Danish Energy Agency

Input to the Development of Technical Standards for Offshore Wind Site Investigations in Vietnam

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Foreword

In 2013, Vietnam and Denmark entered into a long-term cooperation agreement for the purpose of strengthening Vietnam’s transition to a low-carbon economy. The Danish Energy Agency (DEA) cooperates with the Ministry of Industry and Trade (MOIT) in Vietnam through the joint Energy Partnership Program between Vietnam and Denmark (DEPP). The program is currently in its third phase (DEPP III, 2021-2026) and covers long-term scenario modelling of the energy sector, developing a regulatory framework for offshore wind development, the integration of renewable energy in the power grid and energy efficiency in the industrial sector. The Danish Energy Agency, the Electricity Authority of Vietnam (EAV) and the Danish Embassy in Hanoi are overall responsible for the implementation of activities under this program.

This project builds upon a strong foundation of Danish-Vietnamese cooperation in the offshore wind sector. Denmark, with over three decades of experience in offshore wind development and currently generating approximately 50% of its electricity from wind power, has been sharing its expertise with Vietnam under DEPP.

Under the Strategic Engagement Cooperation (SEC) project with the former Ministry of Natural Resources and Environment (MONRE) during 2022-2025, the Danish Energy Agency (DEA), the Geological Survey of Denmark and Greenland (GEUS), and Energinet (the Danish transmission systems operator) engaged with multiple Vietnamese stakeholders to share experiences in Maritime Spatial Planning (MSP) and disseminate technical knowledge on offshore wind site investigations to organizations including the EAV, the Vietnam Agency for Sea and Islands (VASI), Vinamarine, Vietnam National Industry - Energy Group (Petrovietnam PVN), Vietnam Electricity (EVN), and the Vietnam Petroleum Institute (VPI).

Through DEPP, Denmark continues to support EAV in capacity building on leading and managing offshore wind development and roll-out, sharing knowledge on Denmark's one-stop-shop model hosted at DEA and experiences with designing and operating competitive tender frameworks for offshore wind projects.

Acknowledgements

The successful completion of this document would not have been possible without the valuable contributions, guidance, and support of numerous individuals and organizations.

We would like to express our sincere appreciation to the Electricity Authority of Vietnam for their trust, collaboration, and continued support throughout the duration of this project.

We extend our gratitude to Vietnam Petroleum Institute, whose expertise, local knowledge, and cooperation enriched the relevance of this work. Its contributions ensured that the report reflects a comprehensive perspective grounded in the context of Vietnam.

We would also like to acknowledge the contributions of the Geological Survey of Denmark and Greenland, which provided feedback and critical insights at various stages of the project. Its involvement significantly strengthened the quality and robustness of this document.

Finally, we appreciate the dedication and efforts of all team members involved in this project, whose commitment and professionalism made this work possible.

Executive Summary

Vietnam has set out an ambitious target for offshore wind power (OSW) as a central pillar of its long-term energy transition. Under the revised Power Development Plan VIII (PDP8), Vietnam targets at least 6-17 GW of offshore wind capacity in operation by 2030-2035, with a significantly larger expansion foreseen toward 2050 [1, 2]. Achieving these targets is critical for ensuring energy security, supporting sustained economic growth, and meeting national climate commitments.

Offshore wind projects, however, are among the most capital-intensive and technically complex energy investments. International experience shows that early-stage project risks, particularly those related to seabed conditions, metocean extremes, and environmental constraints, are a major driver of costs, delays, and investment uncertainty. High-quality, well-sequenced site investigations are therefore not merely a technical requirement; they are a strategic policy instrument to de-risk projects, reduce system costs, and ensure timely delivery of offshore wind capacity.

This document addresses a critical gap in Vietnam's offshore wind framework: the absence of clear, standardized technical guidance for offshore wind site investigations. It provides Vietnamese authorities with a structured, internationally benchmarked foundation for developing national technical standards (TCVN) for offshore wind site investigations, while taking into account Vietnam's evolving regulatory environment, institutional structure, and marine conditions.

Site investigations matter for Vietnam's nascent offshore wind industry

Site investigations provide the factual basis for almost all key decisions in offshore wind development. They underpin pre-feasibility and feasibility studies, inform spatial planning and environmental assessments, enable cost-efficient engineering design, and form the foundation for bankability and project financing. Weak or inconsistent site investigation practices can increase uncertainty, lead to conservative design assumptions, raise financing costs, and ultimately increase electricity prices borne by consumers.

The development of offshore wind in Vietnam faces several structural challenges that make robust site investigations particularly important:

- Offshore wind development must proceed at scale and under tight timelines to meet PDP-Revised targets.
- Early projects will define market confidence and shape long-term investment appetite.
- Vietnam's marine environment is complex, with variable seabed conditions, monsoon climate patterns, tropical cyclones, and competing marine uses.
- The regulatory framework is still maturing, creating uncertainty for developers during early project phases.

Reducing risks, especially during the early stages of development, is essential. International experience demonstrates that front-loading knowledge through structured site investigations is one of the most effective ways to achieve this.

Key lessons from Denmark

Denmark's offshore wind development over more than three decades provides a relevant reference for Vietnam. A defining feature of the Danish model is strong public-sector leadership in early-stage site investigations. Danish authorities commission and manage comprehensive preliminary site investigations before investor selection, covering seabed conditions, metocean data, environmental baselines, and cable routes. The resulting data packages are made available to all qualified bidders.

This approach delivers several tangible benefits:

- Reduced development risk and lower financing costs.
- Faster project delivery and fewer delays during construction.
- More competitive bidding.
- Avoidance of duplicated surveys and wasted investments.

While Vietnam's institutional context differs from Denmark's, the underlying principles, of early de-risking, clear role allocation, and data transparency, are directly applicable and highly relevant.

Progress and gaps in Vietnam's offshore wind framework

Vietnam has made important progress in establishing a legal foundation for offshore wind development. The Law on Electricity 2024 [3], Decree 58/2025/NĐ-CP [4], and recent resolutions on investor selection provide greater clarity on project approval, sea area allocation, and incentives. Maritime Spatial Planning (MSP) has also been approved [5], creating a strategic framework for offshore activities.

Several challenges remain that directly affect site investigations:

- Not clearly assigned areas to offshore wind development areas in the MSP, although survey licenses since have been granted to a number of project sites.
- National technical standards specific to offshore wind site investigations remain under development, but are not complete. Reference must be made to international standards.
- Undefined timing and minimum requirements for site surveys during early project stages.
- Fragmented responsibilities among authorities, requiring extensive inter-ministerial coordination, and uncertainty for developers.
- Risk of duplicated or sub-optimal surveys, particularly where developers must act without clear guidance.

Without addressing these issues, Vietnam risks higher project costs, slower implementation, and ultimately increased pressure on electricity prices.

A proposed phased approach to site investigations

This document responds directly to these challenges and aims at supporting Vietnamese authorities in developing a coherent, phased, and internationally aligned framework for offshore wind site investigations. Through a review of best practice from Danish experience, and an assessment of Vietnam's current regulatory and institutional framework for offshore wind development, this document proposes a phased approach to site investigations aligned with

Vietnam's project approval process. It further provides detailed technical guidance for geophysical, geotechnical, metocean, and environmental surveys; and offers concrete recommendations for regulatory, institutional, and procedural improvements. The guidance is intended to inform future regulations and national technical standards, while remaining flexible enough to accommodate site-specific conditions and technological developments.

A central recommendation of this document is the adoption of a phased approach to offshore wind site investigations, structured into three phases of progressive detail and cost:

1. **Desktop Study**: early screening using existing data to identify suitable areas, key constraints, and data gaps.

2. **Preliminary Field Survey**: limited, site-wide field investigations to validate assumptions, identify obstacles, and define detailed survey scopes.

3. **Detailed Investigation**: targeted, high-resolution surveys at confirmed infrastructure locations to deliver bankable data for final design and financing, as well as construction and decommissioning.

This approach allows risks to be identified early, survey scopes to be targeted, investments to be optimized, and regulatory decisions to be based on progressively stronger evidence.

Recommendations for Vietnamese authorities

Based on the analysis and technical guidance presented in this report, the following strategic directions are highlighted for policy makers:

- Define areas and requirements for preliminary site investigations
- Formalize a phased approach to site investigations in regulation and guidance.
- Develop national technical standards for offshore wind site investigations, building on international norms, which this report can provide a foundation for.
- Improve coordination and data sharing among ministries and agencies.
- Use site investigation data proactively to inform updates to the maritime spatial planning, environmental assessment, and project prioritization.
- Clarify roles and responsibilities for detailed site investigations
- Bring forward the power purchase agreement negotiation to align with preliminary feasibility study and investment policy approval.

By implementing these measures, Vietnam can significantly reduce early-stage project risks, accelerate offshore wind deployment, and create a more attractive investment environment, while safeguarding environmental and social interests.

In conclusion, robust site investigations are not a technical detail but a cornerstone of a successful offshore wind strategy. Establishing clear standards and strong institutional practices in this area will play a decisive role in determining whether Vietnam's offshore wind ambitions are delivered on time, on budget, and at the lowest possible cost to society.

