FOWPI

FIRST OFFSHORE WIND PROJECT OF INDIA

This Project is funded by The European Union

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About FOWPI

The First Offshore Wind Farm Project of India (FOWPI) is part of the “Clean Energy Cooperation with India (CECI) “, which aims at enhancing India's capacity to deploy low carbon energy production and improve energy efficiency, thereby contributing to the mitigation of global climate change. Project activities will support India's efforts to secure the energy supply security, within a well-established framework for strategic energy cooperation between the EU and India.

FOWPI objective is to plan and prepare a first 200MW offshore wind farm near the coast of Gujarat, 25km off Jafarabad. The Project will bring the vast experience of offshore wind from the European market to India and will set up a knowledge centre in the country. The FOWPI project will provide technical assistance for preparation of the first offshore windfarm to Ministry of New and Renewable Energy (MNRE) through design and technical specification of the wind farm including foundations, electrical network, wind turbines etc. This will also include specific technical studies for the selected site, including coastal surveys, environmental assessments, cost-benefit analysis, transmission layouts, monitoring systems, safety measures, and other relevant technical studies as identified. All to be used as advisory material by a wind farm developer considering investing in the project.

FOWPI will be led by COWI A/S (Denmark) with key support from WinDForce Management Ltd. (India). The project is prepared in cooperation with the European Union (EU), the Ministry of New and Renewable Energy of India (MNRE) and the National Institute of Wind Energy- India (NIWE).

The project is awarded under the Indo-European co-operation on Renewable Energy Program and funded through the European Union.

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Disclaimer

Copyright statements

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Inception Report

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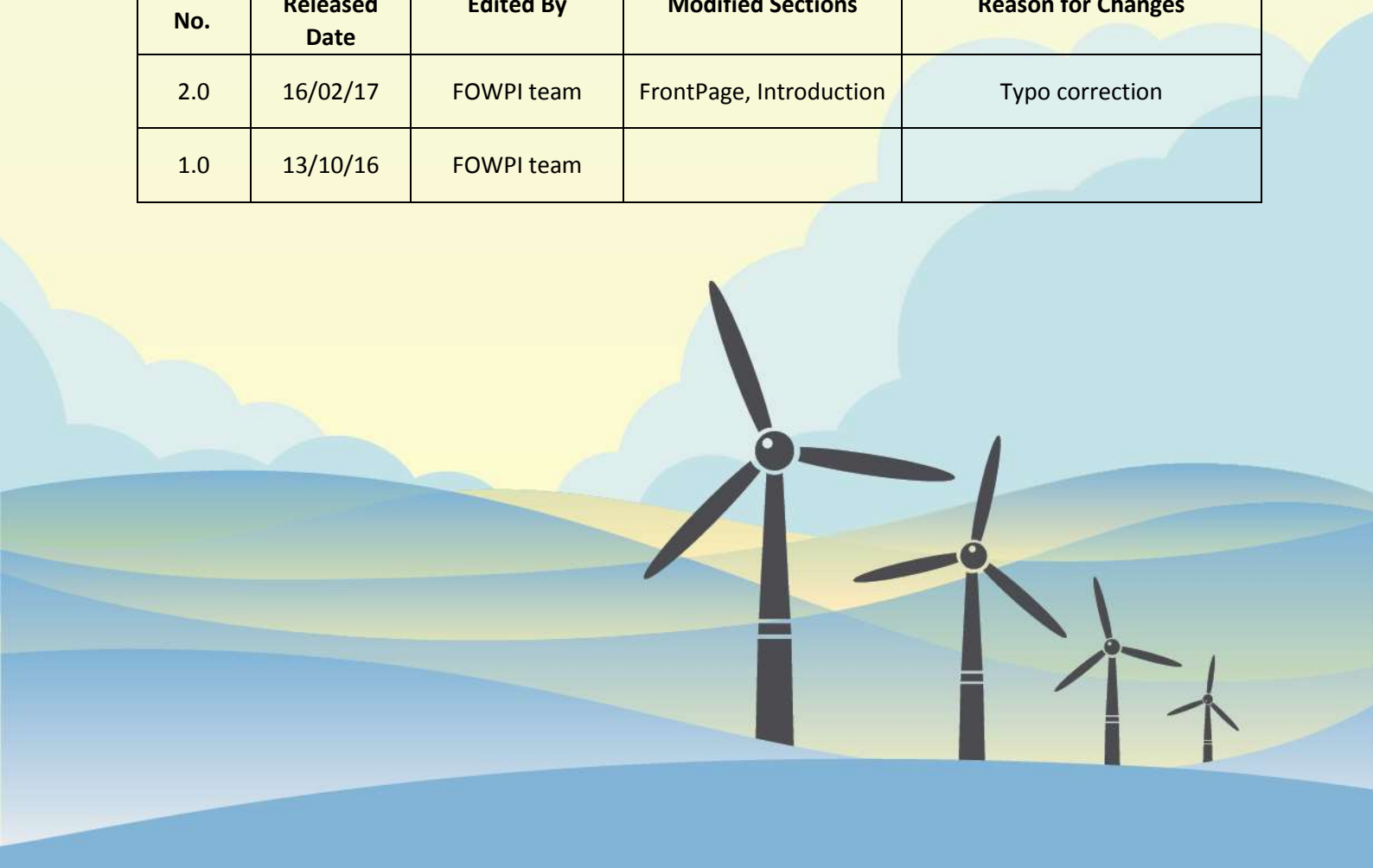

Contents

ABOUT FOWPI 3

DISCLAIMER 3

COPYRIGHT STATEMENTS 3

ACKNOWLEDGEMENTS 4

CONTACT INFORMATION 4

CONTENTS 6

EXECUTIVE SUMMARY 9

1. INTRODUCTION 11

1.1 BACKGROUND 11
1.2 CONTEXT OF THE PROJECT 11
1.3 INCEPTION PHASE 12
1.4 INCEPTION REPORT 12

2. FOWPI – FIRST OFFSHORE WIND FARM PROJECT OF INDIA 15

2.1 SCOPE OF WORK ADAPTATION 15
2.2 REVISED PROJECT OBJECTIVE 15
2.3 INITIAL FINDINGS 16
2.4 FINAL PROJECT FRAMEWORK 17
2.4.1 WORK PACKAGES 17
2.4.2 WORK PLAN 32
2.4.3 ORGANIZATIONAL STRUCTURE 35
2.4.5 KEY DELIVERABLES 36
2.4.4 REPORTING 37

3 BASELINE ASSESSMENT 39

3.1 PROGRESS IN COLLECTING DATA 39
3.2 KEY CHALLENGES 39

List of Figures

Figure 1 Overview of activities over the life time cycle of an offshore wind farm. FOWPI covers up to PRE-FID level. 19
Figure 2 Illustration of offshore wind farm foundations designed by COWI. From left: Thornton Bank Concrete, Wikinger Jacket, 2* London Array Monopiles, Nysted Concrete, Rødsand 2 Offshore Substation 24
Figure 3 High-level overview of implementation plan for all the work packages. 32
Figure 4 Implementation plan for all sub-packages within the WP1 32
Figure 5 Implementation plan for all main activities within the WP2.1. 33
Figure 6 Implementation plan for all main activities within the WP2.2 33
Figure 7 Implementation plan for all main activities within the WP2.3 33
Figure 8 Implementation plan for all main activities within the WP2.4 33
Figure 9 Implementation plan for all main activities within the WP2.5 34
Figure 10 High-Level Project Organization 35

List of Tables

Table 1 Overview of Work Packages 17
Table 2 High-level summary overview of the input, activities and output for each of the Work Packages 18
Table 3 Summary input, activities and output for the "Site Layout Optimization" sub-package in WP1 20
Table 4 Summary input, activities and output for the "Yield Estimates" sub-package in WP1 20
Table 5 Summary input, activities and output for the "Environment and Consenting" sub-package in WP1 21
Table 6 Summary input, activities and output of the "Metocean Assessment Wind Wave and Current" sub-package in WP1 22
Table 7 Summary input, activities and output for the "Soil Investigations" sub-package in WP1 23
Table 8 Summary input, activities and output for the "Foundation Design" sub-package in WP1 23
Table 9 Summary input, activities and output for the "Wind Turbine Technology" sub-package in WP1 24
Table 10 Summary input, activities and output for the "Electrical Services" sub-package in WP1 25
Table 11 Summary input, activities and output for the "Coastal / Onshore" sub-package in WP1 26
Table 12 Specific summary of the input, activities and output for the WP2.1 27
Table 13 Specific summary of the input, activities and output for the WP2.2 28
Table 14 Specific summary of the input, activities and output for the WP2.3 29
Table 15 Specific summary of the input, activities and output for the WP2.4 29
Table 16 Specific summary of the input, activities and output for the WP2.5 30
Table 17 Offshore wind implementation outlook 35
Table 18 FOWPI Key Deliverables 36

Executive summary

India has one of the fastest growing economies in the world and has an increasing energy demand, which is expected to double in 2020 compared to the present demand. The Clean Energy Cooperation Initiative has the purpose to assist India to meet the future energy demand by utilising sustainable energy generation technologies and to introduce energy efficiency measures.

