Comprehensive Study Report

Development of the National Standards for Offshore Wind Power (OWP) – Vietnam

ETP - UNOPS

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Chapter 1. Executive Summary

1.1 Brief overview of the study

Vietnam has a vast coastline of over 3000 km, presenting a promising opportunity for the development of Offshore Wind Power (OWP). This could play a significant role in meeting the country's surging electricity demand sustainably. The transition from fossil fuels to OWP could also provide an economic boost, environmental benefits, and energy security and help achieve decarbonization targets. Recognizing the potential of OWP, the Vietnamese government has emphasized its importance as one of the nation's economic focuses in Resolution No. 36/NQ-CP and No. 26/NQ-CP.

Although Vietnam has made significant achievements in realizing onshore and nearshore wind projects in recent years, there are currently no operational offshore projects in the country. Nevertheless, Vietnam has set an ambitious target of achieving 6 GW of offshore wind power by 2030 as outlined in the Power Development Plan (PDP) VIII.

The absence of national standards (TCVNs) tailored specifically to offshore wind power (OWP) has been recognized as a significant obstacle to the advancement of offshore wind energy in Vietnam. This technical assistance project aims to create a comprehensive set of national standards for OWP. This initiative adheres to governmental procedures for the development and approval of national standards as mandated by the Ministry of Science and Technology (MOST). It is a collaborative effort between the ETP and the Directorate for Standards, Metrology, and Quality (STAMEQ), which operates under MOST. The primary goal of this project is to formulate a comprehensive set of standards, thereby promoting the deployment of renewable energy in Vietnam through the establishment of these national standards.

This extensive investigation endeavors to meticulously examine the present status of Offshore Wind Power (OWP) in Vietnam and construct a comprehensive strategy for the advancement of Vietnam's Technical Standards (TCVNs), by governmental guidelines. The assessment encompasses defining OWP, appraising regulatory frameworks, evaluating current industry standards, and pinpointing crucial technical criteria. Furthermore, the study broadens its horizon to undertake a comparative analysis encompassing five nations: Taiwan, Korea, the United Kingdom, Germany, and the Netherlands, to extract valuable insights from global offshore wind standardization practices. Overall, this study offers valuable insights and direction for shaping regulatory frameworks and technical standards to advance OWP in Vietnam.

The report is structured into seven chapters, starting with an Introduction in Chapter 2 that outlines the research questions and emphasizes the importance of standards. Chapter 3 defines Offshore Wind Power (OWP) in Vietnam and examines the current status and application of technical regulations and standards for nearshore and offshore projects. It also scrutinizes the hierarchical structure of technical standards in Vietnam, highlighting any disparities from international norms.

In Chapter 4, a thorough examination of global policies, regulations, and standards is conducted, featuring case studies of offshore wind standards development in five countries. Efforts to promote offshore wind power initiatives are expected to accelerate industry growth and facilitate the establishment of national standards, guided by a comprehensive understanding of the regulatory landscape governing offshore wind projects.

Chapter 5 addresses the need for specific offshore wind power development standards suitable for Vietnam. By analyzing these requirements and identifying gaps compared to countries with extensive offshore wind experience, the research team proposes a list of 20 TCVNs to address these disparities and support the implementation of OWP projects in Vietnam.

Chapter 6 outlines the methodologies and approaches for developing these TCVNs, including team organization and responsibilities. The proposed national standards will draw on international best practices and expertise from countries with advanced OWP development. A roadmap for the creation of these standards will be meticulously crafted and aligned with project deliverables for seamless implementation.

Finally, Chapter 7 presents the Consultant's conclusions and recommendations. It assesses how identified gaps impact the overall progress of OWP project development in compliance with regulations. Moreover, the standards proposed serve as invaluable guidance for stakeholders spanning designers, suppliers, purchasers, operators, and regulators across the developmental, implementation, and operational phases of OWP facilities.