Abbreviations

COD	Commercial Operation Date
CPT	Cone Penetration Test
DEA	Danish Energy Agency
DEPP III	Danish Energy Partnership Programme III
DNV(GL)	Det Norske Veritas
EAV	Electricity Authority Vietnam
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction
EU	European Union
EVN	Vietnam Electricity
(Pre)-FS	(Pre-) Feasibility Study
GEUS	Geological Survey of Denmark and Greenland
GIS	Geographic Information System
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMCA	International Marine Contractors Association
IRC	Investment Registration Certificate
ISO	International Organization for Standardization
LCOE	Levelized Cost of Energy
MAE	Ministry of Agriculture and Environment (Vietnam)
MND	Ministry of Defense (Vietnam)
MOF	Ministry of Finance (Vietnam)
MOIT	Ministry of Industry and Trade (Vietnam)
MONRE	Former Ministry of Natural Resources and Environment (Vietnam), now MAE
MOST	Ministry of Science and Technology (Vietnam)
MPS	Ministry of Public Security (Vietnam)
MSP	Marine Spatial Plan
OSW	Offshore Wind

PDP (8)	Power Development Plan (8)
PPA	Power Purchase Agreement
PVN	Vietnam National Industry - Energy Group, Petrovietnam
SCADA	Supervisory Control and Data Acquisition
SEA	Strategic Environmental Assessment
SEC	Strategic Engagement Cooperation
SOE	State-Owned Enterprise
TCVN	*Tiêu chuẩn Việt Nam* - Standards of Vietnam
UXO	Unexploded Ordnance
VASI	Vietnam Agency of Seas and Islands
VPI	Vietnam Petroleum Institute

1

Introduction

1. Introduction

Vietnam is embarking on an ambitious energy transition to meet its growing electricity demand while achieving its climate commitments. Offshore wind (OSW) has been identified as a cornerstone of this transition, with a capacity targeting 17 GW offshore wind to be in operation by 2035 [1, 2]. Looking toward 2050, the offshore wind capacity is expected to increase by at least tenfold, positioning Vietnam among the leading emerging markets for offshore wind development in Southeast Asia.

In order to succeed on this journey, a suitable and supportive framework is required. Essential for this is establishing standards for how to conduct site investigations of the offshore wind sites. Site investigations are critical to the preparation of (pre-)feasibility studies and serve as the basis for informed decision-making throughout the project lifecycle. They provide essential data on conditions and parameters that directly influence project feasibility, design optimization, and risk assessment among other things. Solid standards for site investigations will be a foundation for (pre-)feasibility studies, tender design, and investment decisions.

Knowledge about site conditions will also enable the Vietnamese energy authorities to give first priority to the cheapest and least complicated projects in an effort to lower the LCOE for the first projects to lower risk-premiums and increase the chances of completion on time.

This report has been developed following the identification of a critical need for Vietnamese authorities to establish a common framework detailing technical standards for site investigations to ensure consistency, quality, and adequacy of data collection across upcoming offshore wind projects.

The aim of the report is to inform the Vietnamese government on the establishment of the most suitable standards, taking into account both international experience and national context. A key part of this report is a set of operational recommendations to MOIT and other relevant stakeholders.

In the following, international and Danish experience on standards for OSW site investigations will be presented, followed by an overview of the current regulatory framework for offshore wind in Vietnam. Based on this, an overview of relevant site investigation frameworks and requirements is presented, including suggestions regarding geophysical, geotechnical, met-ocean and environmental surveys, as well as a thorough description of potential data requirements. With a stronger evidence base, the process for establishing suitable standards will become more informed and effective.

1.1 Methodology

The development of this report follows a methodology incorporating multiple sources of information:

- Technical discussions with Vietnamese authorities, industry experts, and Danish partners to ensure guidelines are practical and implementable within Vietnam's regulatory and institutional framework. Including knowledge sharing workshop held in Hanoi on 6 August 2025, and earlier engagements with Vietnamese authorities on Marine Spatial Planning (MSP) under the Strategic Engagement Cooperation (SEC) programme.

- Study of Danish experience on offshore wind surveys, requirements, results databases, and regulatory frameworks administered by the Danish Energy Agency.

- Overview of existing regulations and standards in Vietnam: Analysis of Vietnamese legal frameworks including the 2024 Electricity Law [3], Decree 58/2025/ND-CP [4], and relevant circulars [6, 7, 8, 9].

- Guidelines on technical standards for offshore wind site investigations based on Vietnamese and international standards from International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), Det Norske Veritas (DNV) and the International Hydrographic Organization (IHO).

1.2 Key Definitions

To ensure clarity throughout this report, the following key terms are defined:

Data collection activities

- **Desktop study:** Early-stage data collection activities to assess site feasibility based on existing data. This can be based on public or other proprietary data sets. It is also used to inform the scope of subsequent field surveys.

- **Preliminary field survey:** These involve field activities over a broad area to confirm the results of the documentation study and develop initial site characteristics. The results will inform the scope of the detailed survey.

- **Detailed survey:** Comprehensive site investigation at the confirmed location of infrastructure with the aim to gather bankable, high-resolution data for detailed feasibility studies and final engineering design required for financial close as well as construction and decommissioning.

- **Geophysical:** Non-intrusive surveys which employ remote sensing methods to provide fundamental knowledge about seabed and sub-seabed conditions.

- **Geotechnical:** Subsurface data, which describes the technical characteristics of the ground.

- **Metocean:** A term combining meteorology and oceanography, representing the integration of atmospheric and oceanic factors.

Reports

- **Preliminary feasibility study (pre-FS):** An initial assessment conducted based on information gathered during the desktop study. It also includes a Preliminary Environmental Impact Assessment [10]. The pre-FS is used to support investment policy approval decision.

- **Feasibility study (FS):** A comprehensive study conducted after investment policy approval. The FS includes geotechnical data, metocean analysis, wind resource assessment, preliminary engineering design, grid connection and power system integration, decommissioning and end of life plan. Based on current legislation, the FS must be approved within 24 months from signing the project contract [4]. The FS serves as the basis for obtaining construction permits and achieving financial close.

- **Environmental Impact Assessment (EIA):** A comprehensive study of environmental and social impacts of the project, to be approved within 24 months from the singing of the project contract alongside the FS [4]. General requirements for Environmental Impact Assessments in Vietnam include project information, legal compliance, technology review, baseline environmental and social conditions, impact assessment, waste management, mitigation measures, monitoring plan and stakeholder consultation [10].

2

Danish experience with offshore wind site investigations

2. Danish experience with offshore wind site investigations

This chapter describes the Danish experience with offshore wind site investigations, situating it within the overall regulatory framework for offshore wind in Denmark and highlighting elements that are relevant in an international context. Particular attention is paid to the division of responsibilities between public authorities and developers, the sequencing of investigations, and the implications for cost, competition, and project timelines.

2.1 Institutional setting for offshore wind development in Denmark

Denmark's offshore wind development framework is characterized by strong central coordination, early strategic planning, and a clear allocation of responsibilities between public authorities and developers. At the core of this framework is the Danish Energy Agency (DEA), which functions as a single, integrated authority for offshore wind permitting and planning.

The DEA acts as a *one-stop-shop* for offshore wind development. It serves as the single point of contact for all permitting-related matters and is responsible for coordinating internally with other relevant authorities, such as the Danish Maritime Authority, the Ministry of Defence, the Danish Nature Agency and relevant municipal authorities.

Rather than requiring developers to approach each authority individually, the DEA consolidates requirements and conditions into a single, streamlined permitting process. This approach provides transparency and predictability and significantly reduces regulatory timeline risk.

Within this framework, the DEA is responsible for spatial planning, tender design, market dialogue, and coordination of environmental assessments. The technical preparation of projects is led by the Danish transmission system operator, Energinet, ensuring a clear separation between regulatory oversight and technical execution. It also allows for an early involvement of the grid operator in order to plan for and prepare the electricity system for significant new generation, most often in GW-scale steps.

2.2 Framework for preliminary OSW site investigations in Denmark

A defining feature of the Danish approach is the state-led de-risking of offshore wind sites. Once a political agreement on offshore wind deployment has been reached and enacted, Energinet, in coordination with the DEA and the Ministry of Climate, Energy and Utilities, initiates comprehensive Preliminary Site Investigations of the designated gross areas.

The Danish model includes clearly defined institutional roles. The DEA holds the overall responsibility for:

- Overseeing spatial planning for offshore wind;
- Designing tenders and auction frameworks;
- Conducting market dialogue prior to site investigations;

- Coordinating Strategic Environmental Assessments (SEA);
- Commissioning specific studies, often in collaboration with Energinet and private subcontractors.
- Conducting auctions for offshore wind projects

Energinet is responsible for:

- Leading the technical preparation of offshore wind projects;
- Conducting or procuring feasibility studies, including wind, seabed, and environmental surveys;
- Managing spatial data and study results in a centralized data platform;
- Overseeing landfall routing and grid integration planning.

Figure 1 shows an indicative timeline for the activities during site investigation period in Denmark, including the roles and responsibilities of the authorities.

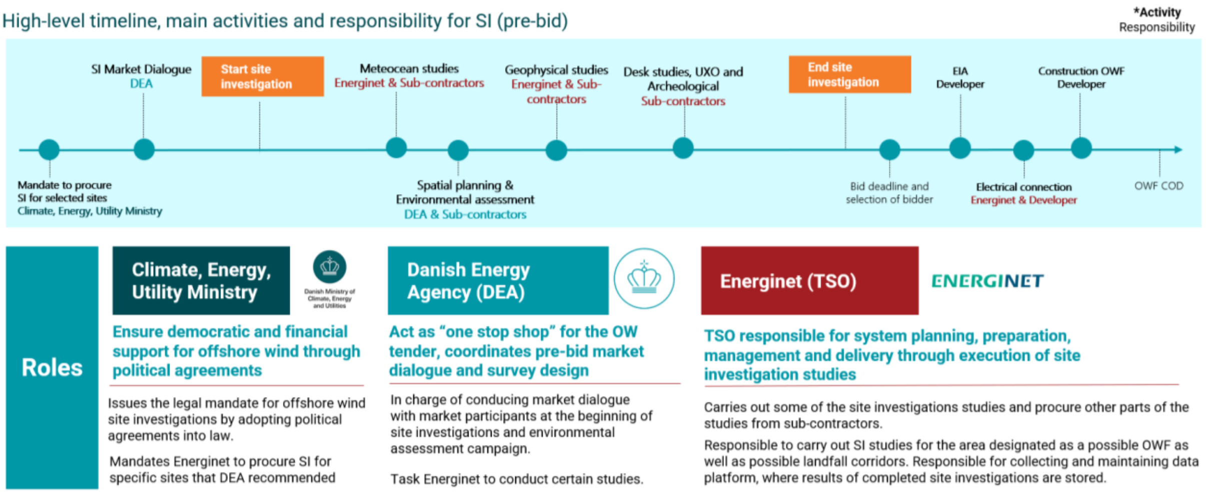

Figure 1 - An indicative timeline for the main activities for site investigations including the roles and responsibilities for site investigations in Denmark

These investigations are commissioned and financed by the state, and the costs are then recuperated from the winning developer. The rationale is to reduce development risk, ensure consistency in data quality, and create a level playing field for all bidders. Preliminary site investigations typically include:

- Metocean measurements (e.g. LiDAR and hindcast data)
- Geophysical seabed surveys
- Geotechnical investigations (desk studies, Cone Penetration Tests (CPTs), boreholes)
- Survey of Unexploded Ordnances (UXO)
- Marine archaeology assessments
- Environmental baseline studies and Strategic Environmental Assessments
- Cable route surveys and landfall site investigation

All results are consolidated into a comprehensive data package provided to pre-qualified bidders. The DEA integrates the findings into an advanced 3D Integrated Geological Model, which, together with all underlying raw data, is made available to interested developers free of charge. The site investigations reports and data that have been published for current Danish offshore wind tenders are published online [11]. This also includes the Scope of Works documents for the various site investigations for the latest offshore wind tenders in Denmark, which describes in detail the types of surveys, the level of detail and accuracy, and how the data should be processed and published. The raw and processed data from the investigations are accessible through an open Azure Data Platform [12]. The Ministry of Defence has restricted access to bathymetric data in Denmark for national security reasons [13]. Potential bidders must apply for data access [14].