Offshore wind power has become an important factor in the European energy supply mix with an installed total offshore wind farm capacity of 11.5 GW at present and growing fast. The offshore wind farm technology face a number of technical challenges due to the harsh installation and operation conditions. The construction costs for offshore wind farms were high for the first offshore wind farms, but are for new offshore projects in Europe decreasing. This has been achieved through lessons learned related to design issues and development of effective construction methodologies and cost effective O&M strategies.

The EU Delegation to India granted the development of the First Offshore Wind Farm Project of India (FOWPI) to COWI in December 2015. Local key-support is provided by the Indian company WinDForce Management Ltd with COWI India Ltd also being involved in the project implementation. FOWPI will develop a 200 MW project up to the stage of Pre-Financial-Investment-Decision and will provide general assistance for capacity building of Indian stakeholders within offshore wind power. The project will be based on work already prepared by another EU-supported offshore wind project FOWIND.

The FOWPI team will use their combined qualifications, experience and proven track record from European offshore wind projects to benefit this project and in general development of Indian Offshore wind power.

FOWPI will provide technical as well as non-technical output. The technical services will provide a basis for prospective tenderers to estimate safely costs of a wind farm of their design. The non-technical services will add to the capacity of Indian stakeholders within offshore wind power. This report presents the updated plans of the services to be provided by the project. The only on-site investigation to be delivered is a geophysical survey providing bathymetry, in-depth seismic scanning and magnetometer data as well as side-scan sonar results.

In parallel with FOWPI, MNRE is preparing tender/subsidy/tariff schemes to be implemented. The project consequently interfaces to this work. The abovementioned FOWIND project will measure wind on-site and report a wind study to be used by FOWPI.

Indian Offshore Wind is to happen, and this report describes the plans for how the FOWPI will contribute to enabling the first 200 MW wind farm to be implemented at lowest possible risk for the project developer as an example to follow. FOWIND paved the way for us and after FOWPI, the large-scale offshore wind investments in India will follow.

1. Introduction

1.1 Background

The EU Delegation to India granted the development of the First Offshore Wind Farm Project of India (FOWPI) to the Joint Venture SACO in December 2015. COWI A/S is part of the JV SACO-consortium and lead the project implementation. Local key-support is provided by the Indian company WinDForce Management Ltd with COWI India Ltd also involved in the project implementation.

FOWPI will develop a 200 MW project up to the stage of Pre-Financial-Investment-Decision and provide general assistance for capacity building of Indian stakeholders within offshore wind power.

The project is supported by a grant of EUR 1.8 MM from the EU.

1.2 Context of the project

India has one of the fastest growing economies in the world and has an increasing energy demand. The energy demand is expected in 2035 to be at least three times the energy demand of today. This project is one of the three projects that are part of the “Clean Energy Cooperation with India (CECI) “, which aims at enhancing India's capacity to deploy low carbon energy production and improve energy efficiency, thereby contributing to the mitigation of global climate change and meet the future energy demand.

With the climate change issue on the world top agenda and taking into account the present high consumption of fossil fuel in the country, India has an important role to play concerning reduction of the emission of greenhouse gases. One way to meet this challenge is to increase the utilisation of India´s abundant renewable energy resources.

Approximately 65% of the electricity generation in India is based on fossil fuel. The contribution by renewable energy is in the order of 10% and the Indian energy policy sets out targets for significantly increasing the use of renewable energy resources. One of the means to increase the amount of renewable energy is to include offshore wind power.

Offshore wind power is different from onshore wind power in terms of technology and framework setup. The technical challenges and the risks are higher for operating at sea and the framework shall take into account the state regulations on sea areas.

This project will contribute to reinforce the basis for development of offshore wind power in India by further transferring EU experiences and embrace these experiences to the Indian context. The specific objectives of the project are to:

- contribute to the development of the first offshore wind farm project in India based on experiences and state of the art technical solutions from the EU offshore sector
- transfer of knowhow to relevant stakeholders by a capacity building programme including assistance in formulation of an enabling framework for utilising Indian offshore wind power resources

This project is expected to work in close coordination with and build upon the findings and results of the "Facilitating Offshore Wind in India" (FOWIND) project which aims at supporting the offshore wind

development in India through the Global Wind Energy Council led consortium, which includes Indian as well as EU partners.

1.3 Inception Phase

The FOWPI-contract was in December 2015 signed between the Joint-Venture SACO-consortium and the EU-Delegation to India. The project organization, as briefly mentioned above in Section 1.1, shows COWI A/S, member of the JV SACO-consortium and so working on behalf of SACO, as leader of the project implementation. Local key-support is provided by the Indian company WinDForce Management Ltd with COWI India Ltd also involved in the project implementation.

After project commencement on 18 January 2016 COWI prepared for the inception mission, including the study of available FOWIND reports. The Inception Mission was carried out during February 1-5 with the objective to have proper kick-off meetings with key stakeholders and discussions over the project scope of work and plan. The Inception Mission comprised three main events:

- On the 2nd of February 2016, a two-party kick-off-meeting was held in New Delhi between the EU-Delegation and COWI. In this setting, COWI holding the contract with the EU-Delegation through the Frame-Work was implemented.
- On the 3rd of February 2016, a kick-off-meeting between MNRE, NIWE, EU-Delegation, COWI and WinDForce was held in the form of a work-shop-like meeting. As requested by MNRE, the meeting was mainly focused on changing/adapting the scope of the FOWPI-contract to align with the actual development objectives of MNRE for the offshore wind power sector.
  The meeting resulted in the need to change the "pilot plant" concept of the FOWPI-contract to a "200 MW wind farm" and to locate the project near the planned Lidar-location 25 km off Jafarabad, off the coast of Gujarat. COWI should then propose a new project framework adjusting services to the new project dimensions and cutting other services to stay within the existing budget.
- A visit to the Gujarat region to explore the coastline. A meeting with the local TSO was not arranged and it has been postponed until after the release of FOWINDs grid-connection report on which the discussion will be built.

FOWPI had also informal orientation meetings with NIWE, NIOT and other stakeholders during the Inception Phase to ensure coordination with these parties.

Meetings were held in Delhi between the mentioned parties and representatives of FOWIND during March and April, and further adjustments were implemented on the scope of work.

A final revised project framework was signed by the EU-Delegation in August 2016 and the Addendum no. 1 to the specific contract no 2015/368469 was operational from the 26th of August 2016. The revised scope of work is introduced in the following chapter.

1.4 Inception Report

During the project inception phase COWI as Consultant, the EU-Delegation as Client and MNRE as Final Recipient worked together to re-define the project scope and design quality level to meet the specific needs of India. Publicly available existing material on offshore wind in India has been reviewed and contact has been established with key stakeholders, in particular the Ministry of New and Renewable Energy (MNRE), the National Institute for Wind Energy (NIWE), the EU delegation to India and the FOWIND project. As described

above in Section 1.3 an inception mission took place including proper kick-off meetings and discussions on the project plan.

This inception report summarizes the outcome of the inception phase and establishes a refined action plan of operations, a work plan and a revised methodology for each stage of the project. The report builds upon the technical proposal submitted in November 2015, based on which the project was awarded to the SACO Consortium.

The initial work packages and actions as introduced in the technical proposal have been adapted to reflect the findings and agreements of the inception phase, in particular the size of the First Indian Offshore Wind Farm project for which the services of SACO Consortium are prepared shall be 200 MW - and shall be named "First Offshore Wind Farm Project of India (FOWPI)". The new project implementation plan is focused on bridging the gap between currently available information and the requirements for the development of the first offshore wind project of India to achieve the project objectives.

