FOWPI (https://www.fowpi.in/)
FIRST OFFSHORE WIND PROJECT OF INDIA

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Risk Evaluation

The following sections introduce an overview of risk evaluation in relation to offshore wind energy. Four key risk areas will be introduced along with links to numerous procedures used to manage risks in European Offshore Wind, which can form the basis for development of risk evaluation guidelines for Indian offshore wind. Ultimately a simplified risk assessment approach will be described and an example of risk assessment will be provided for each key area.

Risk Evaluation

In Europe, risk evaluation guidelines were initially developed for the chemical process industries and the offshore oil and gas industry and then adapted for offshore wind energy conditions. When planning offshore wind farm projects, risk evaluation is required to ensure that risks to humans, the project, the environment and assets are identified, understood and effectively managed.

The outcome of future developments cannot be foreseen with certainty due to the unavailability of complete information. This uncertainty related to all offshore wind farm activities is defined as risk. [1] If an incident is bound to happen (no uncertainty as the probability is almost 100%) the incident is not considered a risk and it must be eliminated during normal project execution.

Certain equipment, activities or situations at an offshore wind farm may have the potential to cause harm. These are defined as hazards.

The definition of risk traditionally combines three elements: it starts with a potential event and then combines its frequency (or probability) with its potential severity. A high risk event would have a high likelihood of occurring and a severe impact if it actually occurred.

Risk evaluation mainly consists of four main steps:

1) Identification: in this step possible negative external and internal conditions/events/ situations/ and incidents are identified that may be detrimental to the ability to achieve a specific objective.

2) Analysis: in this step potential situations are analysed to determine the relationships between their causes and consequences, their magnitudes and likely outcomes.

3) Assessment: modelling of different scenarios using different assumptions and assessing the frequencies of scenarios.

4) Management: a strategy or a combination of strategies designed to avert, mitigate, control and / or minimize risks. The overall objective is to reduce risks to human life or the environment and the resulting costs, liabilities and losses.

Four key risk areas are introduced in the below table. These areas should always be addressed in the risk management for Offshore Wind projects.

Risk Type	**Definition** [2]	**Remarks**
Technological risks	Concern risks resulting from activities such as design and engineering, manufacturing, technological processes and test procedures.	Wind turbine technology maturity (new model vs proven model) can result in higher or lower risks. The developer's scope will affect the overall extent of project technical risks, e.g. are offshore substations within or outside outside the scope?

Financial risks	Concern the probability of losses which may impact the ability of the project to provide the expected return.	The process of selling electricity includes risks relating to grid availability, curtailment, delays, etc. Many of these can be transferred to the electricity consumer via proper PPA contract term definition. The higher the risk, the higher the risk premium and thus the cost of capital and required tariff.
Environmental risks	Environmental risks concern the actual or potential effects on living organisms and the environment due to an organizations' activities.	The risks in this area are normally considered to be lower than those in the offshore oil and gas industry but still of high level, in particular, during the construction phase.
Health and Safety	Health and safety risks concern to the potential loss of life, injury, liability, loss, or any other negative incident that is caused by external or internal activities.	The offshore work environment is one of the most challenging and expose individuals to very high risk. So proper health and safety should be the number one priority for any wind developer working offshore.

The European Offshore Wind industry has developed procedures for managing risks which can form the basis for the development of risk evaluation guidelines for Indian Offshore Wind. There follows a non-comprehensive list is provided for guidance:

1) International guideline on the risk management of offshore wind farms, Offshore Code of Practice, VdS [3]
2) FOWPI report on "Environmental scoping" [4] with a comprehensive evaluation of Environmental risks
3) FOWPI report on "Procedures for offshore wind" [5] with a comprehensive evaluation of health and safety risks

Risk Assessment

The following guidelines show examples of feasible approaches to risk assessment and can be used as inspiration and assistance for the identification of project risks and the assessment of consequences. The risk assessment needs to be customized for each specific project and parameters such as frequency and cost of consequence must be calibrated against the project time line and the project expenditure, e.g. CAPEX and OPEX.

The Guidelines contain:

1. a list of ideas on how to identify risks.
2. a table for rating the **probability** of occurrence during the project implementation phase(or frequency, i.e. how often could the hazard occur) - Table 1.
3. a table for the evaluation of the **potential cost of consequences** (how great is the expected cost compared with the size of the project) - Table 2
4. a **scoring system** - Table 3 - giving an indication of which mitigating actions to choose.

1. Identification of Risks

Efficient methods for identifying risks comprise:

- workshops
- brainstorming in consultation with experienced colleagues (and external experts)
- interviews with the project stakeholders
- scenario technique
- experience collected from other similar projects
- analysis of the special conditions for the project

2. Probability Rating

Table 1		
Rating	**Description**	**Probability of occurrence**
1	seldom (or never)	less than 1 %

2	not likely	1 - 10 %
3	neutral	10 - 30 %
4	likely	30 - 70 %
5	most likely	70 - 85 %

3. Potential Cost of Consequences Rating

Table 2		
Rating	**Potential cost of consequences ***	**Risk level**
1	100%	Very serious
2	50%	Serious
3	25%	Medium
4	10%	Small
5	1% or less	Very small

* = compared with the size of the project

4. Mitigation Action based on Risk Scoring

The combination of consequences and frequency (= risk score) gives an indication of which mitigating actions to choose. The risk score is calculated multiplying the frequency rating by the consequence rating.