By front-loading site investigation costs and sharing the results with interested developers, Denmark significantly reduces uncertainty related to ground conditions, environmental constraints, and metocean extremes.

Market dialogue is an integral element of the Danish site investigation process. Prior to initiating surveys, the DEA conducts structured discussions with industry stakeholders to gather input on the scope and level of detail of planned investigations; survey methodologies and data formats; practical constraints related to offshore operations, all with a view to minimising their need for contingencies and risk-premiums in their business cases.

This dialogue ensures that pre-bid studies are aligned with developer needs and industry best practice, while maintaining regulatory neutrality. It also allows the investigation program to evolve in response to technological advances and changing regulatory requirements, including updates to EU environmental legislation.

Internationally, responsibility for site investigations varies widely. In many markets, developers are responsible for most pre-bid investigations, which can lead to fragmented data, higher costs, and longer development timelines.

The Danish experience demonstrates that early, state-led site investigations, combined with strong data transparency and strategic environmental planning, can significantly reduce overall system costs and accelerate deployment. While the model requires institutional capacity and upfront public investment, it provides a compelling reference for countries aiming to scale offshore wind rapidly while maintaining high environmental and regulatory standards.

2.3 Technical components of preliminary site investigations

2.3.1 Seabed and geotechnical investigations

Seabed investigations form a core component of Danish site investigations and begin with an accurate assessment of water depth, which informs survey planning, equipment selection, and safety procedures.

Key elements include:

- Characterisation of seabed materials (firm ground, soft sediments, rock);
- Assessment of seabed stability, sediment transport, and morphology;
- Identification of obstructive or sensitive features, including shipwrecks, boulders, UXO, existing cables and pipelines, and ecological habitats.

Energinet manages the overall investigation program and tenders specialized tasks, such as geotechnical sampling, sonar surveys, and UXO detection, to qualified contractors to ensure high data quality and regulatory compliance.

The specific guidelines for the submission of geological, geophysical, geotechnical and geochemical data are detailed in Executive Order 543 [15]. In 2023, the Danish Energy Agency commissioned a survey of the Danish North Sea [16] to acquire geophysical data in regions with a lack of data and geological information. The purpose was to establish a better basis for developing conceptual geological models and mapping geological units of importance for offshore wind farm development. The activities were carried out by The Geological Survey of Denmark and Greenland (GEUS) using a specialised survey vessel and involved geophysical mapping with single and multichannel seismic surveyance and included over 3100 km of survey lines. A sub-bottom profiler, a multibeam echo sounder and a side scan sonar were deployed to support the seismic mapping.

The survey area includes the whole project area; both offshore and onshore infrastructure locations.

2.3.2 Metocean studies

Metocean studies characterize both normal and extreme environmental conditions affecting offshore wind sites. These include:

- Wind conditions, including extreme events
- Waves, currents, and water levels
- Ice conditions in inner Danish waters

All metocean studies are independently reviewed and certified by accredited third parties. The resulting datasets are essential for defining design parameters, assessing environmental loads, planning installation activities, and estimating long-term energy production and revenues.

2.3.3 Environmental assessment and spatial integration

Denmark applies a two-tier environmental assessment approach. At the strategic level, the DEA conducts Strategic Environmental Assessments (SEA) for broader marine regions, such as the North Sea. These assessments identify cumulative and large-scale environmental conflicts, including bird migration corridors and marine mammal habitats, and inform the selection and design of auction areas.

At the project level, more detailed Environmental Impact Assessments (EIA) are conducted, covering both offshore and onshore components. This staged approach allows early avoidance of major conflicts while maintaining flexibility in the level of detail required for individual sites, in line with evolving EU environmental legislation.

Marine mammals, particularly harbour porpoise, grey seal, and harbour seal, are a central focus of EIAs in Denmark. Construction activities such as pile driving can generate underwater noise capable of causing behavioural disturbance or temporary or permanent hearing loss. Birds and bats, which may use the sea area for feeding, breeding, resting, and those which migrate through the area also form a key part of the environmental assessment.

Denmark applies defined threshold values for different impact categories and requires mitigation measures where necessary. These may include noise reduction technologies, operational restrictions, or seasonal limitations.

Additional impacts, such as seabed disturbance, increased vessel traffic, habitat loss, and prolonged construction periods, are also assessed. Final permitting decisions are based on the cumulative findings of the EIA.

The survey area includes all offshore areas, as well as cable routing corridors and onshore infrastructure locations. This requires coordination with municipalities and alignment with local land-use plans. These processes ensure that offshore wind developments are integrated responsibly into terrestrial environments and local communities.

2.4 Post-award surveys

Once an offshore wind project is awarded, responsibility for further site investigations shifts from Energinet to the developer. These post-award investigations are necessary to refine designs, further de-risking, meet permitting conditions, and prepare for construction.

Core post-award activities typically include detailed geotechnical surveys, ground modelling and UXO clearance. Depending on site conditions and permit requirements, supplementary investigations may be required, such as additional metocean measurements or targeted environmental studies. The scope and duration of these investigations are variable and are informed by findings from earlier studies, as well as input from the developer's detailed design. Completion timelines typically range from a few months up to one year, depending on site complexity, seasonal constraints, and regulatory deadlines.

3

Guidelines on technical standards for OSW site investigations

3. Guidelines on technical standards for OSW site investigations

This chapter presents proposed guidelines for offshore wind energy site surveys in Vietnam, aimed at supporting the development of future national regulations and technical standards. These guidelines are based on international experience, particularly the Danish model presented in Chapter 2, and have been adapted to suit Vietnam's legal framework and practical conditions.

Understanding the timing of site surveys within the overall project development process is essential for effective planning and resource allocation. Figure 2 illustrates a possible timeline for developing a 1 GW offshore wind project in Vietnam, showing the relationships between site surveys, regulatory approval milestones, and construction phases. This timeline is based on the direct award of a project to a State-Owned Enterprise (SOE). Key milestones are marked in red. In this proposal the negotiation of a Power Purchase Agreement (PPA) is brought forward in the timeline with key terms, including an indexed price, agreed at the same time as the investment policy approval. The intention is to provide the investor more financial certainty on the viability of the project and bankability of the PPA before investing in the more expensive stages of site investigation. The final PPA is signed later, after the approval of the Feasibility Study and the Environmental Impact Assessment. This would reduce the likelihood of additional risk premiums placed on the tariff.