Chapter 2 will introduce the findings during the inception phase, the revised scope of work and the refined project objectives, the new project framework including the updated definition of the Work Packages with methodology description and action plan with time line.

Chapter 3 describes the status of data collection and encountered or expected difficulties.

2. FOWPI – First Offshore Wind Farm Project of India

2.1 Scope of Work Adaptation

Following the kick-off meeting held in New Delhi on 3rd February 2016 and further discussions between the FOWPI team, the EU-Delegation and the MNRE, it was found necessary to adapt the scope of services to be provided to match the current needs of India. Therefor the initial plan was adapted.

The proposed changes mainly consist in:

- Location of the First Indian Offshore Wind Farm Project shall be offshore of the state of Gujarat. The wind farm shall be located near the Lidar location, which is expected to be installed in 2017 by NIWE/MNRE under the FOWIND project.
- Size of the First Indian Offshore Wind Farm Project for which the services of the SACO Consortium are prepared shall be 200 MW - and shall be named the "First Offshore Wind Farm Project of India (FOWPI)".
- The contract duration is 42 months. However, duration of the services is planned to last 30 months only, from 18th January 2016 to 17th July 2018. Therefore, services are considered finalised when 30 months have gone and all scheduled deliverables have been supplied and approved.

2.2 Revised Project Objective

The FOWPI (First Offshore Wind Farm Project of India) will promote the use of sustainable energy in India through:

- Building of Indian Knowledge Bank with data on Indian and European stakeholders and capturing European experience in offshore wind
- Preliminary Design and Technical Specifications for a 200 MW offshore wind farm off the coast of Gujarat, including:
    - Geophysical site survey providing bathymetric map and soil information, and geotechnical desktop study
    - Metocean Assessment
    - Wind Turbine technology guidance
    - Preliminary foundation design, including appurtenances
    - Preliminary electrical design, including array cable layout, substation and grid connection
    - Preliminary wind farm layout and annual energy production estimation
    - Environmental Scoping
    - Coastal & Onshore study, including guidance on construction and O&M harbour
- Development of a Financial Investment Model for the first offshore wind farm in India
- Procedures for Permit Management, Certification and Health and Safety based on EU experience and best practice
- Enhance the capacity of National Institute of Wind Energy (NIWE) to act as the nodal agency for the offshore wind sector in India. Also assist in capacity building of the MNRE for offshore wind
- Secretariat Services including support for stakeholders with technical input and logistical support

2.3 Initial Findings

This section provides an overview of key information and knowledge gathered during the inception phase and that has been considered for the tuning of the implementation methodology and for defining the level of design quality that can be achieved with this project.

- Background knowledge has been gathered based on available FOWIND reports
- No wind, wave, and current data from previous on-site measurement campaigns is available for the area under investigation. On-site wind measurement will be initiated in the first quarter of 2017.
- No bathymetry data and geotechnical information from previous surveys is available for the area under investigation
- The Indian onshore wind farm business has shown considerable interest in the project and in being involved in the overall implementation process for offshore wind power in India.
- Relevant harbour facilities has been addressed along the coastline near the area under investigation and also promising grid connection points where the wind project could be connected in the future
- NIWE will during 2017 carry out geophysical survey and geotechnical investigations in the vicinity of the site area under investigation
- FOWIND grid study for the Gujarat region will not be available until 2017.
- The preliminary feasibility study for the Gujarat region carried out by FOWIND anticipates low wind speeds at the site area under investigation.
- Synergies have been identified with the project "Delivering Policy and Commercial Readiness for Indian Offshore Wind" in making coordinated budget assumptions for offshore wind projects in India
- Main Stakeholders are:
    - MNRE
    - NIWE
    - EU Delegation
    - FOWIND
    - GETCO
    - WinDForce

2.4 Final Project Framework

In this section, the work packages are first introduced as resulting after the changes performed during the inception phase, then a revised overview of the organizational structure is provided, and after that, an updated work plan is discussed.

2.4.1 Work packages

Table 1 below sets out the resulting Work Packages for this project. Technical Work Packages 1.1 to 1.9 and Non-technical Work Packages 2.1 to 2.5.

Work Package	Scope of Work
1 –Design and Technical Specifications Work Packages	
1.1 – Site Layout Optimization	Design of an optimized wind turbine layout for the project
1.2 – Yield Estimates	Preliminary estimation of the annual energy yield
1.3 – Environment and Consenting	Scoping of environmental and consenting aspects
1.4 – Metocean Assessment: Wind, Wave and Current	Preliminary modelling of the metocean conditions on site
1.5 – Soil Conditions	Geotechnical Desk Top study and Marine Geophysical survey at the site area
1.6 – Foundation Design	Conceptual foundation design
1.7 – Wind Turbine Technology	Preliminary wind turbine type selection and loads modelling
1.8 – Electrical Services	Conceptual design of the electrical package
1.9 – Coastal / Onshore	Survey of feasible facilities for works at shore
2 – Non-technical Work Packages	
2.1 – Knowledge Bank	Build a knowledge bank including a helpdesk platform, enhance the capacity of NIWE as a nodal agency of the offshore wind sector
2.2 – Financial Investment Model	Financial investment model shall be established for the first offshore wind farm in agreement with the needs of Institutes such as EIB, World Bank and Indian investors
2.3 – Procedures	Draft relevant and mandatory procedures for the offshore wind farm
2.4 – Capacity Building	Capacity building to NIWE and MNRE, including study tour to Europe
2.5 – Secretariat Services	Provide support and technical support to the JWG, including annual workshops / conferences

Table 1 Overview of Work Packages

The resulting high-level summary overview of the input, activities and output for each of the Work Packages is provided below and details about each work package specific activities are introduced in the following sections.

Work Package	Input	Activities	Output
WP1 Design and Technical Specifications	• Site location • Two reference WTG sizes • Meteorological Information (i.e. wind data, wave data) • FOWIND EIA guidelines and stakeholders list • FOWIND foundation, wind turbine, and vessel suppliers survey • Local TSO requirements and site constraints • FOWIND grid study	• Wind farm Layout design and optimization • Wind Resource Assessment • Scoping of the key environmental and social issues • Recommendations on framework for EIA and consenting process • Preliminary Metocean Modelling • Geophysical on-site survey • Conceptual design of one foundation type for two reference WTG sizes • Wind turbine technology assessment • Wind Turbine loads estimation • Electrical package conceptual design, onshore and offshore • Identification of potential pre-assembly harbour and O&M facilities	• Preliminary and Optimized wind farm Layout • Annual Energy Production and Uncertainty Estimation • Scoping report for EIA and recommendations • Metocean study report • Weather Windows for Installation • Reporting, charts and data from the geophysical survey • Conceptual design of foundations • Conceptual design of the electrical infrastructure • Suppliers survey
WP2.1 Knowledge bank	European Experience in planning, development, financing, construction and operation of offshore wind farms.	• Knowledge Bank Development • Stakeholders consultations • Knowledge Sharing Workshops • Launch and management of web portal	• Knowledge bank database • Knowledge sharing workshops • Web portal
WP2.2 Financial Investment Model	• Assumptions on costs for offshore wind farm components, infrastructure and operation • Estimated annual energy production	• Preparation of an inventory for investors requirements • Budget definition and modelling • Risk analysis • Design of a financial model	• Financial investment model. • Financial results/performance for a set of scenarios
WP2.3 Procedures	Procedures relevant for authorities applied in the European context	Development of procedures based on the EU best practices and adapted to the Indian conditions.	Procedures for • Permit management • Certification • HSE
WP2.4 Capacity Building	• Stakeholders Consultation in WP2.1 • Nominated staff by MNRE and stakeholders	Carry out training for nominated candidates under the form of study tour to Europe, ad-hoc workshops in India	• Study tour • Workshops • Knowhow transfer to participants
WP2.5 Secretariat Services	Joint Working Groups (JWG) organizations, scope, plan	Assistance in supporting activities, including planning of meeting and progress reporting	• Technical Secretariat function • Meetings and conferences • Annual reports

Table 2 High-level summary overview of the input, activities and output for each of the Work Packages

2.4.1.1 WP1 Design and Technical Specifications

This work package can be divided into separate sub-packages as the design issues related to an offshore wind farm includes several separate key activities. Following below in this section the input, activities and the output are specified for each sub-package.

