

Terms of Reference (TOR)

for

Appointment of Consulting Firm for Pre-feasibility and Detail Feasibility Study to Develop Off-shore Wind Farms in Bangladesh

1. Project Background

Offshore electricity generation, mainly from wind, has increased world-wide rapidly in recent years. Wind and other marine technologies are emerging as an alternative energy options including low-carbon sources of electricity generation. Though liquid petroleum like oil will remain the dominant energy source for many decades to come, but the ocean offers enormous potential for the generation of renewable energy – wind, wave, tidal, biomass, and thermal conversion and salinity gradients. Of these, at present the offshore wind energy industry is the most developed of the ocean based energy sources. The global offshore wind prospect estimates that the installed capacity could grow to 175 GW by 2035.

Bangladesh has immense possibilities of harnessing resources from the 26 blocks in deep and shallow seas, covering more than 118,813 square kilometers of waters altogether comprising territorial sea and an exclusive economic zone extending out to 200 nautical miles (370 km). Beside oil and gas exploration, offshore winds off the coast of Bay of Bengal hold the best source of wind energy. Bangladesh can tap into this resource to ensure a diversified portfolio of renewable energy sources. The unique seabed structure of the Bay of Bengal can be used to our advantage for anchoring offshore wind farms.

In recent years the off-shore wind technology has become mature enough to be deployable with minimum risk. The pace and scale of turbine technology development has been unprecedented with offshore turbines and will continue to grow further in the coming years. This growth and technology innovation is one of the key contributing factors for the industry cost reduction drive. Bangladesh can enjoy manifold benefits of implementing off-shore wind such as faster wind speeds than on land (a small increase in wind speed can yield large increase in energy production), no barriers to wind flow at sea as compared to hills and mountains, lower tower frame on the sea than at the land (greater wind speed can be gained in the lower height), lower impact on society and environment, no land acquisition, smaller fatigue loads enabling extended lifetime of the turbine unit and so on.

Therefore, Bangladesh is intending to identify the potential blocks in its offshore regime to develop wind farms. For meeting the above purposes, Power Division, Ministry of Power, Energy and Mineral Resources intends to appoint a Consulting firm to conduct a two-step assessment comprising- (i) a pre-feasibility assessment of off-shore blocks for wind energy potential, and(ii) a detail feasibility study of two sites identified as the prospective blocks based on the findings of the pre-feasibility study and possibility of harnessing electricity. The study will be carried out under Bangladesh Power Sector Development and Capacity Building (BPSDCB) Project of Power Division.

The project expenditure will be borne from the fund of the Asian Development Bank under the Bangladesh Power System Enhancement and Efficiency Improvement Project (Loan 3523-COL). Power Division will recruit the consulting firm in accordance with ADB Guidelines on the Use of Consultants (2013, and as amended from time to time) using a Quality and Cost-Based Selection (QCBS) method. A quality-cost ratio of 80:20 will be applied for the final selection of the consulting firm based on the Full Technical Proposals from the short-listed firms, and the consulting firm will be engaged using an output-based lump-sum contract.

2. Purpose of the Assignment

The main objectives of this assignment are:

- a) Assess the potential of wind energy at offshore areas of Bangladesh, i. e. Bay of Bengal;
- b) Identify the potential offshore locations for wind power generation;
- c) Develop viable business model for off-shore wind projects;
- d) Attract public/private sector investment in wind power sector;
- e) Increase wind energy share in the power generation.

3. Duration and Location of the Services

The duration of the Pre-feasibility study is 05 (Five) months, and the duration of Detail feasibility study will be 07 (Seven) months. The location of service will be in Bay of Bengal regime of Bangladesh.

There will be two separate contracts for Phase 1 and Phase 2. The second phase of the contract will be signed upon satisfactory completion of the first phase of the assignment (pre-feasibility study). Both Phase 1 and Phase 2 contracts will be output based.

4. Scope of Services

The scope of services includes the followings (including modifications proposed by the consultant, if any) in the scopes of work to meet the objectives of the assignments. The bidder may also suggest modification/improvement to the Scope of Services during their EOI proposal submission.