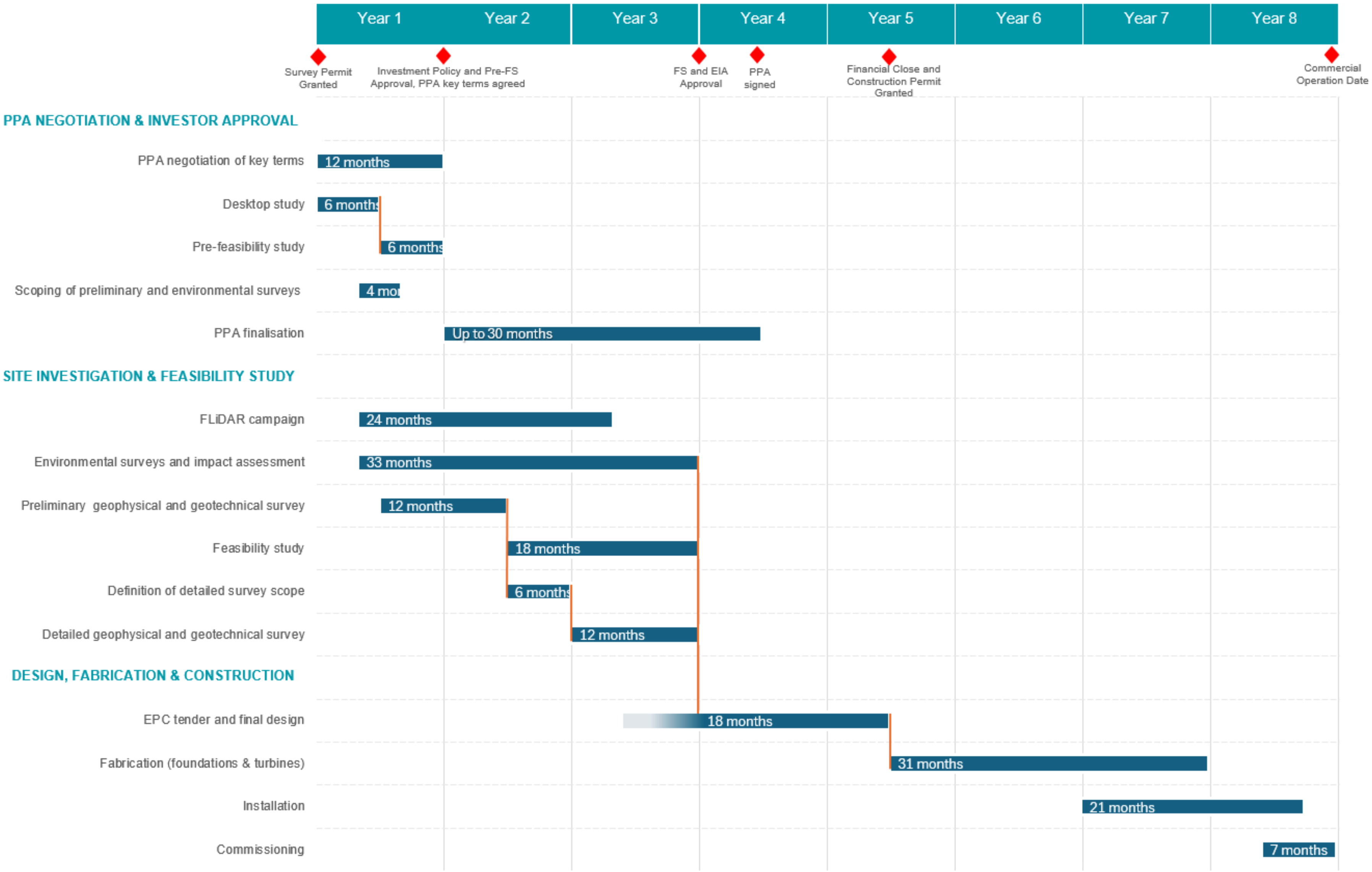

Figure 2 – Proposed timeline for offshore wind power development in Vietnam

Pursuant to Resolution No. 253/2025/QH15 [17] (effective from 1 March 2026), offshore wind power projects scheduled to commence operations during the 2025-2030 period shall be subject to a streamlined approval process with the following key features:

- The project must be included in the Power Development Plan and be scheduled to operate during the 2025-2030 period.
- The project must comply with requirements regarding national defence, security, sovereignty, marine resources, the environment, maritime activities, and oil and gas operations.
- Electricity prices will be negotiated but shall not exceed the ceiling price of the applicable offshore wind power price framework.
- Survey costs are funded from the enterprise's production/business budget in accordance with the Electricity Law 61/2024/QH15 [3].

For projects scheduled to commence operations during the 2031-2035 period, the authority to select investors and approve investment proposals may be delegated to provincial People's Committees for projects under 2,000 MW, subject to conditions. Projects of 2,000 MW or above shall fall under the authority of the Prime Minister. The adjusted Power Plan 8 (Decision 768/QĐ-TTg [2]) and Implementation Plan (Decision 1509/QĐ-BCT [18]) provide an updated list of projects and capacities.

As shown in Figure 2, the proposed project development process comprises the following:

- **PPA negotiation and investor approval**: The appointed investor prepares a pre-feasibility study report based on desktop data collection and obtain approval from the competent authority. The desktop studies will inform the scope of the preliminary geophysical and geotechnical surveys. Along with the agreement of the key terms of the PPA, this concludes with the approval of the investment policy and the signing of the business investment contract. The final PPA is signed after the feasibility study approval and approximately a year before financial close, with an indexed price to reflect the time to commercial operation date.
- **Site Investigations & Feasibility Study**: Meteorological and sea state measurement decided (e.g. LiDAR and a wave buoy) are deployed as early as possible to begin the collection of wind and wave data. Ideally two years of data is collected to ensure that seasonal variation is captured, although longer data collection is beneficial. Informed by the desktop studies, environmental surveys commence early to capture seasonal variation, and the Environmental Impact Assessment is written. In parallel, the preliminary geophysical and geotechnical field survey are conducted. The data from these surveys is used to write the feasibility study, and to scope the detailed geophysical and geotechnical surveys. The site investigation stage ends upon the approval of the feasibility study and the EIA. The time required to write the FS and EIA is included in the survey durations in the chart in Figure 2.
- **Design, Fabrication & Construction**: The developer tenders and selects an Engineering, Procurement, and Construction (EPC) contractor and finalises detailed engineering design. Early engagement of the supply chain may be beneficial for the developer before contracts are agreed upon approval of the FS and EIA. Once the project reaches financial close, and the construction permit has been granted, the developer commences fabrication of foundations, turbines and other infrastructure, and then installation and commissioning to achieve the Commercial Operation Date (COD).

These guidelines outlined in this chapter are advisory in nature and are based on international practical experience. Developers, regulatory authorities and technical consultants may adapt these recommendations to suit the specific conditions of each location and the evolving legal requirements in Vietnam. The types of surveys and investigations carried out are explained in depth in this section. These are split into four disciplines; metocean, geophysical, geotechnical, and environmental. Within each discipline, the objectives are explained, and the scope is divided into three phases of increasing intensity and resolution; a desktop study, a preliminary field survey and a detailed survey.

For each type of survey, a list of applicable standards is given which describes the surveys and investigations required to provide all the necessary data for analysis and design. While international standards outline the investigations required for site characterisation, their approach to data resolution is primarily performance-based. Rather than mandating resolution and line spacings, they require that data be sufficiently resolved to accurately model wind and wave loading, seabed morphology, and foundation conditions for specific design decisions. Consequently, industry best practices have evolved to tailor survey scopes to the characteristics of a given site.

Different markets deploy different regulatory approaches. Some markets prescribe maximum line spacings to ensure data sufficiency and comparability across sites, whilst performance-based markets (Denmark, Netherlands, UK) ensure data sufficiency through data-density benchmarks. In these markets, authorities mandate compliance with high-accuracy standards, which require the surveyor to prove coverage and the detection of objects of a specific size. Developers adjust line spacing according to their specific sensor capabilities and water depth. To guarantee these results, projects must undergo third-party certification and prove the performance benchmarks were met.

For environmental surveys, requirements are governed by national environmental protection laws, which define the species and habitats to be protected. These are supported by technical standards and industry best practices, which prescribe the specific survey methodologies, data resolutions, and seasonal frequencies required to ensure the data is legally and scientifically robust for impact assessments.

3.1 Meteorological and oceanographic survey

Metocean is a term combining meteorology and oceanography, representing the integration of atmospheric and oceanic factors, both of which play an important role in the design, construction and operation of offshore wind power projects.

Objectives

The objectives of oceanographic meteorological surveys are:

- To understand the meteorological and oceanographic characteristics of the proposed project area that may affect the technical design, transportation, installation and operation of the infrastructure.
- Assess the likelihood of adverse conditions that may impede the implementation of technically and economically feasible solutions.
- Provide data as an input to energy resource assessment

Scope by phase

Phase 1: Desktop study

Review existing documentation, identify available data sources in the region, and summarise findings, including:

- General description of the proposed site
- Summarise existing data sources and analyse data gaps
- Identify potential risks

- Estimating wind, wave, current and water level conditions
- Propose a preliminary hydro-meteorological survey programme, including staffing requirements, budget estimates and implementation plan

This phase provides the basic characteristics of existing meteorological and oceanographic conditions and determines the optimal scope and location for field surveys.

Phase 2: Field survey

This phase commences after the definition of the scope based on the desktop study. It requires a long measurement time required to obtain reliable statistical data, particularly for extreme value analysis. Due to the long campaign length and the nature of the collected data, this scope is not further subdivided into preliminary and detailed surveys.

Measurement equipment such as fixed and/or floating LiDAR systems, wave buoys and/or wave radars are deployed during the field survey. The duration of the measurement campaign is dependent on the characteristics of the site and the quality of any existing data, but usually are deployed for a minimum of 12 months in order to capture seasonal variation. Higher reliability and better seasonal representation are achieved with longer campaigns, 24 months is not uncommon. The number of measurement locations depends on the size of the survey area, the length of the cable corridor, the complexity of local oceanographic conditions, and the expected spatial variability of wind resources.

Project developers may consider purchasing and maintaining dedicated metocean measurement equipment for use throughout the project lifecycle as the data is used for operation and maintenance purposes. These investments may include floating or fixed wind LiDAR, wave and current buoys, water level gauges, and temperature sensors.

Applicable standards

Vietnam's Ministry of Science and Technology officially released 20 new National Standards (TCVN) specifically for offshore wind power in 2025. These standards were developed in alignment with international IEC/ISO standards. Specific IEC standards for metocean surveys and analysis are listed in

Table 1. Metocean survey design, data collection and analysis must also meet international certification requirements from organisations such as DNV and Lloyd's.

The standards below give details on the temporal resolution of metocean data required for design. In the early phases, for screening and feasibility studies, a coarse resolution (hourly or monthly averages) is sufficient for layout design, energy production estimation and foundation concept design. At the detailed design stage, high resolution data is required; 10-minute statistics for wind speed and direction, half-hourly statistics and spectra for wave characteristics, as well as extremes. More specific requirements can be found in IEC 61400-3-1, and typical guidance for measurement resolution is presented in '*Metocean data, measurement methods and regulatory considerations for offshore wind development', produced by OWC Consultants* [19].

Table 1 Internation standards for metocean surveys, data analysis and assessment

Standard	Scope
IEC 61400-3-1 (Fixed Offshore Wind) [20]	Specifies design requirements for fixed offshore wind turbines, requiring accurate metocean data (wind, wave, current, water levels) for extreme and operational load cases.
IEC 61400-50-(1, 2 &3):2022 (Remote Sensing) [21, 22, 23]	Specifies methods for using ground-mounted remote sensing devices (e.g., LiDARs, sodars) for wind measurements in site assessment and turbine testing.
IEC TS 62600-101:2024 (Marine Energy) [24]	Focuses on wave energy resource assessment and characterization, applicable to wave measurement campaigns.

Data analysis and output

During the development of offshore wind power projects, typical analyses include: operational climate assessment, extreme climate analysis, and estimation of weather-related downtime.

Operational climate refers to the set of statistical characteristics representing typical metocean conditions at the project site. Operational climate is typically determined by analysing long-term observational data or hindcast models, combined with other sources of information where available. Commonly analysed parameters include:

- Wind speeds by wind direction at different heights.
- Wind shear and veer
- Turbulence intensity
- Extreme wind conditions
- Atmospheric stability, air density, temperature and precipitation.
- Significant wave height, peak period, and wave direction.
- Extreme wave conditions.
- Current: Sub surface currents (speed and direction) measured at different heights in the water column across seasons.
- Water levels: Low-water mark; chart datum; extreme water level; still water level; tidal water level.