Figure 1 below provides an overview of the necessary activities over the life time cycle of an offshore wind farm. This work package comprises those activities that would bring a project to a "Pre-FID" stage, namely those listed under the column "Analysis".

GATES / PHASES	INITIATION → PRE-FID: ANALYSIS	PRE-FID → FID: ENGINEERING & CONTRACTS	FID → Hand-over to commissioning: ENGINEERING & CONSTRUCTION	Hand-over to commissioning → Hand-over to operations: COMMISSIONING	Hand-over to operations → End of operation: OPERATION	End of operation → End of decommissioning: DECOMMISSIONING
GENERAL	• Site layout optimization • Yield estimates • EIA and consenting strategy • Metocean assessment wind, wave & current • Weather windows for installation • Soil investigations • Contract strategy • Project hazard review	• Support to site investigations 1 • Geotechnical interpretations 2	• Support to site investigations 2 • Geotechnical interpretations 3 • Virtual model or mock-up • GIS system for site	• Support to Commissioning	• Support to Operation	• Planning of decommissioning
FOUNDATION	• Supplier survey • Conceptual design	• FEED	• Detailed design • Support to fabrication • Support to installation	• Support to Hand-over from Contractors	• Support to Operation	• Support to decommissioning
WTG	• Supplier survey • WTG selection • Loads and require-ments from WTG • Installation vessel survey	• Support to procurement	• Management of contracts • Supervision of deliveries • Support to installation • Check of O&M manual	• Support to Hand-over from WTG supplier	• Support to Operation	• Support to decommissioning
ELECTRICAL	• Supplier survey • Conceptual design • Substation need assessment • Cable routing studies • Onshore conceptual electrical design	• FEED	• Detailed design • Management of contracts • Supervision of deliveries • Check of O&M manual • Support to installation	• Support to Hand-over from Contractors	• Support to Operation	• Support to decommissioning
SUBSTATION	• Supplier survey • Conceptual design	• FEED	• Detailed design • Support to fabrication • Supervision of deliveries • Support to installation • Check of O&M manual	• Support to Hand-over from Contractors	• Support to Operation	• Support to decommissioning
COASTAL/ ONSHORE	• Preassembly harbour facilities • O&M facilities • Permits	• FEED • Procurement of maintenance vessel(s)	• Detailed design • Supervision at construction site(s) • Supervision of fabrication maintenance vessel(s)	• Support to Hand-over from Contractors	• Support to Operation	• Support to decommissioning

Figure 1 Overview of activities over the life time cycle of an offshore wind farm. FOWPI covers up to PRE-FID level.

The design activities carried out under the FOWPI project will prepare for decision making by the relevant party in a subsequent implementation of the "Engineering and Contract" phase. The design quality level will be of concept quality and not of FEED quality (Front End Engineering Design) concerning the level of details (based on the offshore Oil and Gas understanding of FEED).

WP1.1 Site Layout Optimization

Input	Activities	Output
• Site location • Two reference WTG sizes • Meteorological Information (i.e. wind data)	Wind farm Layout design and optimization	• Preliminary Layout • Optimized Layout for two reference WTG sizes.

Table 3 Summary input, activities and output for the "Site Layout Optimization" sub-package in WP1.

Activities

- A preliminary layout proposal for the 200 MW wind farm will be developed based on two wind turbine types of different sizes, identified by FOWPI, and based on a three arrays of turbines approach.
- One or several optimized wind farm layouts will then be prepared when input information will be available and will take into consideration wind resources assessment, cabling costs and foundation costs as well as environmental impact.

WP1.2 Yield Estimates

Input	Activities	Output
• Optimized layout • Two reference WTG sizes • Meteorological information (i.e. wind data)	Wind Resource Assessment	• Annual Energy Production • Uncertainty Estimation

Table 4 Summary input, activities and output for the "Yield Estimates" sub-package in WP1

Activities

- The wind resource will be calculated on the basis of the FOWIND measurements and modelling work, if available, as well as other available data. The energy yield assessment will consider two selected wind turbine sizes and the optimized wind farm layout.
- Uncertainties will be estimated on the provided annual energy productions

WP1.3 Environment and Consenting

Input	Activities	Output
• Site location • FOWIND EIA guidelines and Stakeholders list	• Desk based screening of environmental and social issues • Scoping of the key environmental and social issues • Scoping consultations with authorities in ESIA • Identify all necessary consents and authorities • Definition of recommendations	• Scoping report for EIA • Recommendations on framework for EIA and consenting process • Consent Register

Table 5 Summary input, activities and output for the "Environment and Consenting" sub-package in WP1

Activities

- Desk based screening of environmental and social issues:
  All publicly available environmental information relating to the offshore wind farm location and associated onshore area will be gathered and reviewed. The purpose of this is to identify whether there are particular habitats or species, which may be impacted by the proposed development and would require further assessment. The same would be conducted for social issues, such as identifying the human environment near the wind farm site and seeing how and if it could be affected by the development.
- Scoping the key environmental and social issues:
  Based on the fact-finding undertaken in the screening process and the FOWIND guidelines on EIA, the identified key environmental and social issues will be highlighted and the scope of further assessments will be defined in the form of a scoping report.
- Scoping consultation with authorities in ESIA:
  Once the scoping exercise is completed, the scoping report would be issued to the authorities for consultation. The aim of this process is to enter into a dialogue with the authorities and key stakeholders to agree the scope of studies and assessments that will be undertaken during the environmental and social impact assessment.
- Identify all necessary consents and authorities:
  A consents register will be compiled, which will identify all the known consents, licenses and approvals that are required for the project to be implemented. This includes but is not limited to consents relating to both offshore and onshore planning, construction, operation, grid connection, cable crossings, new harbour or port facilities, and seabed and landowner agreements. The register will identify the relevant consents and the responsible body for issuing the approvals.
- Definition of recommendations on framework for EIA and consenting process:
  Lessons learned and experience from EU countries who currently have a framework for the consenting and EIA for offshore wind farms will be reviewed and recommendations made with reference to the Indian framework.

WP1.4 Metocean Assessment Wind Wave and Current

Input	Activities	Output
• Site location • Meteorological information (i.e. wind data)	• Preliminary Metocean Modelling • Assessment of future metocean surveys needs • Assessment of weather windows for installation	• Report on preliminary metocean study • Recommendations on site specific metocean surveys • Weather Windows for Installation

Table 6 Summary input, activities and output of the "Metocean Assessment Wind Wave and Current" sub-package in WP1

Activities

- Preliminary Metocean Modelling:
  A metocean study will be carried out for the relevant marine area around the project site. The metocean model will be developed and run by the Indian engineering expert group of COWI in Chennai, which has extensive experience in the field in cooperation with Danish staff. No on-site meteorological measurements will be available as input to the modelling process for the preliminary study. The best available (if any) information about wind, waves and currents in the Gujarat region or from re-analysis datasets will be considered as well as topographic maps to model the conditions on site. The output from the model meets the requirements defined in the standard IEC61400-3 (as required in Europe) and will be summarized in a report. This includes correlation between wind speed and wave height/wave length, currents and correlation or lack of correlation between wind direction and wind speed – as well as many other details requested by IEC61400-3.
- Assessment of future metocean survey needs:
  The preliminary met-ocean study will need to be updated to reach the quality level needed for use in the detailed design of foundations and WTG. Part of this update will consist of validating the met-ocean conditions predicted by the numerical models against site-specific measurements at the actual wind farm site (wind speed and direction, waves, currents, etc.). Detailed bathymetric surveys should be carried out so that the final met-ocean study to be used for detailed design will be based on the actual and confirmed bathymetric conditions in and around the site. Recommendations for the on-site survey campaign, which will be required in order to establish the final met-ocean study, will be provided based on experiences from Europe.
- Assessment of weather windows for installation:
  Based on the established met-ocean data at the particular wind farm site, information on weather windows for installation will be collected and reported. Reliable weather window documentation is a requirement for precise cost estimation of the construction phase and management of expensive installation vessels.
  The weather window documentation will meet the recommendations used by projects in EU.

