groundwater contamination	
Photovoltaics	**High cost per square metre, high maintenance costs for short lifespan**	**Supply chain sustainability** - supply chain management
Energy from Biomass and Waste	**Pressure on natural resources** - raw material/waste availability **Atmospheric emissions:** • Pollutants (VOC, NOX, SOX, PM10, CO, CO2, etc) • Greenhouse gas production • Dust and noise	**Emissions management** - air quality monitoring and management including Air Quality Management Plan **Use of Best Available Technology Not Entailing Excessive Cost (BATNEEC)** - to minimise noise and vibrations

6.1.4 Electricity Supply

Life Cycle Phase and Activity	Risks	Controls
	Habitat depletion, fragmentation and degradation - • Disruption to habitat during commissioning and operation (access for maintenance) • Land contamination associated with substations and transformers (oil spills) • Land clearance and disturbance, localised erosion risks **Community Health and Safety** - noise, odour, vibration, dust creation Noise, vibration, dust and air emission impacts	Environmental planning and management / Environmental Impact Assessment and Environmental Management System- • Avoidance of populated areas • Avoidance of sensitive areas/active marine areas • Ensure that all construction activities are governed by appropriate environmental management plans (e.g. land use, ecological management/habitat restoration, erosion control, water quality, spill prevention and response, etc.) and that

Life Cycle Phase and Activity	Risks	Controls
	Public Nuisance - strain on transport networks and local **infrastructure-** Infrastructure interference, disruption to public rights of way, road network **Impact on terrestrial and aquatic ecology** **Connection with grids** **Natural hazards and risks** - localised geotechnical and flood risks **Atmospheric emissions:** • Pollutants (VOC, NOX, SOX, PM10, CO, CO2, etc) • Greenhouse gas production • Significant engineering works	compliance is monitored **Waste management -** • On-site effluent treatment and discharge quality monitoring • Appropriate waste handling, storage and disposal procedures **Minimize facility footprint -** • Wherever possible in environmental design and ensure appropriate engineering design for local climatic condition • SF6 used as an insulator • Minimise unnecessary use / movement of vehicles, plant and machinery **Emergency preparedness and spill response plans** - appropriate inspection and maintenance programmes

6.1.5 Decommissioning

Life Cycle Phase and Activity	Risks	Controls
Planning and Execution	**Habitat depletion, fragmentation and degradation** - land rehabilitation and restoration **Site remediation / clean-up**	**Rehabilitation and remediation management plan**

6.2 Environmental Risks

6.2.1 Project Feasibility & Planning

Life Cycle Phase and Activity	Risks	Controls
Power Stations, Nuclear Facilities, Hydroelectric Power, Geothermal Facilities, Energy from Biomass and Waste	**Site selection** - impact on communities relating to pollution, transport, waste	**Prefeasibility assessment and social impact assessment**
Electricity transmission	**Subterranean / submarine lines** - impact on communities relating to electromagnetic fields, visual impact, land take	**Prefeasibility assessment and social impact assessment**

6.2.2 Construction

Life Cycle Phase and Activity	Risks	Controls
Power Stations, Nuclear Facilities, Hydroelectric Power, Geothermal Facilities, Energy from Biomass and Waste	**Community health and safety** - transport routes / vehicle accidents emissions/discharges (aqueous and gaseous), noise, dust and vibrations **Public nuisance** - noise, vibration, dust creation, odour, traffic movements, emissions and air quality **Disruption of social / community cohesion and exclusion of vulnerable groups –** • Breakdown of social networks and structures • Socio-economic exclusion of ethnic minorities and indigenous peoples • Socio-cultural tensions between local and foreign workforce from influx and outflow of migrants/ temporary workers and attraction of seasonal residents to project area **Communicable diseases** - spread of diseases to local/foreign populations by construction workforce **Loss of livelihood** - economic displacement, job competition, conflict between local and foreign workers, land use and property **Land acquisition** - loss of access and displacement - temporary and permanent land acquisition and use of natural resources - (particularly for dam and reservoir	**Community / stakeholder relations management -** • Management of interface between local communities and project through stakeholder identification and consultation (including governmental / national / regional / local stakeholders) • Management of community tensions, grievances and concerns through transparent formal grievance mechanism **Community awareness raising and information dissemination on project** • Management of relations with NGOs and national advocacy groups (through consultation and project disclosure) **Social / community baseline assessment** - detailed socio-economic baseline assessments to establish community profiles (e.g. social hierarchy, ethnic groups, socio-cultural and religious practices, skills profile) and public services/resources in a project area **Community development and investment -** community investment (both long and short term) as offset for impacts not fully mitigated