4.1 During Pre-feasibility Study:

- **Review previous studies**
Review previous studies on “Wind Resource Mapping”, On-shore wind studies conducted in different sites especially adjacent to coastal areas of Bangladesh.
- **Data Collection and Analysis**
Collect data from the authentic organizations and established sources on off-shore wind resources, met ocean and geotechnical data. Collection of data is the responsibility of the consultant. If needed, the consultant will procure data from the authentic organization with prior consent from the Client.
- **Identify potentials**
Identify potential of each block for wind power generation at Bay of Bengal based on available data. The consultant will provide a list of potential sites for detailed feasibility study and provide a ranking of the sites with the detailed basis of deriving such ranking. Power Division will assess the list and ranking and select two sites for the next step of the assignment.
- **Plant Capacity**
Depending on the area identified, recommend the plant capacity based on wind data from established sources. The consultant will provide a preliminary design and sizing of the wind turbine including functional specifications viz., optimum height, generation capacity, swept area, rotational speed, tilting angle, etc. including basic parameters of ancillaries.
- **Applicable Technology**
Review the available technology in the market and recommend the best technology for the off-shore project and fix the efficiency level of the equipment. The consultant will determine the optimum height of wind turbines and their generation capacity with recommended

technology. Technology will be selected considering the condition of sea and carrying facilities in deep sea.

- **Method of Implementation of the Project**

Recommend the appropriate financing modality and method of implementation of the project (public/private/joint venture) considering economic, financial and commercial aspects. While recommending any specific methodology of implementation, detail tariff analysis shall also be taken into consideration with a view to making comparison between various methods. Hence, tariff analysis regarding suggested methods shall be included in the report to get a clear concept and to select the most viable method of implementation. The consultant shall recommend the allocation process of potential blocks among power generation utilities to install power plants.

- **Power Evacuation**

Recommend the method of power evacuation to mainland from off-shore and the necessary construction of electrical infrastructure along with arrangements required with concerned utilities/PGCB. Identify key issues and provide solutions/ recommendations for grid stability to the utility to accommodate and integrate the wind power generated from the proposed plants. Identify additional investments and its cost estimates required for power evacuation and successful integration of the wind park in the sea to mainland and nearby power grid. Study the existing power system and identify gaps, load centers to ensure that the wind energy generated is fully utilized without any curtailment. The power evacuation related study needs to be carried out with currently available software of PGCB (i.e. PSS/E, DigSilent).

- **Information dissemination and knowledge sharing**

Prepare a methodology for ranking of the selected locations and organize a knowledge event for the employer to aid selection of the appropriate sites for the second phase (detailed feasibility study). The knowledge event will also comprise knowledge products on technology selection, plant sizing and business model.

As the study is divided into Pre-feasibility and Detail Feasibility study stages, the Detail Feasibility study shall be carried forward based on successful completion of Pre-feasibility stage. The second contract (detail feasibility study) will be signed based on successful completion of the first contract (pre-feasibility study) satisfactory to the employer. However, client is not bound to conduct detail feasibility study in any case. Consultant will rank the potential sites for establishing off-shore wind farm during Pre-feasibility study considering the scopes mentioned for Pre-feasibility study. It will also provide the basis of computing such ranking and organize a knowledge sharing event for the employer on this. Based on the identification of potential sites from Pre-feasibility study, Project Office (in discussion with the consultant) will select the site/sites to carry out Detail Feasibility Study in two locations.

4.2 During Detail Feasibility Study:

The Consultant shall carry out the study in the location identified by the Project Officer.

- **Proposing Optimum Plant Layout**

The Consultant shall study and propose one or more optimum plant layouts showing arrangement of the wind turbines in each array.

- **Structural design**

The consultant will determine suitable technology for WTG foundation among Barge, Semi-submersible, Spar, Tension Leg platform etc. and provide detailed structural design of floater, possible off-shore WTG technology, WTG installation method, control room and all other structural works required in the deep sea for the project.