WP1.5 Soil Investigations

Input	Activities	Output
Site location	• Preparation of desk study based on available data • Geophysical on-site survey • Geotechnical Interpretation of results • Drafting of scope of work for pre-tender geotechnical investigations	• Desk study report • Reporting, charts and data from the geophysical survey • Basis for Owner pre-ender –call for geotechnical investigations

Table 7 Summary input, activities and output for the "Soil Investigations" sub-package in WP1

Activities

- Preparation of desk study based on available data:
  COWI will prepare a desk study assessing available (if any) data and knowledge on soil conditions at the selected site area for the project or near it.
- Geophysical on-site survey:
  The on-site geophysical survey will include multi-beam, side scan, sparker/boomer and magnetometer measurements as well as bathymetric measurements. Output will be a report and maps of bathymetry, observations of magnetic objects, seabed topography and sub-sea surface of geological layers as well as digital 3D mapping of these layers. Based on this survey, it will be possible to assess if pile driving is a feasible option for this project.
- Geotechnical Interpretation of results:
  Preliminary geotechnical interpretation by experts will be prepared based on the provided desk study and geophysical survey. The interpretation will highlight preliminary soil strength data and other information for the future tender for foundation design.
- Drafting of scope of work for pre-tender geotechnical investigations:
  Based on the desk study and expertise on geotechnical investigations we will prepare recommendations on Soil Investigations to be implemented for the first offshore wind farm on India.

WP1.6 Foundation design

Input	Activities	Output
• Wind Farm layout • Two reference WTG sizes • Estimated loads from wind turbine • Desk study and geophysical survey results • FOWIND suppliers survey	• Supplier survey for this specific project • Conceptual design of one type of foundation for three water depths for two reference WTG sizes	• Reporting on suppliers survey • Conceptual design of foundation

Table 8 Summary input, activities and output for the "Foundation Design" sub-package in WP1

Figure 2 Illustration of offshore wind farm foundations designed by COWI. From left: Thornton Bank Concrete, Wikinger Jacket, 2 London Array Monopiles, Nysted Concrete, Rødsand 2 Offshore Substation*

Activities

- Supplier Survey:
  Two suppliers are actually relevant here, namely the steel/concrete manufacturers who manufacture the structures, and the marine contractors who install them offshore. This study will build on FOWIND findings and will look into European and especially Indian suppliers.
- Conceptual Design:
  A preliminary design addressing IEC61400-3 requirements will be developed by COWI and will be in line with EU best practices.
  The conceptual design will consist of one type of foundation for three different water depths and for two reference WTG sizes.
  The steel monopile foundation type is currently believed to be the most feasible solution for the FOWPI project but this can be confirmed only after having assessed the results from the geophysical survey. Other types of foundation can be considered but look less feasible or not realistic for India's first offshore project. Steel monopiles are used for most European offshore wind farms and the technology is continuously under development. For a decade, the use of grouted connections between pile and transition piece has been disputed as the grout in practice is seen to erode over time. Today bolted solutions are being used more and more, and for the FOWPI project, it shall be assessed whether the grouted connections shall be ruled out completely. Appurtenance concepts (boat landings, work platforms, J-tubes and other) will be described based on European experience and best practice.

WP 1.7 Wind Turbine Technology

Input	Activities	Output
• Wind Farm Layout • Wind Resource Assessment • FOWIND Turbine and Vessel Suppliers survey	• Supplier Survey • Wind Turbine type selection • Wind Turbine loads estimation • Wind Turbine installation vessels survey	• Preliminary design loads on foundation • Project specific wind turbine supplier survey • Vessels options for FOWPI

Table 9 Summary input, activities and output for the "Wind Turbine Technology" sub-package in WP1

Activities

- Supplier Survey:
  This study will build on FOWIND findings and will look into European and especially Indian suppliers. The intention is to draft a guideline for approaching potential wind turbine suppliers and for the design of the wind farm. EU-based companies have a lot to offer as has also Chinese companies, but India is strong within onshore wind turbine supply and has potential to offer turbines for the Indian first offshore wind turbine project. Special focus will be on potential Indian wind turbine suppliers and onshore wind turbine models adapted for the offshore context, as a practice successfully already deployed in the past for first time projects in European countries.
- Wind Turbine Type Selection:
  For the preliminary phase of the project, a selection will be made of two generic sample turbine sizes. The choice will depend on the outcome of the Supplier Survey. For the final phase of the projects, based on the preliminary assessments two specific wind turbine models will be identified.
- Wind Turbine loads estimations:
  Design of foundation is one of the most challenging tasks of offshore wind. The interface between wind turbine and foundation is crucial, and focus must be put on getting as accurate as possible the design loads. Due to the lack of on-site meteorological and metocean information, preliminary design loads will be estimated for this project based on experience and best practice and provided as input to the foundation design.
  Work platform to carry major spare parts during repairs will be needed and the assumptions shall be made for the design of these structures.
- Wind Turbine Installation Vessel Survey:
  This study will build on FOWIND findings and will look into European and (if any) Indian suppliers with a focus on the specific needs of the project. For the FOWPI project, we have, for example, the options to bring in purpose-made vessels from Europe or use existing vessels in India and adapt them for installation of offshore wind turbines as it was done in Europe in the past. COWI will assess the different options and suggest a feasible solution for the project.

WP1.8 Electrical Services

Input	Activities	Output
• Wind Farm layout • Local TSO requirements and site constraints • FOWIND grid study	• Supplier Survey • Electrical package conceptual design, onshore and offshore • Export cable route study • Assessment of necessity for substation	• Supplier Survey • Conceptual design of the electrical infrastructure

Table 10 Summary input, activities and output for the "Electrical Services" sub-package in WP1

Activities

- Supplier Survey:
  This study will build on FOWIND findings with a specific focus on the FOWPI project needs. In Europe as well as in India, the potential marine cable suppliers are few, since the product has a limited market. Potential suppliers and their products and ability should be listed. The supplier survey will include offshore substations if it is considered relevant.

- Electrical package conceptual design, onshore and offshore:
  The electrical package of the offshore wind farm includes array cabling, potentially an offshore substation, export cabling, onshore cabling, possibly onshore substation and grid connection. Voltage level is a core consideration in this concept. All European wind farms use 33 KV array cabling between wind turbines but full-scale implementation of solutions are seen on the market with 66 KV to enable export of more power in the same cable core. This could prove to be a good idea for the FOWPI project and allow avoiding a costly offshore substation.
  A conceptual substation design will be presented, either for the wind farm if relevant or for general guidance if not.
  Grid-connection onshore depends on strength and capacity of the available grid – and input must be provided by the local TSO for COWI and TSO in cooperation to suggest a grid connection point for the pilot plant. This study will build on FOWIND findings about the grid status and options for grid connection in the region of Gujarat. Possibly construction of a substation (could be 33kV/110kV or similar) near the coast will be needed – especially if an offshore substation is avoided. Routing from Grid Connection point to onshore substation is necessary, and a high-level approach will be taken in this study.
- Export cable route study:
  A preliminary cable routing study will be presented and will build on FOWIND findings. It will assess the route from wind farm to onshore grid-connection – meeting a connection point at the shore. Sea depth, sailing routes, soil conditions and possibly environmental concerns will be considered.
- Assessment of necessity for substation:
  An evaluation will be carried out to address the possible need for an offshore substation considering the project economics and the different technical solutions for connecting the wind farm to the national grid.

WP1.9 Coastal / onshore

Input	Activities	Output
• Site location • FOWIND study	• Identification of potential pre-assembly harbour and O&M facility locations. • Investigation on permits and consents required for the coastal/onshore elements	• List of pre-assembly harbour facilities and O&M facilities • Consent and permit register

Table 11 Summary input, activities and output for the "Coastal / Onshore" sub-package in WP1

Activities:

- Identification of potential pre-assembly harbour and O&M facility locations:
  Based on the results from the FOWIND project, FOWPI will carry out a specific assessment of the available harbours along the coast and address the most feasible solutions for the wind farm under development for pre-assembly and storage harbour during construction phase and for O&M facilities during the operational lifetime of the wind farm. The first is needed for storage of wind farm components and pre-assembly of towers, nacelles and rotors for the wind turbine – and for load-out of these elements to the installation-vessel. The second type of facility is needed for service personnel to go to site almost on daily bases without spending too much time on transfer and for spare-part storage at harbour, works-shop at harbour and administration.

Recommendation for possible improvements will be proposed so that existing harbours can suit the future needs of the offshore wind industry.