Extreme weather refers to the statistical description of abnormal meteorological and oceanographic conditions at the project site. Estimating extreme meteorological and oceanographic events provides a basis for technical design through the frequency of occurrence of extreme conditions at the project site.

To fully reflect interannual variability during design and energy resource assessment, a timeseries of metocean conditions is generated based on the combination of measured and modelled data. The time series used for analysis must be sufficiently long (typically over 30 years) and have high temporal resolution (typically hourly).

3.2 Geophysical survey

Geophysical surveys are non-intrusive and employ remote sensing methods to provide fundamental knowledge about seabed and sub-seabed conditions necessary for the development of offshore wind projects. These surveys characterise the seabed topography, the nature and distribution of surface sediments, subsurface stratigraphy, as well as the presence of natural or man-made objects.

Objectives

Objectives include:

- **Seabed characteristics**: Mapping seabed morphology, depth and sediment distribution to understand surface conditions and identify potential concerns regarding erosion or stability.
- **Subsurface geological interpretation**: Describe shallow strata, identify geological units and map depths to key layers (e.g. bedrock, aquifers, clay layers) to inform foundation design and installation methods.
- **Geological hazard identification**: Detection and assessment of potential hazards including shallow gas accumulation, faults, unstable slopes, mobile sediments, boulders and caves.
- **Artificial object detection**: Identify the location of artificial objects and obstacles, including UXO, debris, shipwrecks, existing pipelines and cables that may affect layout or require relocation.
- **Archaeological assessment**: Identify potential archaeological features and culturally significant sites requiring protection or further investigation.
- **Foundation and cable route planning**: Provide data to support foundation concept selection, optimise preliminary layout and assess cable route corridors.
- **Planning for geotechnical investigations**: Provide information on the location and scope of intrusive geotechnical investigations by identifying representative and anomalous geological areas.

Scope by phase

Phase 1: Desktop study

- Collect available depth data from nautical charts, previous surveys and public databases.
- Review regional geological maps, publications and reports.
- Evaluate available seismic data from oil and gas exploration, academic research and public databases.
- Identify known hazards, shipwrecks and obstacles from the maritime database.
- Analyse gaps to identify data deficiencies requiring field surveys.

The main outcomes of this phase are the data catalogue, preliminary site characteristics, geological risk screening assessment, and proposed scope for Phase 2 field surveys.

Phase 2: Preliminary Field Survey

The preliminary field survey provides wide coverage of the entire project area and cable corridor to confirm the results of the documentation study and develop initial site characteristics. For example, the Thor offshore wind farm in Denmark was assigned a preliminary survey area of 440km^2, which was then narrowed down to 286 km^2 for the installation of turbines after the surveys were completed. The purpose of assigning a larger survey area is to account for results which may leave some parts of the survey area less suitable for establishment [25].

Geophysical surveys require highly specialised equipment and dedicated vessels (illustrated in Figure 3 and listed below), which are different to those used in geotechnical surveys. Due to the high cost of such equipment, clear scoping and early planning of surveys is required to ensure efficiency. Data resolution at this stage is described for each survey type, further guidance is given in [19].

- **Multi-beam echo sounder**: High-resolution depth mapping of the entire survey area to describe the seabed topography and identify morphological features. Unlike a single beam sonar, this technology emits multiple beams across a wider area in order to capture data more quickly and efficiently. Bathymetry is mapped to a resolution of up to 5 m at this stage.
- **Side-scan sonar**: Acoustic imaging of the seabed surface to identify and classify seabed features, obstacles, debris and potential UXO contacts. Surveyed to a resolution of up to 5 m at this stage.
- **Sub-bottom profiler**: Measures shallow acoustic profiles (typically 0 – 20 m below the seabed) to describe near-surface stratigraphy and identify shallow geological hazards. Surveyed to a vertical resolution of 1 to 5 m, and a line spacing tens to hundreds of metres apart.
- **Ultra-High Resolution Seismic source and streamer**: Towed behind survey vessels to measure deeper seismic sections (typically 20 – 100 m below the seabed) to map geological structures and determine foundation conditions. Surveyed with a line spacing tens to hundreds of metres apart.
- **Magnetometer**: Detects ferromagnetic metal objects for UXO reconnaissance and locates buried cables or pipelines. Surveyed with a line spacing 100 – 200 m.

The main results of this phase are preliminary bathymetric charts, seabed feature maps, initial stratigraphic interpretation, geological hazard register, preliminary UXO target list, and recommendations for detailed surveys.

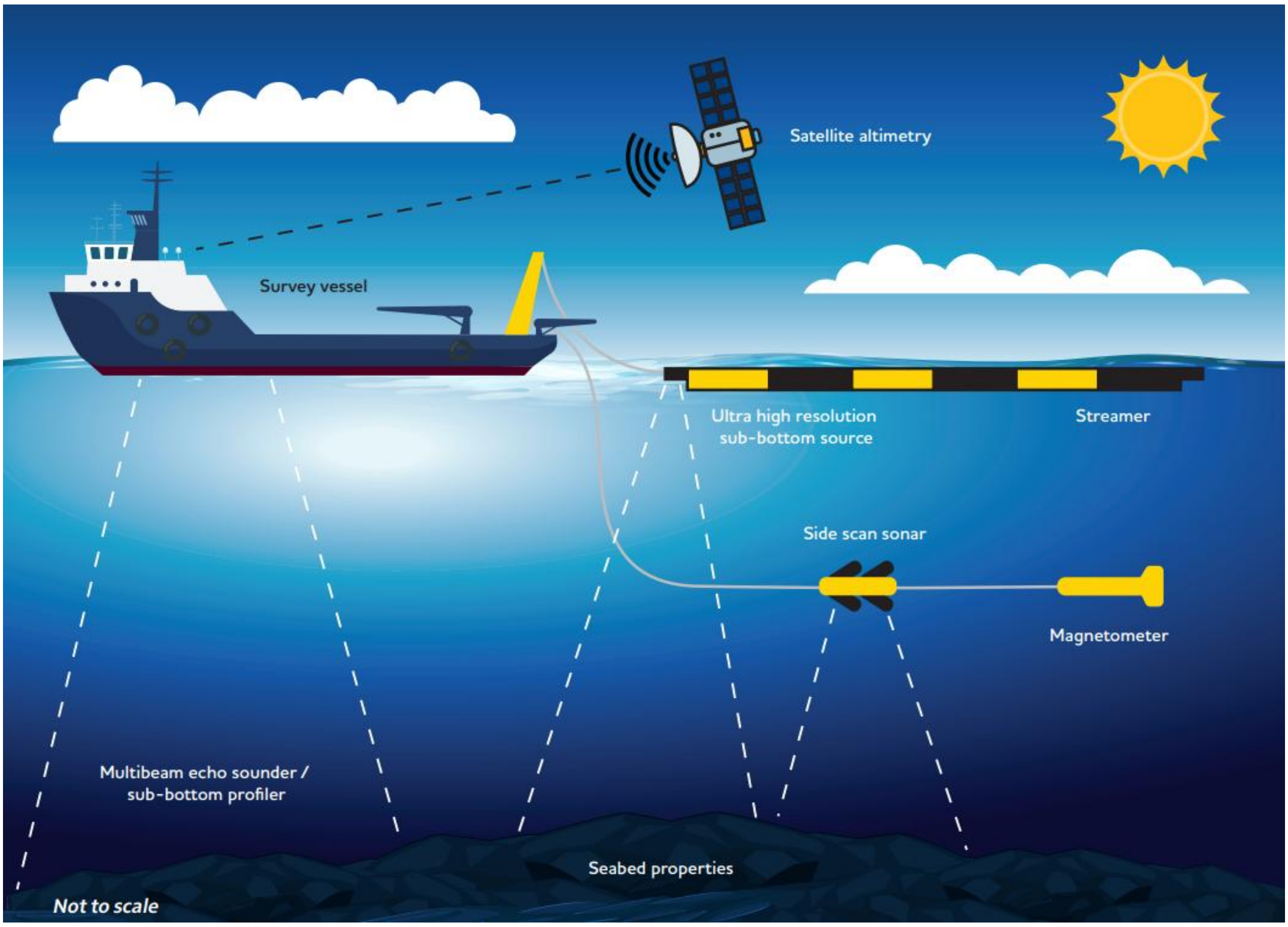

Figure 3 Survey vessel and measurement instruments [26]

Phase 3: Detailed survey

Detailed surveys focus on confirmed turbine locations, offshore substation sites and final cable routes to collect high-resolution data for final design. The main results of this phase are the seabed model and final depth, detailed geological interpretation at selected foundation locations, a list of UXO targets and clearance certification, and an integrated 3D foundation model to be used in the design phase. Data resolution at this stage is described for each survey type, further guidance is given in [19].

Survey technology:

- **High-resolution multi-beam echo sounder**: Detailed depth mapping at infrastructure locations to accurately describe the seabed for high density, precision mapping. Bathymetry is mapped to a resolution of 0.25 m.
- **High-resolution side-scan sonar**: Detailed seabed imaging to identify final obstacles and assess cable route clearance. Surveyed to a resolution of 0.25 m.
- **Ultra high-resolution 3D Seismic**: Collecting three-dimensional seismic data at complex foundation locations to resolve geological uncertainties. Surveyed to a vertical resolution of ~0.1 m for the cable route and ~0.5–1 m for the wind farm site.
- **Multi-sensor magnetometer array**: High-resolution magnetic surveys to verify UXO clearance with a line spacing of 5-10 m.

- Additional specialised surveys as required (e.g., resistivity surveys to assess buried cables, visual inspection using remote operated vehicle for identified contacts).

Applicable standards

Vietnam's Ministry of Science and Technology officially released 20 new National Standards (TCVN) specifically for offshore wind power in 2025. These standards were developed to provide a unified technical framework for the sector and align with international IEC/ISO standards. Where national standards for offshore geophysical surveys are not published, developers are expected to adhere to recognised international standards summarised in Table 2.