1.2. Key findings and recommendations

Currently, Vietnam has made significant progress in formulating technical standards to oversee diverse sectors, including renewable energy. However, there appears to be a gap in specific standards about OWP. Although the current Technical Standards of Vietnam (TCVNs) regarding wind energy offer a foundational framework, they may require further enhancement to adequately address the multifaceted aspects of offshore wind development and ensure alignment with international norms and best practices.
During our investigation into international standards across five countries and the current standards situation of OWP in Vietnam, it came to our attention that there are three overlapping TCVN standards. The Consortium proposes replacing these overlapping standards with other standards that can serve as appropriate technical guidelines for designers, investors, and regulatory authorities during the project preparation phase. Consequently, after presenting to the Directorate for Standards, Metrology, and Quality (STAMEQ) and receiving approval from STAMEQ, the proposed replacement standards include:

1. Update the version of TCVN 10687-1:2015 (IEC 61400-1:2014—Wind turbines — Part 1: Design requirements) according to IEC 61400-1:2019.
2. Update the version of TCVN 10687-24:2018 (IEC 61400-24:2010- Wind turbines - Part 24: Lightning protection) according to IEC 61400-24:2019.
3. Submarine power cables – Test methods and requirements. The reference standard is IEC 63026.

Three have been selected to replace the overlapping TCVN standards. The refined standard portfolio, based on feedback regarding the essentiality of these standards and recommendations from STAMEQ, has been meticulously developed. During the technical council meeting of STAMEQ, ISSQ received strong support for the proposed list of standards, and has now received official approval. This strategic decision marks a significant step forward in establishing a robust framework for offshore wind power national standard development in Vietnam, ensuring alignment with international best practices and addressing the specific needs of the sector.

Chapter 2. Introduction

2.1 Project Background

This study for the United Nations Office for Project Services (UNOPS) supports the Government of Vietnam in developing Vietnamese National Standards (TCVN) for Offshore Wind Power. The Offshore Wind Power (OWP) standards in Vietnam are essential and fundamental for the planning, investigations, testing, manufacturing, endorsement, licensing, construction, operation, and maintenance, as well as the decommissioning process of offshore wind power projects in Vietnam. The development of Standards is paramount for government officials to facilitate the integration of OWP and safeguard a safe, efficient, and sustainable energy system.

The project is carried out by the Consortium, which consists of the Institute for Standard and Quality Development Studies (ISSQ; consortium lead), Pondera Consult B.V. (PONDERA), the National Center for Water Resources Planning and Investigation (NAWAPI), and senior experts from Power Engineering Consulting Company No.1 (PECC1).

The entire project covers the following ten deliverables:

1. Inception Report
2. A comprehensive study report.
3. Draft of the National Standards (TVCN) for OWP according to the list agreed with STAMEQ.
4. Two hybrid-mode consultation workshops will gather feedback and contributions on the draft TCVNs. The workshop proceedings will be collected one week after each event.
5. Trips to international labs in countries with solid experience in the management of OWP and reports, including lessons learned and recommendations for TCVNs in Vietnam
6. Reports on testing principles, practicality of TCVNs, and categorization of mandatory and optional standards
7. The final draft of the TCVNs for OWP was submitted to the Appraisal Council based on the comments and feedback from different stakeholders and in close consultation with STAMEQ.
8. A complete dossier of TCVNs on OWP to submit to MOST for promulgation.
9. Organization of the Final stakeholder workshop and the final workshop report
10. The final Completion report

As seen from the above list, this comprehensive report fulfills deliverable 2. It follows the Inception report submitted to the client in April 2024. The report serves as background information for the client and direct beneficiaries of the project.

2.2 Objective

This comprehensive study aims to address the need to establish national standards for offshore wind power (OWP) in Vietnam. By first analyzing the current state of OWP in Vietnam, including its technical regulations, industry standards, and technical requirements, and second by researching the standards of advanced countries in OWP, this comprehensive study seeks to lay the groundwork for the development and approval of a comprehensive set of Vietnamese National Standards (TCVN) for OWP. These include, amongst others, design requirements for wind turbine components, methods for evaluating wind turbine performance, and techniques for monitoring and controlling wind power plants.