- Investigation on permits and consents required for the coastal/onshore elements:
  This study will also build on the FOWIND findings and will try to address possible permits and consents that are likely to be required for the coastal / onshore elements of the project. This may include consents at the cable landing point and for the onshore cable route where it connects to either an existing onshore substation or a new substation, which may itself require a separate consent. Furthermore, agreements with the landowners may need to be sought for the cable route and location of a substation, if a new one is required.
  The pre-assembly harbour and the O&M-facilities may require permits from the local authority or governing body in the area. FOWPI will contact the relevant stakeholders to ensure that a list of the necessary permits are established.
  A grid connection agreement may also be necessary subject to Indian requirements.

2.4.1.2 WP2.1 Creation of a Knowledge Bank

Input	Activities	Output
European experience in planning, development, financing, construction and operation of offshore wind farms.	• Knowledge Bank Development • Stakeholders consultations • Knowledge Sharing Workshops • Launch and management of web portal	• Knowledge bank database • Knowledge sharing workshops • Web portal

Table 12 Specific summary of the input, activities and output for the WP2.1

Activities

- Knowledge Bank Development:
  The knowledge bank will include a database of stakeholders within the Indian and the European wind industry and relevant authorities, including MNRE & NIWE. The knowledge bank will gather information and experience from key stakeholders in the existing offshore wind industry in Europe and key partnerships will be created between EU and Indian companies to share knowledge & experience. The Knowledge Bank will also include all information gathered by FOWPI.
- Stakeholder Consultations:
  The knowledge bank will act as the initial platform to learn from the European experience in offshore wind industry. The development plan will be adjusted based on consultations with key stakeholders to assure the result will meet the learning needs of India. Based on the inputs received, thematic workshops focusing on the challenges of a first offshore wind project will be conducted. One thematic workshop will be held every year in Delhi.
- Knowledge Sharing Workshops:
  The knowledge sharing workshops will be focused on relevant topics for the offshore wind industry and will be organized in conjunction with the Joint Working Group meetings to ensure the presence of the key experts from Europe across the activities. A few relevant experts will be brought in for the workshops – possibly from Europe, primarily the Consortium own experts.
- Launch and management of Knowledge Platform as a Web Portal:

This Web portal would act as the public-private platform for supporting offshore wind in close alignment with India's National Wind Mission/ National Offshore Wind Plan. This Web portal will be the key source of communication with all the relevant stakeholders in India and Europe and would provide the platform for online discussions between these stakeholders. WinDForce with support from COWI would resolve queries raised by various stakeholders on this portal. At the completion of the FOWPI project, the Knowledge Platform will be relocated under the NIWE portal.

2.4.1.3 WP2.2 Financial Investment Model

Input	Activities	Output
• Assumptions on costs for offshore wind farm components, infrastructure and operation • Estimated annual energy production	• Preparation of an inventory for investors requirements • Budget definition and modelling • Risk analysis • Design of a financial model	• Financial investment model. • Financial results/performance for a set of scenarios

Table 13 Specific summary of the input, activities and output for the WP2.2

Activities

- Preparation of an inventory for investors requirements:
  For the realisation of an offshore wind power plant, an investment model is needed that meets both general and country specific financing requirements. So an inventory of these requirements will be prepared for an Indian offshore wind power project. Consultation with stakeholders are foreseen to align with the actual market conditions.
- Budget definition and modelling:
  A budget calculation will be carried out by use of cost-modelling tool. The tool uses up to date cost data and provides the calculation of CAPEX and OPEX of a complete offshore wind farm. The results are the basis for a techno-economic feasibility analysis. Planned technologies for the project are being evaluated regarding costs, technical feasibility and risks.
- Risk analysis:
  A risk analysis will be carried out for identification and assessment of the risks related to the construction of an offshore wind farm project in India.
- Design of a financial model:
  A financial investment model is designed and developed for an offshore wind power project, which is structured for compliance with the above-identified requirements, as well as for increasing attractiveness for debt providers.

2.4.1.4 WP2.3 Procedures

Input	Activities	Output
Procedures relevant for authorities applied in the European context	Development of procedures based on the EU best practices and adapted to the Indian conditions.	Procedures for • Permit management • Certification • HSE

Table 14 Specific summary of the input, activities and output for the WP2.3

Activities

The process for the procedure definition will consists of three main steps: requirement analysis, identification and evaluation of feasible options based on the European context, and ultimately the drafting of specific procedures for the Indian context.

- Permit management:
  A method for managing the permits for construction and operation of the wind farm will be presented and explained. Examples of the process in getting required permits for offshore wind farms in Europa will be presented, including an overview of the involved authorities.
- Certification:
  Requirements to certification in relation to the characteristics of the project will be explained, as well as different types of certification. Expected certification requirements for an offshore project in India will be defined.
- Health, Safety and the Environment (HSE):
  A model for the organisation for ensuring compliance with health, safety and environmental standards organization of HSE for an offshore project is presented and explained. Essential documents and procedures are discussed.

2.4.1.5 WP2.4 Capacity Building

Input	Activities	Output
• Stakeholders Consultation in WP2.1 • Nominated staff by MNRE and stakeholders	Carry out training for nominated candidates under the form of study tour to Europe, ad-hoc workshops in India	• Study tour • Workshops • Knowhow transfer to participants

Table 15 Specific summary of the input, activities and output for the WP2.4

Activities

The specific capacity needs of Indian Stakeholders will be assessed and a highly focussed capacity building exercise will be designed targeting to train staff that will remain in their positions long enough following the

training to benefit their institution / organisation. The selection should be MNRE/NIWE responsibility, but advising will be provided by FOWPI.

- Study Tour to Europe:
  One study tour for four persons to facilities and institutions in Europe for a week will be arranged. COWI acknowledges that the tour content should be suggested by MNRE/NIWE.
- Ad-hoc workshops in India:
  Over the course of the FOWPI project, a maximum of three one-day ad-hoc workshops will be provided for capacity building with at least two experts from the European context. The potential topics to consider for these workshops will be aligned with the stakeholders needs and will be agreed with MNRE/NIWE.

Legal aspects and advising is outside the scope of work.

2.4.1.6 WP2.5 Secretariat Services

Input	Activities	Output
Joint Working Groups (JWG) organizations, scope, plan	Assistance in supporting the activities, including planning of meeting and progress reporting	• Technical Secretariat function • Meetings and conferences • Annual reports

Table 16 Specific summary of the input, activities and output for the WP2.5

Activities

- Assistance as Technical Secretariat Function:
  The function of the Technical Secretariat would be to support to the Joint Working Groups (JWG) in the framework of the EU-India Energy Panel. To do so, we propose to organize regular physical meetings with the Joint Working Groups. During these meetings (up to 10 meetings during the whole timeframe of the project), an expert of the consortium will explain the progress made on the framework and collect inputs from the JWG. The Technical Secretariat will share the results of the meetings with the other members of the consortium and inputs will be taken into account by the relevant partners in order to ensure a continuous improvement of the framework. The Technical Secretariat will also support the Implementation of framework´s actions.
  Another role by the Technical Secretariat will be to provide inputs on the progress of the preparation of the first offshore wind-farm project in India to the Ministry of New and Renewable Energy and to the National Institute of Wind Energy (NIWE). The Technical Secretariat will be permanently available through an online platform as per the output of Work Package 2.1 to receive all the questions / queries/ comments/ remarks/ feedbacks from the parties involved in the project. The Technical Secretariat will make sure to provide relevant and detailed answers to the MNRE and NIWE in a minimum possible time. The Technical Secretariat will also organize regular meetings with the MNRE and NIWE during which technical aspects related to the project will be analysed, discussed and agreed.
  Finally, the Technical Secretariat will be in charge of preparing the studies to enhance a dialogue on strategic energy security matters and on supporting technologies and policies.
  Annual reports will be drafted on the services provided.

- Organization of meetings and conferences:

  Three meetings of the Joint Working Groups will be organised and held in Delhi, one per year for approximately 30 people and for maximum two days. On this occasion, a maximum of two experts of the consortium will travel from Europe. The agenda of these meetings will be discussed and defined with the JWG.

  A two-day conference will also be organized for approximately 100 participants. For this conference, experts of the consortium based in Europe will also be travelling in order to act as delegates of the conference. The conference would be organized in combination with the Joint Working Group meeting to ensure the presence of the key experts from Europe.

  One meeting per year will be organized with the Contracting Authority and/or the Indian beneficiaries to explain the work done and the steps achieved during the different phase of the project.