Life Cycle Phase and Activity	Risks	Controls
	construction) **Employee health and safety, and labour issues** - employment and poor labour standards, working conditions, child labour and other human rights issues, particularly on hydro power developments and cultivation of crops for biofuels. **Stakeholder / public consultation and disclosure** - communities, NGOs, local and national advocacy groups, badly managed social and community relations, negative exposure, compensation claims **Impacts on local procurement and business** **Host country governance, economy and revenue transparency** -impacts on national economy, sustainable growth and inflation, bribery, corruption and extortion, revenue transparency **Strain on infrastructure and public nuisance** - strain on transport networks drain on and overuse of local infrastructure - including capacity to absorb new/foreign populations (supply and demand) e.g. water resources, power, health, education, housing	**Site security plans** **Community health and safety plans** - vaccinations and awareness raising on communicable diseases **Resettlement and relocation management** - including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies **Human resource policies** - maximization of local employment, introduction of minimum labour standards and compliance audits **Cultural heritage / archaeology management** – • Identification, classification and protection of cultural / archaeological sites in accordance with the country's laws/international standards and conventions • Implementation of a site / feature "watching brief" (continuous visual monitoring) **Supply chain sustainability** - procurement and supply chain management **Partnering with and supporting host governments** - encourage revenue transparency and good governance
Wind Power	**Community health and safety** - transport routes / vehicle accidents emissions/discharges (aqueous and	**Community / stakeholder relations management** • Management of interface between local

Life Cycle Phase and Activity	Risks	Controls
	gaseous), noise, dust and vibrations drain on and overuse of local infrastructure **Strain on infrastructure and public nuisance** - strain on transport networks and local infrastructure **Loss of livelihood** - economic displacement, land use and property, temporary land acquisition and use of natural resources - impact on livelihoods and land value, compensation claims	communities and project through stakeholder identification and consultation (including governmental/national/regional/local stakeholders) • Management of community tensions, grievances and concerns through transparent formal grievance mechanis **Community awareness raising and information dissemination on project** • Management of relations with NGOs and national advocacy groups (through consultation and project disclosure) **Human resource policies** - maximization of local employment **Cultural heritage / archaeology management** • Identification, classification and protection of cultural / archaeological sites in accordance with the country's laws/international standards and conventions • Site / feature "watching brief" (continuous visual monitoring) **Supply chain sustainability** - procurement and supply chain management

Life Cycle Phase and Activity	Risks	Controls
Wave Power	**Loss of livelihood** - economic displacement, disruption to fishing grounds **Stakeholder / public consultation and disclosure** - communities, NGOs, local and national advocacy groups, badly managed social and community relations, negative exposure, compensation claims **Landscape scarring and visual impact** - visual impact	**Community / stakeholder relations management -** • Management of interface between local communities and project through stakeholder identification and consultation (including governmental/national/regional/local stakeholders) • Management of community tensions, grievances and concerns through transparent formal grievance mechanism **Community awareness raising and information dissemination on project** • Management of relations with NGOs and national advocacy groups (through consultation and project disclosure) **Community development and investment** - community investment (both long and short term) as offset for impacts not fully mitigated
Photovoltaics	**Landscape scarring and visual impact** - visual impact	**Community / stakeholder relations management** Community awareness raising and information dissemination on project