- **Conduct metocean and other oceanographic studies**
 Carry out metocean study, geotechnical study and bathymetric survey to establish wind infrastructure on specific locations. Also conduct detail oceanographic and other surveys for the proposed offshore blocks as per required measurements finalized during pre-feasibility study.
- **Material Carrying**
 The consultant will recommend the carrying facilities to the sites in deep sea. Required development of proposed carrying facility including drawing, design and cost estimates should also be suggested.
- **Industry Perspective on Offshore Wind Policy in Bangladesh**
 The Consultant shall conduct a detailed study and propose recommendation on the 'Policy Support', 'Regulatory Support', 'Grid Integration Support', 'Supply Chain Support' and any other support activities necessary for the implementation and operation of offshore wind farms in Bangladesh.
- **Capacity Development**
 The Consultant shall propose a detailed plan for the training and development of O&M manpower of wind power plants. The plan shall include training need assessment. The Consultant shall prepare a training plan for developing specialized group of O&M personnel. Such manpower shall contribute in the implementation of similar power projects along with contribute in the O&M of the constructed offshore wind power plants.
- **Developing O&M Methodology**
 The Consultant shall prepare a suitable O&M methodology including manpower setup, outsourcing requirement, identifying special maintenance tools, spare parts sourcing & requisition plan, etc. The Consultant shall also investigate the challenges and issues pertinent to O&M of the off-shore wind farm and recommend the means of overcoming such challenges.
- **Emergency Response Plan**
 The Consultant shall prepare an emergency response plan that will be followed during the occurrence of any natural calamities or unforeseen conditions.
- **Power Evacuation**
 After the specific sites have been selected in the pre-feasibility phase, conduct detailed study for each selected site to determine best evacuation solution for each site to identify more accurate cost estimate for power evacuation of each offshore wind park. As the constructed evacuation arrangements may require the involvement of public lands/roads and highways, clear instructions regarding the Right of Way should be included in the report by the consultant.
- **Financial & Economic Analysis**
 Cost-benefit analysis for different technological options for wind turbines depending on turbine type, mounting options and potential use of electric storage and/or capacitors. Availability, inter-operability, reliability, scalability and maintenance aspects; defining communication, command and control systems, load consumption, system architecture definition and roadmap (including layout, modules, inverters, transformers, meters, etc.), relationship between the features, system output and performance should be taken into account. The cost estimates for development, construction and operation of the project and predicted revenue, based on the available resource data, as well as indicative quotes or comparison with similar projects;

Financial and economic analysis for the technology suitable for commercial utility-scale grid connected wind power plants at each of the selected sites specifying the investment cost (\$/kW), Cost of O&M, Cost of Decommissioning after Plant Lifetime, levelized cost of energy (\$/kWh), subsidies, incentives, energy tariffs, costs and benefits (including NPV, BCR, FIRR, EIRR) total cost of ownership/life-cycle costs of plant, payback time, insurances costs, costs recovery, etc. should be taken into account.

- **Cost Estimation**

Finalization of detailed bill of quantity for all aspects of the project including mechanical, civil & electrical works and prepare a detailed breakup of cost estimate of each component of the project.

- **Conduct Natural and Other Risk Assessment**

Conduct a risk assessment of the sites based on meteorological data of the area and geotechnical conditions of the area. The consultants will also assess the hydrology/hydrogeology of the area and potential risk of cyclones, tsunamis or other natural calamities as well as historical records or previous investigations.

- **Environmental and Disaster related Issues**

Review the existing environmental laws and regulations and recommend environmental issues that may arise as a result of the implementation of the project. Conduct assessment of possible disaster and environmental impacts of the project at the selected locations in sea. The assessment shall include bird, fish, marine mammal and habitat surveys as well as marine navigation studies, socio-economic surveys, commercial fishing, archaeology, noise analysis, landscape and visual assessment and aviation impact assessments. An analysis of Benthic environmental condition, fish and shellfish surveys, Ornithological environmental surveys, sea mammal environmental surveys in the project area as well as impacts associated to installation and maintenance of turbine on sea and connection of the system to the grids. Based on collected data, the environmental impacts and subsequent mitigation and management required should be reflected in the EIA/ESIA report. Disaster impact assessment along with possible mitigation and management requires to be added in the DIA report. Institutional arrangement for environmental, social, disaster monitoring and management for the project should also be reflected in the report. Prepare a full EIA/ESIA, DIA and RAP report as per development partner agencies guidelines fulfilling the standard of Department of Environment, Bangladesh.

- **Legal and Institutional Aspects**

Review legal and institutional aspects of the marine area, environment and other issues for the proper implementation of the project. Specifically mention the legal and conventional procedures of site acquisition/handover/NOC issuance from concerned authority of environment & water resources and also from marine authority.

- **Preparation of Tender Document and PPA**

Review the existing contract/regulatory documents (PPA, IA, LA, Grid code etc.) for private sector projects and develops a standard contract documents for private sector projects and tender document for public sector projects.