2.4.2 Work Plan

This section introduces the implementation plan for the FOWPI project with first an overall overview with all the work packages and then for each specific work package.

Figure 3 High-level overview of implementation plan for all the work packages.

<u>WP1 Design and Technical Specifications</u>

Figure 4 Implementation plan for all sub-packages within the WP1.

WP2.1 Creation of a Knowledge Bank

Figure 5 Implementation plan for all main activities within the WP2.1.

WP2.2 Financial Investment Model

Figure 6 Implementation plan for all main activities within the WP2.2

WP2.3 Procedures

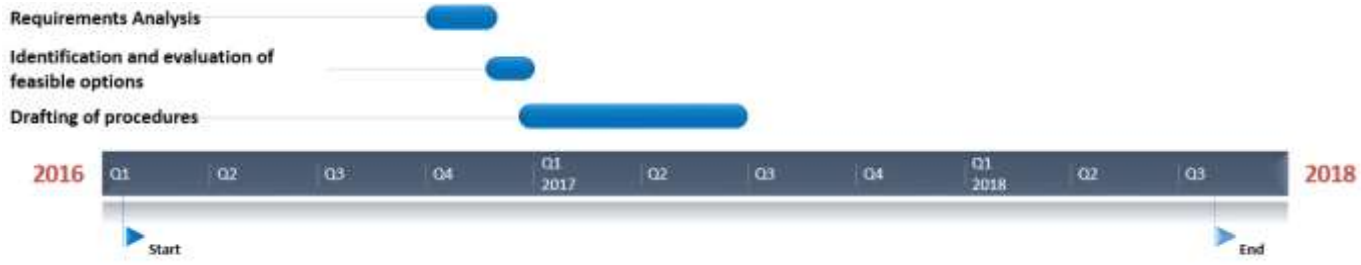

Figure 7 Implementation plan for all main activities within the WP2.3

WP2.4 Capacity Building

Figure 8 Implementation plan for all main activities within the WP2.4

WP2.5 Secretariat for Joint Working Group

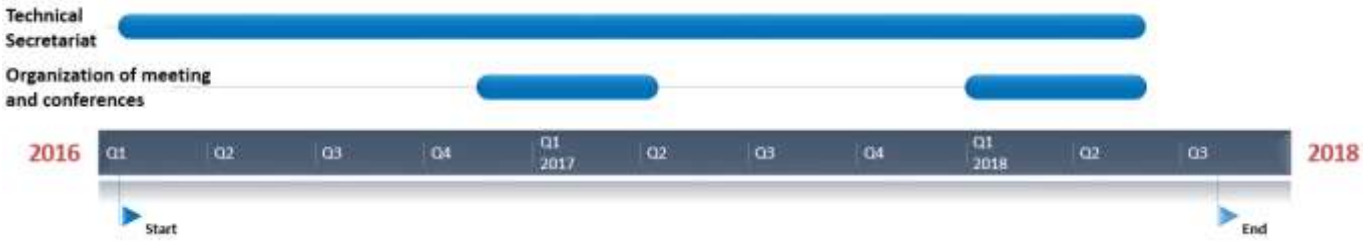

Figure 9 Implementation plan for all main activities within the WP2.5

2.4.2.1 Offshore wind implementation outlook

This section lists and introduces a high-level perspective of the main steps needed for India to successfully build the first offshore wind project. The primary stakeholders involved in this process are highlighted together with a preliminary time plan based on current knowledge of the work status of other projects involved in the development of offshore wind power.

		EU-expertise	Authority	Start	End
2016:					
1	Site Area Selection	FOWPI	MNRE	Aug-16	Sep-16
2	Establish Secretariat for Indian Offshore Wind Stakeholders	FOWPI	MNRE	Apr-16	Dec-16
3	Wind Farm Layout	FOWPI	MNRE	Aug-16	Sep-16
4	Geotechnical Desk Top Study	FOWPI	MNRE	Oct-16	Nov-16
5	Geophysical Offshore Survey	FOWPI	NIOT	Sep-16	Dec-16
6	Wind Grid Integration Study	FOWIND	MNRE	May-16	Dec-16
7	Metocean Study	FOWPI	MNRE	Sep-16	Dec-16
8	Environmental Scoping	FOWPI	MNRE	Sep-16	Dec-16
2017:					
9	Wind Measurements	FOWIND	MNRE	Mar-17	Feb-18
10	Grid Connection Plan	FOWPI	GETCO	Jan-17	Feb-17
11	Knowledge Bank Preparation	FOWPI	MNRE	Apr-16	Mar-17
12	Offshore Wind Conference Report	FOWPI	MNRE	Mar-17	Mar-17
13	Geotechnical Drilling, CPT and lab-test			Jan-17	Jun-17
14	Environmental Impact Assessment			Jan-17	Dec-17
15	Procedures Draft: Permits, Certification, HSE	FOWPI	MNRE	Jan-17	Jun-17
16	Wind Condition Assessment	FOWPI	NIWE	May-17	Nov-17
17	Conceptual Foundation Design	FOWPI	MNRE	Mar-17	Okt-17
18	Electrical Wind Farm Tender Design	FOWPI	MNRE	Aug-17	Sep-17
19	Prelim Substation and Onshore Cabling Design	FOWPI	MNRE	Aug-17	Okt-17

20	Annual Energy Production Estimation	FOWPI	MNRE	Oct-17	Nov-17
21	Budget and Financing Basis	FOWPI	MNRE	Sep-17	Nov-17
2018:					
18	Financing Agreement		MNRE	Dec-17	Jun-18
19	Subsidy System Agreement		MNRE	Dec-17	Jun-18
20	Technical Tender Call Package	ITP	MNRE	Jan-18	Jun-18
21	Tender Call (post-qualification system)	ITP	MNRE	Jul-18	Sep-18
22	Tender Evaluation	ITP	MNRE	Okt-18	Nov-18
23	Contracting of Wind Farm Supplier		MNRE	Otc-18	Dec-18
2019-2020:					
24	**Design and Construction**	**Contractor**	**MNRE**	**Jan-19**	**Dec-20**

Table 17 Offshore wind implementation outlook

2.4.3 Organizational Structure

The revised high-level project organization is introduced in Figure 10 with minor changes from the one introduced during the tendering phase.

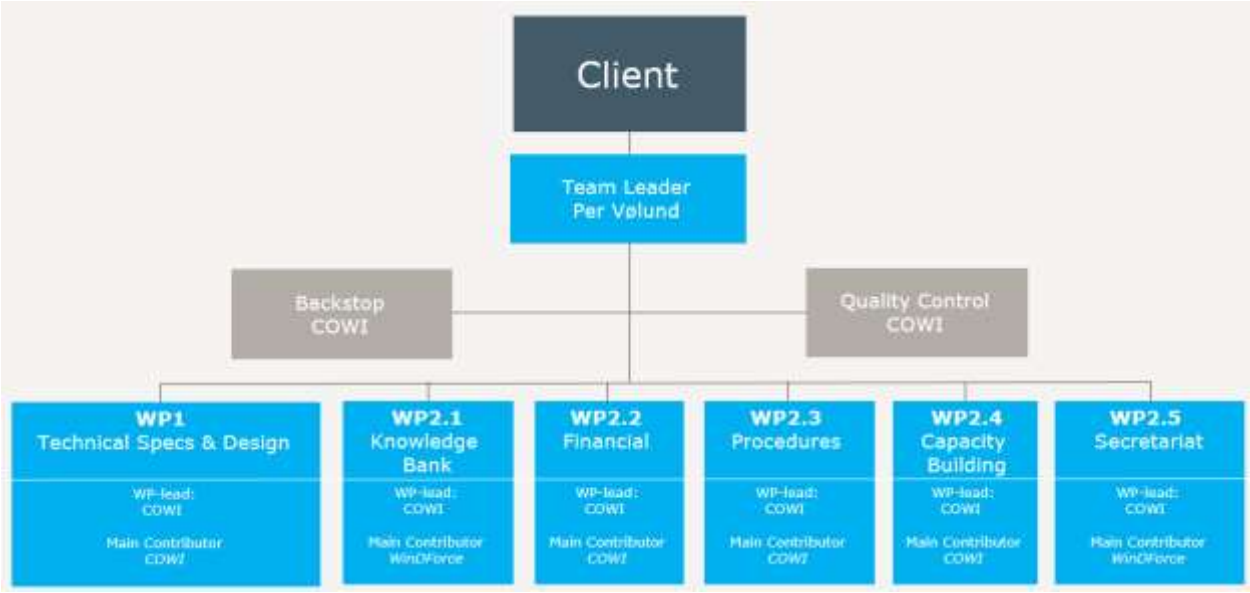

Figure 10 High-Level Project Organization

COWI will be responsible for the project and contract management including coordination of the works performed within each Work Package. COWI will be responsible for work packages as indicated on the organogram.