2.3 Research questions and methodology

To reach the objective of this comprehensive study, the following methodology is applied: (i) collect information about the current state of OWP in Vietnam, (ii) study the international standards on OWP, and

(iii) conduct desk surveys of the current status of technical regulations and standards applied in nearshore and offshore wind power projects in Vietnam, and make a comparison with international standards, and (iv) make recommendations on OWP standards to be developed and implemented in Vietnam.

This has been operationalized in the following study questions to be answered:

1. What is the current state of OWP in Vietnam?
    a) What is the hierarchy and status of technical standards in nearshore/offshore wind power projects in Vietnam?
    b) What is the status of standards applied in nearshore/offshore wind power projects in Vietnam?
2. What are the current states of policies, regulations, and standards for OWP internationally?
    a) What are five suitable reference countries for Vietnam?
    b) What are relevant international and national standards related to OWP?
3. What standards are required in Vietnam for OWP to be developed successfully?
    a) What are the current gaps related to standards for OWP in Vietnam?
    b) What is the proposed list of standards for OWP in Vietnam that should be developed?
    c) What content needs to be included in the standards for OWP in Vietnam?
4. How can the proposed list of standards for OWP in Vietnam be developed?
    a) What is the Consortium's approach to developing the standards?
    b) What is a suitable roadmap for developing the standards?

2.4 The purpose of using standards.

A technical standard is a recognized criterion or prerequisite for a repeatable technical task. It is a formal document that sets uniform procedures, practices, processes, and engineering or technical criteria. Essentially, Offshore Wind Power technological standards offer a clear group of specifications for the item, system, service, performance, and other components. The main intentions of standards are (i) Establish a defined target level of safety for the system to guarantee that human health and safety are not jeopardized, as well as ensure that performance (e.g., energy production) as the structural integrity of the installations meet the target safety and reliability levels. (ii) Establish uniformity regarding terminology, product specifications, protocols, processes, and more across manufacturers, designers, utilities, government agencies, and other stakeholders. (iii) Formalize the technical parts of a project contract or procurement agreement, such as the precise material performance requirements and others.

National or worldwide consensus-based organizations such as IEC, ISO, or API create technical standards for offshore wind. Additionally, businesses can create standards unique to their organization, as is practice for Oil and Gas companies, for example, to maintain the same approach, working methods, and safety standards regardless of the geographical location of their operations.

Standards may be mandatorily enforced through government legislation; however, more often, they are agreed upon and required by all stakeholders (e.g., banks, investors, contractors) rather than being a legal requirement. There are standards applicable throughout all project phases of offshore wind farms, for example, for the design of wind turbines, construction of wind farms, operations and maintenance, and power delivery to the electricity grid.

2.5 Reading guide

- Chapter 3 describes the existing technical documents, including technical regulations, standards, and project requirements on OWP in Vietnam.
- Information about international standards on OWP is collected from relevant data from trusted resources. The results of this part of the study are included in Chapter 4.

- The results, together with insights obtained through the technical expert teams' practical experience, led to identifying gaps and developing a recommended list of standards for OWP projects, which is documented in Chapter 5.
- The essential findings, combined with the deliverables of the previous research questions and the researchers' expert judgments, will lead to the roadmap in Chapter 6.
- Chapter 6 presents the proposed list of National standards and a Roadmap to develop them, while Chapter 7 gives the conclusions and recommendations of this comprehensive study.

Chapter 3. Current Technical Regulations and Standards of OWP in Vietnam

This chapter is guided by the main research question: ''What is the current state of OWP in Vietnam?" and is divided into four sub-questions:

a. What is the definition of OWP in Vietnam?
b. What is the hierarchy of technical standards in Vietnam, and any differences to international practices?
c. What is the current status of technical regulations applied in nearshore/offshore wind power projects in Vietnam?
d. What is the current status of standards applied in nearshore/offshore wind power projects in Vietnam?