- Knowledge sharing and information dissemination

Conduct a knowledge sharing event based on the above deliverables.

5. Detailed Outputs of the assignment (and applicable quality standards, where applicable)

5.1 Team Composition and Qualification Requirements for the Key Experts (and Any Other Requirements that Will Be Used for Evaluating the Key Experts under Data Sheet 21.1 of the ITC)

Consulting services are solicited from consulting firms having experienced in carrying out feasibility studies for off-shore wind farm development. Consulting firms should have experience to perform consultancy services, experience of similar assignments, experience in similar conditions, firm's capability and availability of appropriate skills among key staffs, availability of resources, relevant transactional experience. The proposer is expected to engage the following categories of key experts for the Project and CVs shall be submitted accordingly:

- **Wind Energy/Technical Expert (Team Leader) (Position-1, International, 12 person months (During Pre-feasibility: 5 person months and during Detail feasibility: 7 person months)):** The Team Leader must have a minimum Bachelor's degree in Engineering or Masters in Renewable Energy with minimum 20 years of experience including minimum 5 years of experience in the field of large scale Wind based power projects. S/he should preferably have experience of carrying out feasibility study of minimum of 50 MW offshore Wind based power plant. Besides, s/he should have good understanding on power system planning and load dispatch system. S/he should have knowledge on govt. acts, rules, policies and tariff system for power sector.
- **Transmission Expert (Position-1, International, 7 person months (During Pre-feasibility: 2 person months and during Detail feasibility: 5 person months)):** The Transmission Expert should have at least a Bachelor's degree in electrical or mechanical engineering and 15 years of experience in the power sector including in power generation, transmission/distribution network analysis and grid integration of renewable energy-based generation. S/he should have minimum 5 years of experience in the field of high and medium voltage transmission system. S/he should have knowledge of integration of wind energy with the national grid as well as stability of the national grid.
- **Marine Expert (Position-1, International, 9 person months (During Pre-feasibility: 3 person months and during Detail feasibility: 6 person months)):** The Maritime Expert must have a minimum Bachelor degree in oceanography or any related subject. The expert must have at least 5 years of experience in the field of marine related activities. The expert's experience on off-shore wind power plant development will be considered as an added qualification.
- **Civil Engineer (Position-1, International, 6 person months (During Pre-feasibility: 2 person months and during Detail feasibility: 4 person months)):** The Civil Engineer should have at least a Bachelor's degree in Civil engineering and 15 years of experience in the relevant field. S/he should have minimum 5 years of experience in civil works including drawing, design, different surveys on off shore wind farms. The consultant will provide detailed civil and structural design of WTG foundation, control room and all other civil works require for the project. S/he should be able to estimate cost required for all civil works of the offshore wind power plant.
- **Wind Energy/Technical Expert (Deputy Team Leader) (Position-1, National, 12 person months (During Pre-feasibility: 5 person months and during Detail feasibility: 7 person months)):** The Deputy Team Leader must have a minimum Bachelor's degree in Engineering or Masters in Renewable Energy with minimum 15 years of experience including minimum 5 years of experience in the field of renewable energy projects. S/he should have good understanding on wind power plants. S/he should have knowledge on govt. acts, rules, policies and tariff system related to power sector.
- **Transmission Expert (Position-1, National, 7 person months (During Pre-feasibility: 2 person months and during Detail feasibility: 5 person months)):** The Transmission Expert should have at least a Bachelor's degree in electrical or mechanical engineering and 10 years of experience in the power sector including in power generation, transmission/distribution network analysis and grid integration of renewable energy-based

generation. S/he should have minimum 5 years of experience in the field of high and medium voltage transmission system. Experience of Integration of Variable Renewable Energy (VRE) with the national grid as well as stability of the national grid will be considered as added qualification.