6.2.3 Operation

Life Cycle Phase and Activity	Risks	Controls
Power Stations, Nuclear Facilities, Geothermal Energy, Energy from Biomass and Waste	**Community health and safety** - transport routes / vehicle accidents emissions/discharges (aqueous and gaseous), noise, dust and vibrations **Strain on infrastructure and public nuisance** - strain on transport networks and local infrastructure **Social / community cohesion and exclusion of vulnerable groups** - socio cultural conflict **Loss of livelihood** - economic displacement, job competition, conflict between local and foreign workers, property value **Employee health and safety** - employment and poor labour standards, particualry in the cultivation of crops for biofuels. **Stakeholder/public consultation and disclosure** - communities, NGOs, local and national advocacy groups, badly managed social and community relations, negative exposure, compensation claims	**Community / stakeholder relations management** - • Management of interface between local communities and outsiders/foreign workers through stakeholder identification and consultation (including governmental/national/regional/local stakeholders) • Management of community grievances and concerns through transparent formal grievance mechanism **Community awareness raising and information dissemination on project** • Management of relations with NGOs and national advocacy groups (through consultation and project disclosure) • **Site security plans and security awareness raising** **Health and safety plans** **Human resource policies** - maximization of local employment **Supply chain sustainability** - procurement and supply chain management

Life Cycle Phase and Activity	Risks	Controls
		Partnering with and supporting host governments - encourage revenue transparency and good governance
Hydroelectric Power	**Natural hazards and risks - dam failure** – extreme flood risk, catastrophic loss of life, loss if livelihoods, community assets, compensation claims	**Robust operations and maintenance procedures**
Wind Power	**Landscape scarring, and visual impact** - decrease in property value **Noise** – perceived vs. actual	**Robust operations and maintenance procedures**
Wave Power	**Loss of livelihood** - economic displacement - disruption to fishing grounds	**Community / stakeholder relations management** - Stakeholder identification and governmental / national / regional / local consultation # **Community development and investment** - Community investment (both long and short term) as offset for impact not fully mitigated
Photovoltaics	**No specific risks identified**	**No specific controls required**

6.2.4 Electricity Supply

Life Cycle Phase and Activity	Risks	Controls
	Community health and safety • Transport routes / vehicle accidents emissions/discharges (aqueous and gaseous), noise, dust and vibrations, electromagnetic field • Electrical safety to communities during operation **Strain on infrastructure and public nuisance -** strain on transport networks and local infrastructure traffic movements **Employee health and safety** - employment and poor labour standards, worker health and safety during inspections/maintenance, including handling of PCB (carcinogen) contaminated transformer oil and exposure to electromagnetic fields **Community health and safety** **Land acquisition** - loss of access and displacement, temporary and permanent displacement, land acquisition and use of natural resources - impact on livelihoods and land value, compensation claims) **Cultural heritage and archaeology** **Employee health and safety** - employment and poor	**Community health and safety plans** - awareness raising on health and safety **Community / stakeholder relations management -** • Management of interface between local communities and outsiders/foreign workers through stakeholder identification and consultation (including governmental/national/regional/local stakeholders) • Management of community grievances and concerns through transparent formal grievance mechanism • Community awareness raising and information dissemination on project • Management of relations with NGOs and national advocacy groups (through consultation and project disclosure) **Site security plans** **Resettlement management -** community compensation strategy for land acquisition **Human resource policies** - maximization of local employment

Life Cycle Phase and Activity	Risks	Controls
	labour standards **Stakeholder / public consultation and disclosure** - communities, NGOs, local and national advocacy groups, badly managed social and community relations, negative exposure, compensation claims **Host country governance, national economy and revenue transparency** - economy - sustainable growth and inflation, bribery, corruption and extortion **Supply chain sustainability** - Security of supply and provision of ongoing supply to the community and customers **Provision of electricity to vulnerable persons (fuel poverty)** **Landscape and visual impact scarring** - visual impact of above ground electricity transmission lines	**Cultural heritage / archaeology management -** • Identification, classification and protection of cultural / archaeological sites in accordance with the country's laws/international standards and conventions • Site / feature "watching brief" " (continuous visual monitoring) **Supply chain sustainability** - Procurement and supply chain management **Partnering with and supporting host governments** - encourage revenue transparency and good governance **Community development and investment** - fuel poverty programmes to assist vulnerable customers