Table 2 Recommended international standards and guidelines for geophysical surveys

Standard	Scope
IEC 61400-3 [20]	Offshore Site Assessment, part of the IEC standards framework For offshore wind projects, assessment of external conditions requires understanding soil conditions and seismic factors to ensure structural integrity.
IHO S-44 [27]	Standards for Hydrographic Surveys This publication can be used to define the minimum scope of hydrographic surveys based on different use cases. It does not contain procedures for setting up equipment, conducting surveys, or for processing the resultant data.
IMCA S 003 [28]	Guidelines for Marine Geophysical Operations This document provides comprehensive guidelines for the use of Multibeam Echosounders in offshore surveys, detailing the technical aspects, calibration, data processing, and standards for accuracy.
DNVGL-ST-0126 [29]	Support Structures for Wind Turbines This standard specifies general principles and guidelines for the structural design of wind turbine support structures. Section 7.3 includes guidance on soil investigations.

Data analysis and outputs

Geophysical data processing must follow industry best practices to produce suitable products for engineering design. Data is processed and mapped using Geographic Information System (GIS) software into standardised file types. Typical outputs from survey data analysis includes:

- Bathymetry mapping including tide correction, sound velocity adjustment and data quality filtering
- Sonar underwater slope scanning to map continental slopes, trench walls, or artificial structures.
- Seabed imaging and habitat mapping
- Isopach maps and interpreted cross-sections showing thickness variations of stratigraphic layers.
- Geological hazard register including high-density processed data mapping of shallow subsurface structures.
- Sediment displacement and velocity analysis
- UXO mapping and assessment

3.3 Geotechnical investigation

Geotechnical investigations provide essential subsurface data, which describes the technical characteristics of the ground necessary for foundation design, cable burial assessment, and geological risk assessment. These investigations also inform turbine placement, and ensure structural stability against environmental loads, reducing project risks and costs. The scope of geotechnical work increases progressively through the investigation phases, reflecting the increasing need for detail as the project progressed through the design process. The quality and quantity of geotechnical information impacts project risk, foundation costs, and capital raising potential.

Geotechnical investigations require specialised equipment and dedicated vessels, which are different to those used in geophysical surveys, as well as laboratory testing facilities. Due to the high cost of such equipment, clear scoping and early planning of surveys is required to ensure efficiency.

Objectives

Objectives include:

- **Verifying soil stratigraphy**: Field verification of geological interpretations from geophysical surveys through direct observation of soil and rock types.
- **Soil classification**: Identifying and classifying soil types according to recognised standards (e.g. ISO 14688-1:2017 [30]) to establish a geotechnical profile along depth.
- **Determine technical parameters**: Measure or derive the soil properties necessary for foundation design, including: shear strength (undrained and drained), deformation properties (Young's modulus, shear modulus), consolidation properties, density, dynamic behaviour and response to cyclic loading.
- **Supporting foundation design**: Providing data for analysing the axial and lateral load-bearing capacity of piles, predicting settlement and deformation, assessing pile driving capability, analysing fatigue and dynamic behaviour.
- **Cable burial assessment**: Describe the soil along the cable route to assess burial suitability and select the appropriate installation method.
- **Geological hazard field inspection**: Confirm the nature and extent of geological hazards identified from geophysical surveys through direct sampling and testing.

Scope by phase

Phase 1: Desktop study

This stage involves reviewing available geotechnical data from other projects or studies and identification of potential geotechnical hazards. It is also where data deficiencies are analyses to make recommendations for field surveys.

Phase 2: Preliminary Field Survey

The scope includes a limited number locations within the wind farm area selected based on findings from the desktop survey, plus sampling points along the cable corridor. Testing methods typically include:

- **Cone Penetration Test (CPT)** with pore water pressure measurements. 3 to 5 locations within the project site and every 5 km along the cable route [19].
- **Core sampling** using vibrocore or gravity core sampling at selected locations. 3 to 5 locations within the project site and every 5 km along the cable route [19].

- **Basic laboratory tests**: grading, undrained strength, density.
- **Grab sampling** provides physical ground-truth ensuring accurate interpretation of sediment texture from side scan sonar data and enhancing bathymetric data used for foundation design and cable route planning. Typically taken at a density of 1 per 3 km^2. [31]
- **Thermal testing** to measure heat dissipation through the soil for cable design and routing.

The main results from this phase include a geological model, preliminary soil design parameters, confirmation or refinement of the foundation concept design, and the proposed scope for the detailed geotechnical survey.

Phase 3: Detailed Survey

The detailed geotechnical campaign provides comprehensive, site-specific data for all turbine and substation locations, as well as systematic sampling along the cable route (at 1 km intervals [19]) to support final design and certification.

The scope of the survey depends on the type of foundation; monopile, jacket pile or suction bucket, or gravity foundations. All will require CPT and/or boreholes at the locations, the number and depth required depends on the type of foundation. For solitary wind turbine structures (e.g. monopiles), one boring to sufficient depth for recovery of soil or rock samples for laboratory testing is recommended as a minimum. In cases where soil conditions are highly varying within small spatial areas and foundations with a diameter of more than 20 m are used, more than one boring or more than one CPT per wind turbine position may be needed [29]. Additional locations for potential foundation positions are also recommended to account for the potential to deselect locations deemed unsuitable based on the findings.

Testing methods include CPT with pore water pressure measurement to measure cone resistance, skin friction and pore water pressure, providing data for soil classification and deriving technical parameters. Seismic CPT is used to measure shear wave velocity to support dynamic analysis. T-bar penetration tests, as opposed to a conical rod, are used at sites with soft clay to profile undrained shear strength. Field vane shear tests are used to directly measure undrained shear strength and sensitivity in clay, by inserting a vane and rotating it at a constant rate and measuring applied torque. Piezometers, for example vibrating wire, may also be installed for long-term pore water pressure monitoring if required. These methods, illustrated in Figure 4, can be applied at the seabed surface or, if required, at deeper levels by deploying the test through a borehole.

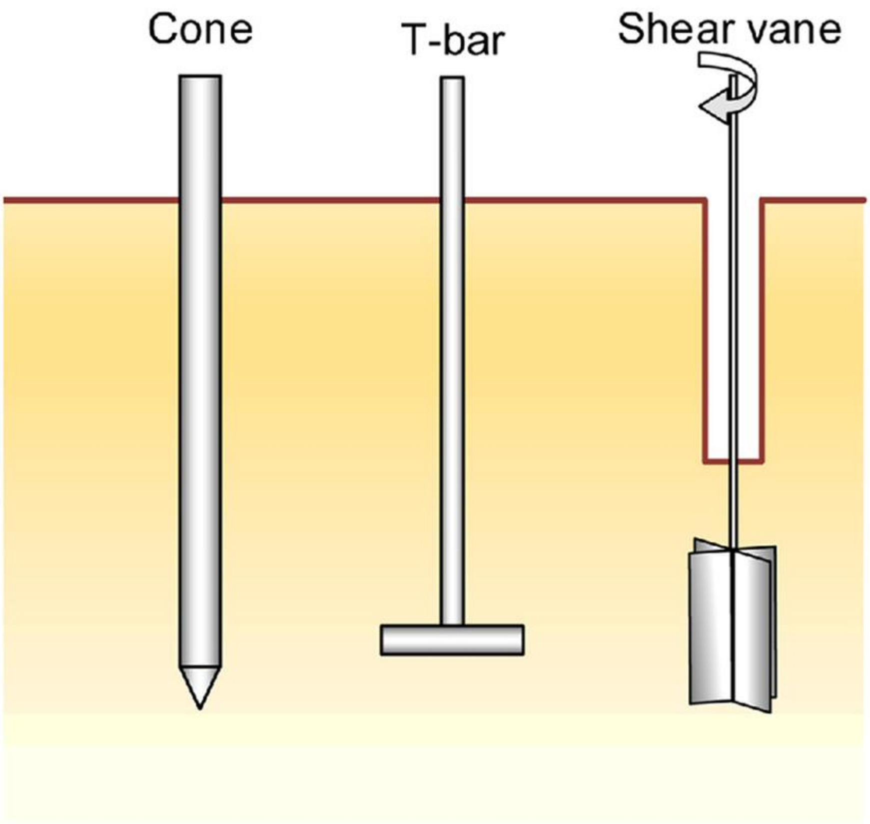

Figure 4 Types of rod used in penetration testing [32]

Sampling is carried out through boreholes using rotary drilling techniques with continuous or point sampling. Sampling equipment includes thin-walled sampling tubes for soft to moderately hard clay, plastic-lined sampling tubes for cohesive soils, and rotary core sampling for rock and very hard/cemented soils.

The laboratory testing programme includes:

- Moisture content, particle size distribution, water content thresholds, and unit weight.
- Triaxial compression tests, direct shear tests, uniaxial compression tests.
- Oedometer testing to determine consolidation coefficient and compression characteristics.
- Cyclic testing, resonance testing for dynamic and fatigue behaviour assessment.
- Chemical testing: pH, sulphate content, chloride content and organic content to assess corrosion.

The cable route survey includes shallow CPT (approximately 5m below the seabed) or vibro-core sampling at regular intervals along the corridor. Supplementary surveys are conducted at intersections, landing points and locations identified as challenging from earlier surveys.

Key results from the detailed geotechnical survey include the final geotechnical design report presenting the design soil profile and soil characteristics for each foundation location, cable burial assessment data for installation method selection, and geotechnical hazard and risk assessments.

Applicable standards

The new TCVN standards issued in 2025 provide design requirements that will be adjusted for Vietnamese geological conditions. These standards are based on internation IEC/ISO standards, and therefore geotechnical surveys must comply with recognised international standards for internationally funded projects, some examples of which are given in Table 3.