- **Financial/Economic Analyst (Position-1, National, 6 person months (During Pre-feasibility: 2 person months and during Detail feasibility: 4 person months)):** The Financial/Economic Analyst must have a minimum Masters in Economics/Finance/ Business Administration or any relevant subject with a minimum of 5 years of experience in financial/economic analysis. The specialist shall be able to provide the cost benefit analysis of the project including possible tariff model for transmission of RE based power through grid.
 - **Environmental Expert (Position-1, National, 4 person months (During Pre-feasibility: 1 person months and during Detail feasibility: 3 person months)):** The Environmental Expert must have a minimum Master's degree in any Environment related subject from a recognized institute. The expert must have a minimum of 5 years of experience in the field of environment including experience of off shore environmental surveys.
 - **Legal and Institutional Expert (Position-1, National, 4 person months (During Pre-feasibility: 1 person months and during Detail feasibility: 3 person months)):** The Legal and Institutional Expert must have a minimum Master's degree in any subject or LLM from a recognized institute or B. Sc. in Engineering degree. The expert should have knowledge on national and international laws, rules and regulations of Bangladesh especially for marine areas. S/he should also have knowledge on electricity related acts, policy, rules and regulation of Bangladesh relevant to power generation, transmission, distribution and renewable energy related issues.
- * **Consulting Firm may propose additional Key Expert mentioning person months and qualifications and experiences for conducting such study.**

5.2 Reporting Requirements and Time Schedule for Deliverables

Deliverables during Pre-feasibility Stage:

- Inception Report on Pre-feasibility study within 15 (fifteen) days of signing of the contract.
- Interim Prefeasibility Report within 2 (two) months after signing of the contract.
- Draft Prefeasibility Study Report within 3 (three) months after signing of the contract.
- Hold Stakeholders Consultation Workshop on Draft Pre-feasibility after submission of draft report.
- Final Prefeasibility Study Report within 5(five) months after signing of the contract.

Deliverables during Detail Feasibility Stage:

- Inception Report on Detailed Feasibility Study within 01(one) month of signing of contract of 2nd phase incorporating work methodology and work plan to accomplish study on specific sites;
- Interim Report on Detailed Feasibility Study on allocated sites within 3 (three) months after signing of the contract of 2nd phase with the analysis of specific sites condition, generating capacity and possible infrastructure etc.
- Draft Feasibility Study Report within 5(five) months after signing of the contract of 2nd phase with the analysis of sites condition, generating capacity, possible infrastructure grid integration and tariff methodology etc.
- Hold Stakeholders Consultation Workshop on Draft Feasibility Study Report after submission of DFR.

- Finalization of Feasibility Study Report within 7 (seven) months after signing of the contract of 2nd phase.

10 (Ten) copies of each report, a soft copy and all power evacuation related simulation case files have to be submitted;

Person to receive the Report: Project Director, BPSDCB Project, Power Division

5.3 Relevant background information or materials for the assignment: *Not applicable*

5.4 Indication is downstream work is potentially considered: No downstream work is expected at the end of the feasibility study.

5.5 Training and capacity building requirement:

Manpower training: Arrangement for 2 (two) trainings (one during Pre-feasibility and one during Detail Feasibility Stage) of approximately 15 personnel to enrich experience of project personnel and officials of Power Division, SREDA, Power Cell and concerned utilities (i.e. PGCB, BPDB etc.). Place of trainings will be selected in consultation with client.

5.6 Equipment procurement: —*Not applicable*

6. Client's Input and Counterpart Personnel

(a) Services, facilities and property to be made available to the Consultant by the Client:

Facilitation and Reporting

Consultant will work in close association with BPSDCB Project Office, SREDA, Power Cell, PGCB, BPDB and other relevant utilities. A coordination mechanism will be set up to review progress, provide guidance and advice. The designated personnel of the entities will interact with the Consultants and provide data, arrange discussions and assistance as required. The Consultant will work under the guidance of Project Director, BPSDCB Project.

Logistics Support

BPSDCB Project Office will provide meeting room and logistic support for the communication with executing agencies when necessary. Office accommodation, site visits, secretarial service will have to be arranged by the consulting firm at their own costs.

(b) Professional and support counterpart personnel will be assigned by Project Director, BPSDCB Project to the Consultant's team

(c) Selection of sites and concerned power generation Utility: Consultant will rank the potential sites for establishing off-shore wind farm during Pre-feasibility study considering the scopes mentioned for Pre-feasibility study. Based on the identification of potential sites from Pre-feasibility study, Project Office and consultant will select the site/sites to carry out Detail Feasibility Study.

7. Client will provide the following inputs, project data and reports to facilitate preparation of the Proposals:

The consultant will have to collect relevant project data and reports from the relevant departments as required to successfully completing the study. If data is needed to be procured, cost shall be borne by the consultant.