3.1 Definition of OWP

In Vietnam, the distinction between nearshore and offshore wind energy depends on the distribution of authority between national and provincial governments. Circular 19/2023/TT-BCT, dated November 2023, on providing methods for determination of frame price for solar and wind power generation plants, Article 2, clause 7, specified the definition for Offshore Wind Power Plant is "Offshore Wind Power Plants are grid-connected wind power plants where the centers of the foundation of the wind turbines built beyond the six nautical miles seaward[1]."

Circular 11/2021/NĐ-CP, dated February 19, 2021, Regulation on Assigning Certain Sea Areas to Organizations and Individuals for the Exploitation and Use of Marine Resources, Article 2, Clause 5 specified the definition of the six nautical miles seaward: a line that is six nautical miles from the lowest average seawater edge over many years.

3.2 Project phases of offshore wind farms/elements of an offshore wind farm

Regarding Decree 15/2021/NĐ-CP, on elaborating specific regulations on the Management of Construction projects, Article 4, the project phases of an offshore wind farm shall encompass a step-by-step progression from conception to operation. In Viet Nam, Offshore Wind Power (OWP) projects will likely involve the following key stages:

- Selection of the site and Inclusion of the project in the National Power Development Plans (NPDP) if the project still needs to be specified in the NPDP;
- Pre-feasibility study (if required) and project proposal;
- Project development surveys and site investigations, Feasibility Study, and Basic Design completed with Environment and Social Impact Assessment (ESIA), Agreement with authorities regarding maritime, aviation, fire protection and electric power system, land and sea surface usage, …, Power Purchase Agreement (PPA) with the Off takers;
- Technical Design and application for Permitting and Licensing;
- Project implementation, including financing and contracts, manufacturing and procurement, construction and installation, and commissioning;
- Operation & Maintenance (O&M);

[1] The 6-nautical-mile is the boundary of jurisdiction for deciding the maritime area between the Ministry of Natural Resources and Environment (MONRE) and the Provincial People's Committee, as per stipulated in Decree 11/2021/ND-CP, Article 8, Clauses 2 and 3, On assignment of certain sea areas to organizations and individuals for exploitation and use of marine resources.

- Decommissioning.

An offshore wind power project typically comprises the following main elements:

- An offshore wind farm includes offshore wind turbines and generators, offshore substations, and inter-array submarine cables that connect strings of wind turbines to the offshore substations.
- Submarine export cables connect offshore substations to the onshore substations.
- An onshore substation connects the power plant to the power system.
- Onshore facilities support the operation and maintenance (O&M) activities of the power plants.

3.3 Current status of technical regulations applied in OWP projects in Vietnam

National Technical Standards

The technical regulation framework in Viet Nam consists of technical regulations (QCVN), national standards (TCVN), industrial standards (TCN), and institution standards (TCCS). The principles for application of standards are stipulated in Law 68/2006/QH11 on standards and technical regulations, article 23 that 1. standards shall be applied on the principle of voluntariness. The application of part or the whole of a specific standard shall become mandatory when requested in a legislation document or technical regulation; 2. Industrial and institutional standards shall be applied within the scope of management of organizations that announce them.

A competent state agency promulgates a technical regulation for mandatory application. The principles for and methods of application of technical regulations are stipulated in the forgoing Law (law 68/2006/QH11), article 38.

The current hierarchy of technical regulations and standards in Vietnam is described in the following order:

- Law on Technical Regulations and Standards
- National/Regional Technical Regulations (QCVN)
- National Standards (TCVN)
- Institutional Standards (TCCS)

Based on Vietnam's current laws regarding national standards and regulations, the Consortium focuses on studying the current status of national standards for nearshore/offshore wind power projects in Vietnam.