Table 3 - International standards, recommended practices and guidelines for geotechnical surveys

Standard	Scope
IEC 61400-3 [20]	Offshore Site Assessment, part of the IEC standard framework For offshore wind projects, assessment of external conditions requires understanding soil conditions and seismic factors to ensure structural integrity.
DNVGL-RP-C212 [33]	Offshore soil mechanics and geotechnical engineering This recommended practice provides guidance for planning and execution of soil investigations as well as guidance for modelling, analysis and prediction of geotechnical capacities of offshore foundations.
DNVGL-ST-0126 [29]	Support Structures for Wind Turbines This standard specifies general principles and guidelines for the structural design of wind turbine support structures. Section 7.3 includes guidance on soil investigations.

Certification bodies recognised by international lenders require geotechnical investigations to comply with recognised standards and be carried out by competent contractors with appropriate quality management systems.

Data analysis and output

Geotechnical data processing must provide suitable outputs for foundation engineering design as well as export and array cable design.

- CPT charts, adjusted pore water pressure, temperature; soil classification; derived technical parameters
- Laboratory test summary table and statistical analysis, design soil cross-section, characteristic values, foundation model
- Integration of geophysical and geotechnical data into a 3D model with design soil profiles at each infrastructure location
- Record of field and laboratory activities. Interpretative report. Design recommendations, geological risk assessment, risk analysis

3.4 Environmental survey

The implementation of offshore wind power projects has environmental and social impacts and must be carefully planned and managed. As part of the process, developers must generate an Environmental Impact Assessment (EIA) alongside the Feasibility Study.

Objectives

The objectives of the environmental survey are:

- To establish baseline environmental conditions in the project area, along the cable corridor and the onshore project area.
- To identify sensitive ecosystems and social aspects that need to be protected.
- To provide input data to support the selection of the project location, scale and layout options.
- Support the preparation of EIA and (pre-)feasibility studies.

Scope by phase

Phase 1: Desktop study

The scope of this phase is to review existing documentation, identify available data sources in the area, and summarise findings, including:

- Collection of existing data sources and analysis of data gaps
- Identification of vulnerable ecosystems (e.g., endangered species or those in/near protected areas or important habitats)
- Investigation into the potential conflicts and coexistence of offshore wind and environmental and social aspects in the project locality.
- Preliminary estimation of environmental and ecological impacts associated with the project
- Consideration of potential cumulative impacts.
- Scoping of field surveys to supplement existing data and fill data gaps.

Based on available data, a comprehensive field survey programme is developed to support the EIA, incorporating resource requirements, budget and implementation plan.

Phase 2: Field survey

This phase commences after the definition of the scope based on the desktop study. Field surveys are launched early owing to seasonal monitoring requirements and extended survey campaigns.

Environmental survey timing depends on the target species but must be representative of annual variation to accommodate species with seasonal behaviour such as migratory birds and breeding marine mammals.

Applicable standards

Projects must comply with national EIA laws [10]. Currently, Vietnam's legal framework and regulations still lack specific guidance for environmental surveys of offshore wind projects. Developers should refer to widely recognised international standards, for example those listed in Table 4. Securing project financing and ensuring bankability from international lenders will require evidence of stringent environmental standards.

Table 4 International standards for environmental surveys, data analysis and assessment

Standard	Scope
ISO 18406:2017. Underwater acoustics [35]	Measurement of radiated underwater noise from percussive pile driving

Data analysis and output

In environmental surveys, typical analyses include:

- **Underwater noise**: Underwater noise often affects marine species through permanent and temporary threshold shifts and behavioural responses. For offshore wind energy, the main sources of noise include: vessels (survey vessels, service vessels, watercraft), geophysical activities (seismic surveys, sonar surveys), foundation installation (pile driving, blasting if applicable), and wind turbine operation.

- **Benthic organisms**: These include benthic animals, corals, seagrasses and marine sediments key components that are typically surveyed to establish baseline data. Survey results should describe and map the distribution of benthic organisms, identify areas of high biodiversity, estimate potential impacts from construction and operation, and carry out additional monitoring as required.

- **Birds and bats**: Including seabirds, migratory birds, migratory bats, fish-eating birds, birds of prey (e.g. sea eagles, cormorants), or mosquito-eating bats. Survey results should describe and map the seasonal distribution and abundance of species, identify migration routes and important habitats, assess collision and disturbance risks, and propose mitigation and monitoring measures.

- **Large marine animals**: Including marine mammals (whales, dolphins, manatees), cartilaginous fish (sharks, rays) and sea turtles. Survey results should indicate the presence, distribution and abundance of species, identify habitat use patterns and sensitive areas (breeding, nursing and feeding areas), assess sensitivity to noise and installation activities, and propose mitigation measures.

- **Fish**: Survey results should describe and map the baseline status of fish species, populations and habitats within the project area. The data collected will support the assessment of impacts on fisheries and ecosystems, and provide information for project design and mitigation measures.

The data gathered during environmental and social surveys are reported in in the EIA, which details the impacts of the development of the offshore wind farm throughout its lifecycle across all areas where its infrastructure is located. The purpose is to ensure compliance with environmental regulations and support the development of mitigation measures to reduce ecological impacts. The key aspects of the EIA scope include**:**

- **Project information**: project origin, investor, approving authority, legal/technical basis, EIA methods used.

- **Technology review**: assessment of selected technologies, project components, and activities that may cause environmental impacts.

- **Physical Environment**: Assessment of hydrography, sedimentology, geochemistry, water quality, and noise/vibration.

- **Biological Environment**: Evaluation of impacts on marine mammals, birds (migration and foraging), fish, and benthic habitats.

- **Human & Socio-economic Environment**: Analysis of effects on fisheries, maritime safety, shipping routes, underwater cultural heritage (e.g., shipwrecks), and visual/landscape impacts.
- **Project Lifecycle**: Consideration of impacts during construction (e.g., piling noise), operation (e.g., electro-magnetic fields, habitat changes), and decommissioning.
- **Impact assessment**: identification and prediction of major environmental impacts and waste during project phases, including impacts on biodiversity, heritage sites, land clearance/relocation, and potential environ-mental emergencies. Assessment of cumulative impacts.
- **Legal compliance**: consistency with environmental protection planning, national/regional/provincial plans, and environmental laws.
- **Mitigation measures**: methods to reduce environmental impacts, environmental restoration/remediation, biodiversity offset plans (if applicable), and emergency response plans.
- **Monitoring plan**: environmental management and monitoring program.
- **Consultation**: results of stakeholder consultations.

The approval of the EIA and the feasibility study mark the end of the survey phase of project development, and the start of the final design phase.

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4

Appendix A

A. Regulatory framework for offshore wind development in Vietnam

Vietnam's offshore wind sector is entering a pivotal phase as the country sets ambitious targets and the need for clean power to support economic growth. Despite strong resources and investor interest, the regulatory framework remains in transition, with recently amended laws and several implementing decrees still under development. Developers must therefore navigate a mix of existing rules and pending guidance. The following section summarises the key legislation and regulatory mechanism shaping offshore wind development in Vietnam.

A1. Current regulatory framework

The offshore wind planning and target: The revised PDP8 outlines eight offshore wind projects totalling 6,000 MW, with designated areas in the North, South Central, and Southern regions of Vietnam. Additionally, a capacity target of 11,032 MW has been set for 2035.

The Maritime Spatial Plan (MSP) for 2021-2030, with a vision to 2050, was approved in June 2024 [5]. The MSP establishes a zoning system to promote clean, renewable energy and the development of new marine industries. It also provides the framework for offshore wind site selection and zoning. However, both the current MSP and the revised PDP8 do not specify exact geographical areas for offshore wind projects. As a result, the allocation of sea areas for offshore wind development will require a consultation process led by the Ministry of Agriculture and Environment (MAE), with all relevant ministries to avoid overlaps and conflicts in marine resource use.

Clear definition for offshore wind power project: The Law on Electricity 2024 provides definition of wind power projects at sea, which are now classified as either “nearshore” or “offshore” projects. An offshore wind project is one in which all turbines are located in marine areas beyond six nautical miles from the shore within Vietnam's territorial waters. This definition aligns with the distinct technical characteristics and legal frameworks applicable to each type of project.

Assignment of sea area: Decree 65/2025/NĐ-CP [36] and decree 11/2021/ NĐ-CP [37] introduce regulations for sea area allocation, including specific grounds for rejecting applications that overlap with defence zones, protected ecosystems, or existing marine infrastructure. The decree also clarifies the application process and strengthens coordination among the MAE, MOIT, defence authorities, and provincial governments. Overall, the decree establishes a more structured and predictable process for securing sea use rights for OSW projects.

Decree 58/2025/NĐ-CP [4] stipulates that the maximum sea area for site surveys is 20 hectares per 1 MW, while the maximum sea area for offshore wind farm construction is 5 hectares per 1 MW (equal to 5 MW/km^2). Based on the development of wind power technology over time, MOIT may propose adjustments to the specified sea area limits.

Offshore wind survey: The Law on Electricity 2024 [3] and Decree 58/2025/ NĐ-CP [4] have provided regulations on the conduct of site investigations for implementation of OSW projects. According to these, the OSW survey shall be implemented by either a 100% state-owned enterprise assigned by the Prime Minister or an entity selected in accordance with procedure promulgated by the Government. Decree 58 [4] specifies detailed requirements for selection of entities to conduct OSW survey, survey contents, survey data reporting and handling.

In terms of surveyed data, the surveying entity is required to submit the data to MAE and MOIT within 60 days from completion of survey activities.

Project approval and investor selection: The resolution 253/2025/QH15 [17] of the National Assembly has opened the door for a wide range of investors to participate in offshore wind development. Accordingly, not only state-owned enterprises but also private companies, including domestic firms and those with foreign investment, are eligible to take part. Criteria for investors seeking to develop offshore wind projects in Vietnam will be detailed by the Government.

For the first 6,000 MW, investors will be selected through direct assignment. To shorten the approval timeline and create favourable conditions for investors, the Prime Minister will approve the investment policy and simultaneously assign the project to the selected investor, instead of using a competitive bidding process. This mechanism will apply until January 1, 2031.

For the capacity planned for the period 2031-2035, selection of investors will follow the existing regulation. The provincial authorities are mandated to approve the investment policy. In both cases, whether a project is directly assigned or an investor is selected through bidding, the proposed price submitted by the selected investor must fall within the annual pricing framework set by the government and will serve as the maximum price for negotiating and concluding the power purchase agreement with the electricity buyer.