Table 3	
Risk score	**Mitigating action**
More than 14	Act now
8 - 14	Plan
Less than 8	Accept for now

However, easily remediable risks should always be acted on although the risk score may be low. Risks should always be reduced to ALARP (a level that is as low as reasonably practicable).

- Act Now: The risk incident is evident and mitigation shall be commenced immediately
- Plan: Actions must be planned ahead and/or early warnings must be identified and monitored in order to have sufficient time to adjust.
- Accept for now: The potential consequences of the risk are accepted until next review

Example of Risk Assessment

This section will introduce an example of risk assessment for the four key risk areas mentioned above.

Technological Risks

Risk Identification			Evaluate and decide mitigating action					
Risk no.	Risk Title	Triggers, consequences and other comments	Potential cost of consequences (k Euro)	Probability	Min. Impact	Max. Impact	Scoring	Type of mitigating action
1	Incorrect pre-construction site conditions estimation	Wind turbine structure and components may experience higher fatigue loads than expected impacting the main components life time.	10000	3: 10-30%	1000	3000	15	Act now
2	Damage to export cable	Underwater currents weaken the export cable protection and expose the cable to damage by fishing activities.	10000	4: 30-70%	3000	7000	20	Act now
3	Underdeveloped spare part supply chain	The spare parts supply chain does not develop as expected and the project experience longer downtimes due to lack of spare parts.	1000	3: 10-30%	100	300	6	Accept for now

Mitigation Plan

Task no.	Task title	Task description	Task related to risk no.	Start date	Due date	Task Status
1	Export cable protection	Design a site specific export cable protection to prevent underwater currents to expose the cable.	2	01 September 2018	01 July 2019	Ongoing

Financial Risks

Risk Identification			Evaluate and decide mitigating action					
Risk no.	Risk title	Triggers, consequences and other comments	Potential cost of consequences (k Euro)	Probability	Min. impact	Max. impact	Scoring	Type of mitigating action
1	Decommissioning costs	Large uncertainties on the cost of decommissioning the wind farm.	10000	3: 10-30%	1000	3000	15	Act now
2	Underdeveloped ports	The funding are insufficient for ports development and a proper operational hub cannot be established in the project premises.	5000	4: 30-70%	1500	3500	16	Act now
3	Change in support schema	The public supporting schema is cut during the operational life time of the project.	1000	2: 1-10%	10	100	4	Accept for now

Mitigation Plan

Task no.	Task title	Task description	Task related to risk no.	Start date	Due date	Task Status
1	Port development	Include a budget for port development in the overall project budget.	2	01 July 2019	01 February 2020	Planning

Environmental Risks

Risk Identification				Evaluate and decide mitigating action				
Risk no	Risk title	Triggers, consequences and other comments	Potential cost of consequences (k Euro)	Probability	Min. impact	Max. impact	Scoring	Type of mitigating action
1	Impact on fisheries output	The sea fauna may be affected by ongoing construction operations, heavy vessels traffic, etc.	2000	3: 10-30%	200	600	9	Plan
2	Noise pollution	Despite the application of best practices, the underwater noise pollution could still be above limits delaying the process.	3000	2: 1-10%	30	300	6	Accept for now
3	Oil Leakage	Oil may be spilled by vessels during installation phase, wind turbines during the operation phase.	100	3: 10-30%	10	30	3	Accept for now

Mitigation Plan

Task no.	Task title	Task description	Task related to risk no.	Start date	Due date	Task Status
1	Mitigate impact on fishing industry	Carry out proper monitoring and implement state of the art procedures to preserve the biomarine diveristy and fauna	1	01 January 2018	31 August 2018	Completed

Health and Safety Risks

Risk Identification				Evaluate and decide mitigating action				
Risk no	Risk title	Triggers, consequences and other comments	Potential cost of consequences (k Euro)	Probability	Min. impact	Max. impact	Scoring	Type of mitigating action
1	Collision against offshore wind turbines	A vessel, boat, cargo could collide with one of the offshore wind turbines.	4000	2: 1-10%	40	400	8	Plan
2	Adverse weather during maintenance activities	Improper weather forecasting may expose maintenance crew to unsafe work conditions offshore.	1000	4: 30-70%	300	700	8	Plan
3	Work from height	A large range of activities offshore relate to work from height and so workers are exposed to potential fall.	100	2: 1-10%	1	10	3	Accept for now

Mitigation Plan

Task no.	Task title	Task description	Task related to risk no.	Start date	Due date	Task Status
1	Weather forecasting	Define and adopt state of the art solution for weather forecasting to assure safe operation and maintenance operations offshore.	2	01 January 2018	31 August 2018	Completed

For more information, refer the following informative links/material:

1. Pre-Feasibility Report For Offshore Wind Power Development In Gujarat (http://www.fowind.in/publications/report)

2. Business Dictionary (http://www.businessdictionary.com/definition/technical-risk.html)

3. International Guideline on the Risk Management of Offshore Wind Farms (https://shop.vds.de/de/download/c12680e60af7a0d7137d41f0ae5fd278/)

4. FOWPI Report on Environmental Scoping and Consent Register (http://www.fowpi.in/uploads/download_document/fowpi_environmental_scoping_report_and_consent_register_v1_ilovepdf_compressed_1593274251.pdf)

5. FOWPI Report on Procedures for Offshore Wind
(http://www.fowpi.in/uploads/download_document/fowpi_procedures_for_offshore_wind__v2__78896846064.pdf)

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