Technical regulation framework

Current technical regulations relating to the development of OWPs consist of the following:

- QCVN 01:2021/BXD, National technical regulation on construction planning.
- QCVN 02:2022/BXD, National Technical Regulation on Natural Physical and Climatic Data for Construction.
- QCVN 03:2022/BXD, National Technical Regulation on Classifications of Buildings and Structures for Design.
- QCVN QTĐ 05:2009/BCT, National Technical Codes for Testing, Acceptance Test for Power Facility.
- QCVN QTĐ 06:2009/BCT National Technical Codes for Operating and Maintenance Power System Facilities.
- QCVN 07: 2009/BCT, National Technical Codes for Installation Power System Project.
- Electrical Equipment Regulation 11 TCN 18:2006.

Technical regulation QCVN 01:2021/BXD

The technical regulation QCVN 01:2021/BXD is issued by the Ministry of Construction under Circular No. 01/2021/TT-BXD dated May 19, 2021, by the Minister of Construction. This technical regulation specifies the limited levels of technical characteristics and mandatory management requirements that must be complied with in planning activities for district areas, inter-district areas, urban planning, and rural planning. It includes the processes of drafting, appraisal, approval, adjustment of planning, and organizing the implementation of planning. This regulation serves as a basis for the development of national standards and local laws in the field of urban-rural planning. It does not contain specific technical requirements for offshore wind power construction planning.

Technical regulation QCVN 02:2022/BXD

The technical regulation QCVN 02:2022/BXD is issued by the Ministry of Construction under Circular No. 02/2022/TT-BXD dated September 26, 2022, by the Minister of Construction. This technical regulation specifies the natural condition data applicable in the preparation, appraisal, and approval of construction activities. This includes construction planning, development of construction investment projects, construction design, construction execution, supervision of construction, and management of construction investment projects in Vietnam. The content of the standard has provided complete data for design purposes, including data on climate, weather, adverse natural phenomena, lightning density, wind, and earthquakes. The natural condition data specified in the regulations are helpful for the Pre-FS documentation phase. In subsequent design phases, specific surveys such as seabed topography, geology, and meteorological and hydrological conditions should be conducted according to the objectives established for the particular project's design class.

Technical regulation QCVN 03:2022/BXD

The technical regulation QCVN 03:2022/BXD is issued by the Ministry of Construction under Circular No. 05/2022/TT-BXD dated November 30, 2022, by the Minister of Construction. This regulation stipulates classifications of buildings and construction structures based on the following:

a. Consequences caused by damaged or destroyed structure elements (hereinafter referred to as "consequence class");
b. Design lifetime of buildings and structures;
c. Fire-related technical classifications of buildings and structures include fire-resistance category, fire risk level of structure, and fire risk category by occupancy;
d. The consequence classes of constructions are divided into three classes: C1 (Low), C2 (Moderate), and C3 (High), as specified under Annex A of the regulation. Offshore wind turbines, with large structures typically exceeding 100 meters in height, fall into the consequence class C3 (High consequence class). Moreover, the TCVN 10687-1:2015 (IEC 61400-1:2014), international standards IEC 61400-1:2019, and IEC 61400-3:2019 categorize wind turbines into four classes (I, II, III, and S) based on annual average wind speed and reference wind speed. This classification discrepancy could cause difficulties for investors, designers, and government-competent authorities during project design, appraisal, implementation, and acceptance.

The design lifetimes are divided into four levels: 1,2,3 and 4, with a lifetime of 20, 25, 50, and 100 years, respectively. The OWPs are categories to energy construction projects (industrial sector); the design lifetime of offshore wind turbines shall be at least 50 years as per regulation in Table 01 of technical regulation QCVN 03:2022/BXD. However, international standards IEC 61400-1:2019 and IEC 61400-3:2019 specify that the designed lifetime for wind turbines shall be at least 20 years. This discrepancy potentially causes difficulty for investors, designers, and government-competent authorities in the progress of design, appraisal, implementation, and acceptance of the projects.