Development incentives: Decree 58/2025/ND-CP [4] sets out specific development incentives for offshore wind projects that obtain investment approval before January 1, 2031, as follows:

- Exemption from the sea area use fee during construction for up to three years from the commencement of construction, followed by a 50% reduction in sea use fees for a period of 12 years.
- Exemption from land use tax or land rent during construction for up to three years from the commencement of construction. After this exemption period, any further exemptions or reductions will be applied in accordance with land and investment laws.
- Project selling electricity to the national power grid are entitled to a minimum long-term contracted electricity offtake of 80% during the loan repayment period, for up to 15 years

Tariffs and PPAs: Electricity tariffs for offshore wind projects supplying the national grid will be negotiated in accordance with Circular 12/2025/TT-BCT [38], but may not exceed the annual tariff cap set by the MOIT. Circular 12 sets out the core mandatory contents of the PPA, including the rights and obligations of the parties during the power sector restructuring and the transitional period of the competitive power market; the transfer of the seller’s rights and obligations; the payment of fees, taxes, and other liabilities arising during PPA performance; the governing law; the contract language; and the tariff calculation method. The parties may negotiate additional terms, provided they remain compliant with Vietnamese law.

A2. Governance structure and Institutional roles

- **The Prime Minister:** According to the Law on Government organization [39], the Government and Prime Minister issue decrees, regulations and mechanisms for management of energy activities, approval of energy development strategies and plans and decisions on policies for energy tariffs, large scale projects or especially important projects.

- **Ministry of Industry and Trade (MOIT):** Overseeing activities in the energy sector, including offshore wind development. Its mandates include developing national power development plans and proposing policies and mechanisms for power sector growth. The ministry also appraises investment dossiers for power projects, ensuring alignment with the PDPs and compliance with relevant technical requirements.

- **Ministry of Agriculture and Environment (MAE):** Is responsible for the state management of seas and islands, with key mandates including developing and submitting MSPs for approval, overseeing compliance with regulations on the use of marine areas, and issuing sea survey permits. The ministry also reviews and appraises environmental impact assessment (EIA) reports for projects under its authority.

- **Ministry of National Defense (MND) and Ministry of Public Security (MPS):** Although these ministries do not assess the economic or technical aspects of offshore wind projects, they play a critical role in providing opinions related to national defense and security. All offshore wind projects must obtain their approval before site investigation can begin. This national security approval is not a simple consultation; it is a non-negotiable prerequisite. In cases where these ministries raise objections, the project will be rejected.

- **Ministry of Finance (MOF):** MOF acts as the lead authority for coordinating and appraising investment policy decisions under the Prime Minister's jurisdiction. It reviews project dossiers, facilitates inter-ministerial consultations, and consolidates inputs on all aspects of proposed projects. Based on this appraisal, MOF submits recommendations and proposed conditions to the Prime Minister for final decision.

- **Ministry of Science and Technology (MOST):** Is responsible for developing national technical standards (TCVN) for the sector. In 2025, MOST introduced a comprehensive set of 20 new TCVNs for offshore wind, marking a significant milestone for the industry. While they do not yet include standards for site investigation surveys, developers are advised to follow recognized international standards (such as IEC, ISO, DNV) until national standards are established.

A3. Offshore Wind Power Project Development Process

A3.1. Preparation phase

- **Marine area use licensing:** the proposed OSW project must be included in the PDP or the Implementation plan of PDP, also consistent with other plans such as MSP [5]. According to Clause 1, Article 27 of the Law on Electricity 2024 [3], offshore wind project surveys shall comply with Law of the Sea [40], Law on Natural Resources, Environment Of Sea And Islands [41], and Law on Construction [42], international treaties to which Vietnam is a member, and international practices. The application for sea area use is detailed in Decree 11/2021/ NĐ-CP [37] and Decree 65/2025/ NĐ-CP [36].

- **Conduct preliminary site investigation and wind potential assessment**: including wind measurement and data analysis to determine the generation potential of the area under Article 27 of Decree 58/2025/NĐ-CP [4].

- **Preparation of pre-feasibility study:** in accordance with the Law on Construction [42], projects subject to the Prime Minister's jurisdiction for approval of investment policy are required to prepare a pre-feasibility study. Article 53 of the Law on Construction stipulates the required contents of the pre-feasibility study report.

- **Preliminary Environmental Impact Assessment:** investors shall prepare environmental impact assessment (EIA) reports in accordance with the Law on Environmental Protection [10].

- **Submission of investment policy proposal:** investors shall prepare dossiers to propose approval of investment policy for offshore wind power projects under Article 28 of the Law on Electricity 2024 [3].
- **Investment policy approval:** for projects covering the 6,000 MW as planned in PDP8 for the period until 2030, dossiers should be submitted to MOF for appraisal and obtaining investment policy approval from the Prime Minister. Other projects will follow the existing regulation.
- **Issuance of an Investment Registration Certificate (IRC):** MOF or provincial authority where the project is implemented issues the IRC in accordance with the Law on Investment and the specific delegation of authority stipulated in the Prime Minister's decision approving the investment policy.

A3.2. Implementation phase

- **Feasibility Study (FS):** Preparation and approval of the feasibility study, including basic design, construction investment, economic-technical report in compliance with the Law on Construction. In accordance with Article 29 of Decree 58/2025/ND-CP [4], the competent authority is responsible for appraising the relevant technical contents of the feasibility study within 24 months from the date of signing the business investment project contract.
- **Environmental Impact Assessment:** prepared after the investment policy has been approved and is a mandatory requirement for the approval of the feasibility report and the implementation of the project.
- **Signing sector-specific agreements:** Grid connection agreement; Electricity metering agreement; Protection relay coordination and automation agreement; SCADA and telecommunications agreement, according to Circular 05/2019/TT-BCT [43] on the regulation of transmission, distribution and electricity metering systems.
- **Negotiation of the PPA:** In accordance with Article 29 of Decree 58/2025/NĐ-CP [4], within 30 months from the date on which contract of business investment project is signed, the buyer and investors shall have the responsibility and obligation to negotiate and decide PPA prices to in order to conclude PPA.
- **Construction survey**: Conduct detailed geophysical, geotechnical, and metocean surveys in accordance with Section 1 of the Law on Construction 2020 [42]. Construction surveys can be carried out immediately after the project's investment policy has been approved and assigned to the investor, and they serve as the basis for construction design.
- **Construction Design**: Carry out construction design and design appraisal in accordance with Section 2 of the Law on Construction 2020 [42].
- **Construction**: Proceed with the construction of the project in accordance with the approved design. Note that offshore wind power projects are exempt from construction permits under the Law on Construction 2020 [42].
- **Grid connection**: Complete procedures to connect the project to the national grid.
- **Trial operation:** testing, and official commissioning.
- **Commercial operation**

A3.3. Current process and regulatory challenges

- **Maritime Spatial Planning**: Vietnam's MSP is under continuous development. Key challenges include the absence of clearly designated offshore wind zones in existing plans, and the need to better coordinate energy development with other marine uses such as fisheries, shipping, and conservation.

- **Inter-ministerial consensus**: Achieving agreement among ministries on areas designated for offshore wind development remains challenging. In cases of conflict, there is no clearly defined mechanism for inter-ministerial negotiation or dispute resolution. Within the MSP framework, offshore wind is currently treated as a lower priority compared to other marine uses.

- **Complex and lengthy approval processes**: Licensing and administrative procedures remain complicated and time-consuming, prolonging project implementation and reducing overall project attractiveness. There is a need for a clear and agreed roadmap with deadlines for involved authorities.

- **No requirement for site survey prior to investment policy approval**: the Law on Construction [42] only sets out a general framework for construction investment projects and does not require the conduct of a project's preliminary site investigation. The Law on Electricity 2024 [3] includes provisions on site surveys for OSW power development, but does not clearly specify at which stage of the project such surveys must be carried out. Therefore, investors may submit an application for approval of the project's investment policy without conducting a field survey. In such cases, all related risks are borne by the investor.

- **Unclear approval authority for projects from 2031 onward**: The new resolution of the National Assembly clearly specifies that the Prime Minister has approval authority for projects within the first 6,000 MW. Projects outside this scope will be implemented in accordance with existing laws. Accordingly, it can be understood that investors for projects planned for the period from 2031 onward will be selected through a bidding process. However, the authority to decide on the investment policy and to organize the bidding process for these OSW power projects has not yet been clearly defined under the current legal framework.

- **Evolving regulatory landscape**: Over the past year, numerous laws, policies, and implementing regulations in the energy and investment sectors have been newly issued or amended to address implementation bottlenecks and attract investment in the power sector. However, the legal framework specific to offshore wind development remains incomplete, lacking sufficient clarity. As a result, investors face significant uncertainty due to the lack of long-term policy vision and regulatory certainty, which increases project risks and investment costs.

A4. References

36. Decree 65/2025/NĐ-CP, Amendments to some articles of decree no. 40/2016/nd-cp dated May 15, 2016 of the government detailing the implementation of some articles of the law on resources and environment of seas and islands and decree no. 11/2021/ NĐ-CP dated February 10, 2021 of the government on assignment of certain sea areas to organizations and individuals for exploitation and use of marine resources
37. Decree No. 11/2021/ND-CP dated February 10, 2021 on assignment of certain sea areas to organizations and individuals for exploitation and use marine resources
38. Circular No. 12/2025/TT-BCT dated February 01, 2025 on methods for determining electricity generation service price; rules for determining electricity price for electricity project implementation; main contents of power purchase agreement
39. Law No. 63/2025/QH15 Law on Government Organization, February 18, 2025
40. Law No. 18/2012/QH13 Law on Vietnamese Sea, June 21, 2012
41. Law No. 82/2015/QH13. Law on Marine Resources, Environment, and Islands (2015).
42. Law No. 50/2014/QH13. Law on Construction, effective since January 01, 2015
43. Circular No. 05/2019/TT-BCT, amendments to Circular 16/2017/TT-BCT on development of solar power projects and standard form power purchase agreement (PPA) thereof. March 11, 2019