WinDForce is sub consultant to COWI and will deliver local Indian wind-business network expertise and assist with secretarial services, seminars and logistics in India. WinDForce will be in charge of the work packages as shown on the organogram.

2.4.5 Key Deliverables

ID	Deliverable	
Year 1		
0	Contract Commencement Date	18 January 2016
1	Monthly Reports (2 pp.)	1-12 mth
2	Inception Mission Report (including updated project plan)	3 mth* (9 mth)
3	Interim Report 1 (20 pp.), incl. Scope of Work for Geotechnical Investigations	6 mth* (10 mth)
4	Tour Report Study Tour to Europe	9 mth**
5	Wind Farm Design Report no. 01, including: • Report on Grid Connection Plan • Report on Soil and Bathymetric Conditions (geophysical survey and geotechnical desk-top study) • Report on Metocean • Scoping Report on Environment and Consenting • Launch of Knowledge Bank	11 mth* (14mth)
6	Annual Knowledge Sharing Workshop Report	12 mth
7	Interim Report 2 (20 pp.)	12 mth
*** = postponed due to the change in scope of work** **** = postponed, to be organized in collaboration with FOWIND**		
Year 2:		
8	Monthly Reports (2 pp.)	13 – 24 mth
9	Interim Report 3 (20 pp.)	18 mth
10	Report Draft Procedures on Permit Management, Certification and HSE	23 mth
11	Wind Farm Design Report no. 02, including: • Report on Foundation Design • Report on Electrical Design • Report on Layout and Annual Energy Production • Report on Financial Modelling • Report on Coastal and Onshore	23 mth
12	Report on the Secretariat Function	23 mth
13	Annual Knowledge Sharing Workshop Report	24 mth
14	Interim Report 4 (20 pp.)	24 mth
Year 2.5:		
15	Monthly Reports (2 pp.)	25-30 mth
16	Final Draft Report	28 mth
17	Closing Meeting with Client	29 mth
18	Final Report with recommendations	30 mth

Table 18 FOWPI Key Deliverables

2.4.4 Reporting

The following reports will be provided in English in the original version and one copy.

2.4.4.1 Interim Reports

An Interim Report will be provided on a monthly basis. This will provide an operational / technical update of about two pages.

Interim Technical Reports will be submitted on a six months basis and will be limited to 20 pages without including appendices such as studies or manuals. Progress will be reported and status of deliverables provided.

2.4.4.2 Ad-Hoc Reports

Ad-hoc reports may be requested by the EU Delegation, for example sector updates, briefs for high-profile meetings. This could also include reports from experts attending conferences, workshops and work groups.

2.4.4.3 Draft Final Report

A Draft Final Report of a maximum 30 pages (not including annexes) shall be submitted no later than one month before the end of the period of implementation of the FOWPI project.

The Report shall describe the work done, results achieved, problems encountered and recommendations for the way forward.

2.4.4.4 Final Report

A Final Report shall incorporate any comments received from the parties on the draft report and be submitted within 30 days after receiving comments on the draft report.

The detailed analyses underpinning the recommendations will be presented in annexes to the main report.

3 Baseline Assessment

3.1 Progress in Collecting Data

- Quarterly coordination meetings will be held in New Delhi with representatives from MNRE, NIWE, the EU-Delegation and EU-founded projects, i.e. FOWPI and FOWIND. This meeting will focus on avoiding duplication of works and assuring knowledge exchange between the different projects so that India can fully benefit from resources invested in the development of offshore wind power.
- Monthly meetings will be held between FOWPI and the project "Delivering Policy and Commercial Readiness for Indian Offshore Wind" to exchange knowledge and information about budget assumptions for the first offshore wind farm project of India.
- A list of relevant European stakeholders from which we expect to draw lessons learned and experience to transfer to India, will be developed based on a desk based screening of all companies previously involved in already built offshore projects in Europe.
- The wind conditions on site will be modelled based on meso-scale and reanalysis datasets
- Wave measurements from wave buoy will be purchased from available offshore measurement stations in the premises of the site area under investigation
- Geotechnical information will be purchased from past geotechnical investigation campaigns carried out offshore in the premises near the site area under investigation.

3.2 Key Challenges

- Availability of results from the FOWIND project:
  The findings from the FOWIND's project may not be available in due time and the impact on the FOWPI project could be significant and influence negatively on the timely completion of the project and on the quality of the design. Proper coordination and discussion will be needed with FOWIND management and eventual delays shall be overcome by adopting an adjustable implementation plan.
- Site selection:
  The wind farm site was at suggestion from MNRE selected during the inception phase in cooperation with the Client, MNRE and other relevant stakeholders based on FOWIND findings and located near the Lidar position.
- Design level and site characteristics:
  FOWPI will be developed up to the stage of Pre-Financial-Investment-Decision based on a common understanding with the Client and the Final Recipient after the inception phase.
  The design will be carried out according to national and international standards and best practice but the lack of specific on-site information such as geotechnical data will limit the design accuracy and therefore result in higher uncertainties and higher risks for the contractor. In Europe, development has proven that good site data and subsequently good design brings the best prices from contractors and they are consequently always a request from investors to project developers.
- Institutions and Stakeholders:
  The project may encounter political challenges as planning and approval of offshore wind farm projects involve a number of different types of authorities and legal areas. COWI has experienced such challenges before and can draw from its experience to support the process with the right solutions.

It is noted that high staff turnover within MNRE, NIWE and other state-level actors might represent a challenge for a smooth implementation plan. Proper coordination and discussion will be needed between the parties, to successfully reaching the goal.
The coastal local communities and the fishing industry has been marginally involved so far in the discussion about offshore wind power and might constitute challenging stakeholders in relation to the implementation of the first offshore wind farm project. Proper consultations should be planned in the near future to inform and prepare such important stakeholders.

- Capacity Building:
  One of the key objectives of the FOWPI project is to support the capacity building in India but there is a risk that the relevant institutions and staff are not available for such training. It is noted that high staff turn-over and limited human resources are issues within MNRE, NIWE and other state-level actors. This might represent a challenge with respect to identification of the persons and authorities who should participate in these activities, including the study tour to Europe.
  The identification will be carefully carried out by the stakeholders who will have an important role in the development of offshore wind power in India and proper assessment of the training needs prior to the selection of the participants and the formulation of the final capacity building programmes.
- Political distress:
  There is currently a lack of a political and regulatory framework for offshore wind power in India and this may present uncertainty on how the project will be processed and when it gets to the execution phase. The legal, regulatory and technical framework for offshore wind farms are more complex and comprehensive compared to conventional onshore wind farms. The reason is that many administrative areas and legal regulations govern the use and the resources of the sea. As many interests are related to the sea, conflicts may arise between the various parties, using the sea areas. FOWPI will collaborate with all the relevant stakeholders to support the development of offshore wind power in India.
- Lack of interest in knowledge sharing from European companies:
  There could be a potential risk to find low interest within the European companies in sharing knowledge or in being involved in the Indian offshore wind power. FOWPI will work to support India in attracting attention and increasing awareness about the great potential of offshore wind power.
- Lack of interest from investors:
  The lack of capital for the pilot wind farm is not a risk specifically for this study but is a risk in relation to the following implementation phase. The financial risk is primarily due to the nature of project as offshore wind power is a new technology in India and the production cost per kWh by offshore wind farms is higher compared to the production cost by onshore wind farms. FOWPI will assist in comforting potential investors that the risk is moderate based on well-established European schemes for EU offshore wind farms and assuring that key requirements from international financial institutions are taken into account.
- Data copyright:
  It should be highlighted that in general terms any data, which may relate directly or indirectly to National Defence/Security, will have strict restriction for both processing and export. It is anticipated that several dataset generated under the FOWPI project will most probably fall within this class of restricted information. This may pose some limitations to the full involvement of external stakeholders in the Indian offshore wind power.

FOWPI

FIRST OFFSHORE WIND
PROJECT OF INDIA