The fire resistance is divided into five categories: I, II, III, and V, depending on the number of stories (or fire service height of construction), fire risk category by occupancy, fire compartment area, and fire hazard of technology process within the constructions. Fire risk levels of structural elements are divided into S0, S1, S2, and S3, depending on the fire risks of the elements. The fire risk category by occupancy (hazard occupancy) is classified into five fire risk categories by occupancy of F1, F2, F3, F4, and F5 depending on use characteristics and threat to human safety in case of fire, considering age, physicality, possibility of people sleeping, number of occupied people. Currently, national technical regulations still need to be put in place to guide fire prevention and firefighting measures for offshore wind power projects precisely. This potential causes inconsistent design of fire protection among projects and between the appraised design documents and actual supplies provided by suppliers.

Technical regulation QCVN QTĐ-5:2009/BCT

The technical regulation QCVN QTĐ-5:2009/BCT is issued by the Ministry of Industry and Trade under Circular No. 40/2009/TT-BCT dated December 31, 2009, by the Minister of Industry and Trade. This technical regulation specifies the requirements for inspection activities during installation, completion testing, and periodic testing for electrical apparatus of power grids, hydropower, and thermal power plants. This regulation has not specified the respective requirements for Wind Power Plants.

Technical regulation QCVN QTĐ-6:2009/BCT

The technical regulation QCVN QTĐ-6:2009/BCT, issued by the Ministry of Industry and Trade under Circular No. 40/2009/TT-BCT dated December 31, 2009, by the Minister of Industry and Trade, outlines the technical requirements essential for the operation and maintenance of hydraulic structures and auxiliary mechanical equipment in hydropower plants, thermal process equipment in thermal power plants, and electrical apparatus within power grids. These standards are formulated to ensure the safety, environmental protection, and reliability of the associated facilities and equipment. However, this regulation does not include specific requirements for Wind Power Plants.

Technical regulation QCVN QTĐ-7:2009/BCT

The technical regulation QCVN QTĐ-7:2009/BCT is issued by the Ministry of Industry and Trade under Circular No. 40/2009/TT-BCT dated December 31, 2009, by the Minister of Industry and Trade. This regulation provides requirements for technical tasks such as constructing and repairing electrical apparatus in the power grid. This regulation is applied to creating and installing electrical facilities with voltages up to 500 kV. The requirements outlined in the regulation are suitable for installing onshore electrical power systems but do not yet include provisions for installing offshore electrical apparatus, typically provided in pre-assembled packages.

Electrical Equipment Regulation, promulgated under Decision No. 19/2006/QD-BCN dated July 11, 2006, by the Ministry of Industry. This regulation is divided into four parts: Part I details general requirements, Part II covers power transmission systems, Part III focuses on power distribution and substations, and Part IV addresses protection and automation. The requirements outlined in the regulation are suitable for onshore power systems, but the application to offshore systems requires further analysis and assessment.

Offshore Survey and Investigation

Under construction law regulations, establishing an investment project requires the results of construction surveys, with meteorological, hydrological, and geological parameters being crucial. Currently, technical regulations for Offshore Wind Power (OWP) project survey activities are available. However, as stipulated in Decree 15/2021/ND-CP, the technical guidelines for preparing construction survey objectives on elaborating certain regulations on the Management of Construction projects, Article 26, are still being determined.

Approval and Appraisal

Referring to Decree 06/2021/NĐCP, elaborating on the implementation of several regulations on quality management, construction, and maintenance of construction works, appendix VIII, OWPs are often designated as Grade I projects or above, based on their level of importance or capacity level. In line with

Decree 15/2021, Article 3, Appendix X, categorizes offshore wind energy as projects significantly impacting safety and community interests. So, the feasibility study reports for offshore wind projects must undergo appraisal by a specialized construction regulatory body as mandated by Articles 13 and 14 of Decree 15/2021. Furthermore, technical design documentation requires evaluation by a construction authority specialized in this field, as outlined in Articles 36 and 37.