6.2.5 Decommissioning

Life Cycle Phase and Activity	Risks	Controls
Planning and Execution	**Loss of livelihood** - economic displacement - community financial support **Social / community cohesion and exclusion of vulnerable groups** - socio cultural conflict and unrest **Loss of livelihood** - economic displacement, loss of income and employment - dependency on project related jobs **Land rehabilitation and restoration** **Site remediation/clean-up** **Employee health and safety** - employment and poor labour standards, child labour **Stakeholder / public consultation and disclosure** - communities, NGOs, local and national advocacy groups, badly managed social and community relations, negative exposure, compensation claims	**Community development and investment** - community investment (both long and short term) e.g. health care facilities, micro-finance initiative **Rehabilitation and remediation management plan**

7. Key considerations

1. Are the appropriate permits held from the Environmental Regulator? Is the site in full compliance with these?
2. Are existing environmental reports available for review? Are these up to date with respect to current site operations?
3. How does the company tackle the issue of greenhouse gas emissions? Has the company considered less GHG emitting fuel, or has the best available technology been used?
4. How does the company deal with biodiversity protection?
5. Are there appropriate procedures in place for waste management, accidental releases, environmental management, etc?
6. Are appropriate procedures in place for storage and handling of chemicals and energy once created?
7. What other hazardous materials are used in the operation of the facility?
8. Has the customer planned for all the necessary provisions to restore and rehabilitate the site or to mitigate damages?
9. Have affected communities been involved in a public engagement process? Are identified risks being managed appropriately? Is a fit for purpose Grievance Mechanism in place?

8. Regulation and Best Practice

Permits, consents and licences are likely to be required for power generation operations, the specifics of which will depend on the relevant regulatory framework in the location of the facility. In developing regions, weaker governance structures may mean that there is less stringent implementation of local controls and regulations or indeed there may be no controls at all. In such cases, international environmental and social standards and industry best practice should ideally be adopted by the project proponent as a demonstration of Best Practice.

In the case of almost all large-scale new build, expansion and development projects an Environmental and Social Impact Assessment (ESIA) will be required particularly where project-related debt financing is being sought. A comprehensive ESIA undertaken to international standards allows both the project sponsor and the investors to assess the full range of potential environmental and social impacts related to a project development, operation and decommissioning. Part of the ESIA process is to design appropriate mitigation measures and environmental and social management plans and to set a framework for the monitoring the performance of these measures on a long term basis. This limits and controls compliance and remediation costs as well as long term credit and reputation risks.

For smaller scale projects and operations a full ESIA may not be required. Focused studies on particular issues of concern may however, be helpful in identifying potential environmental and social risks associated with certain project activities.

The table below lists key international standards and publicly available best practice reference materials relevant to the power generation sector.

9. Additional resources

Multilateral:

1) IFC Performance Standards
2) Greenhouse gas Protocol Initiative
3) Business Council for Sustainable Development
4) Intergovernmental Panel on Climate Change 'IPCC Special Report on Carbon dioxide Capture and Storage'
5) Stockholm Convention on Persistent Organic Pollutants
6) EU Directive for Waste Management
7) The Global Environment Facility
8) EU Policies: Integrated Pollution prevention and control.
9) International Labour Organisation (ILO) Labour Standards
10) Security Issues and Human Rights - Voluntary Principles

Government:

1) Health and Safety Executive Noise Regulations (complete)
2) Health and Safety Executive Guidance for Employers for the Control of Noise at Work Regulations 2005
3) Air Quality Criteria for Particulate Matter Environmental Protection Agency United States Government

Industry Association:

1) Alternative Energy Engineering Options
2) World Coal Institute
3) International Hydropower Association
4) International Energy Agency
5) International Atomic Energy Agency (IAEA)
6) The Carbon Principles
7) Better Coal