For the appraisal process conducted by the specialized government authority, the submission dossier must include approved documents for fire prevention and firefighting, environmental impact assessment reports, and any other pertinent approvals or agreements. Offshore wind power projects may touch upon various sensitive areas, including national defense, air traffic and maritime safety, mineral exploitation, protected areas, and fishing zones. Nonetheless, OWP is currently unregulated in Vietnamese law; examples include:

- The Vietnamese Maritime Law, Law No.18/2012/QH13, currently lacks a definition for offshore wind power, does not specify offshore wind energy as a marine resource, and does not include regulations for offshore wind power equipment and structures as maritime construction devices and facilities.
- The Law on Environmental Protection and Marine Resources, No. 82/2015/QH13, lacks specific provisions for protecting the marine environment during offshore wind power's surveying, research, and development processes.
- The Law on Environmental Protection, Law No. 72/2020/QH14, currently lacks provisions addressing environmental protection throughout the surveying, construction, operation, and decommissioning phases of offshore wind power facilities.
- The Maritime Code 95/2015/QH13 does not specify regulations on maritime safety signals, required safety distances for wind farms or wind turbines and generators, submarine cable pathways, and especially for areas where maritime traffic lanes intersect with submarine cable routes.
- The existing technical regulations for fire prevention and firefighting do not cover the design of fire prevention and firefighting systems, specifically for wind turbines and offshore substations.
- There are no national standards or guidelines for determining survey objectives, designing, and layout planning of offshore wind farms, offshore substations, and submarine cable systems, nor are there any for the engineering and structural calculations of wind turbine foundations and towers.
- The lack of clear and comprehensive technical regulations and standards significantly complicates the process and increases the risks and challenges for specialized government authorities and investors. This complexity affects the issuance of survey permits, the appraisal of fundamental and technical design documentation, and the inspection process by government authorities. These challenges hinder the certification process for offshore wind power (OWP) projects, making it difficult to verify that they meet the conditions required for commercial operation.

Construction management, operation & maintenance, and demolition of the projects

The Regulation on Construction Management[2] stipulates the requirements for the preparatory, execution, and completion phases of projects. However, it lacks clarity on the specific requirements for Offshore Wind Power (OWP) projects in aspects such as:

- Decree 15/2021/NĐ-CP, on elaborating particular regulations on the Management of Construction projects, mandates that design documents submitted for appraisal by relevant state authorities, depending on the project phase, must delineate the list of standards, technical regulations applied, technical specifications, and maintenance procedures for the construction. Currently, comprehensive national standards for the design, operation, and dismantling of OWP projects are yet to be fully developed.

[2] Decree 15/2021/NĐ-CP, on elaborating certain regulation on Management of Construction projects, Article 4 construction project phases.

- Furthermore, Decree 06/2021/NĐ-CP, which elaborates on implementing several quality management regulations, outlines the testing, inspection, and acceptance criteria necessary for project quality control. However, the technical standards and procedures for testing, monitoring, and surveying OWP remain insufficient.
- Circular No. 02/2019/TT-BCT, which governs Wind Power Project development and Power Purchase Agreements for wind power, has not defined critical parameters such as the sea surface area and the safety corridor for submarine cables associated with offshore wind power. While it requires a feasibility study report that includes a plan and technical solutions for the cost of dismantling and disposing of wind power plant equipment post-project, it falls short of providing guidelines or regulations on the disposal of waste materials from dismantling offshore wind power plant equipment after its lifecycle. Moreover, there are no clear regulations on safety and sea surface area utilization for offshore wind power projects.
- These unclear technical regulations for OWP pose significant challenges and difficulties for investors and state inspectors in enforcing the requirements on testing, monitoring, and surveying for OWP, necessitating a proposal for specific guidelines and standards to support the effective development of offshore wind power.

Table 1: The details of Technical Regulation Documents are presented in the table below:

No	Description	Technical regulation contents that influence the Development of OWP
I	**Technical Regulations regarding approval and agreement**	
1	Law on marine and island environment resources No.82/2015/QH13	The Law on Marine and Island Environment Resources 82/2015 was promulgated by the 13th National Assembly, dated June 25, 2015, on natural resources and environmental protection of sea and islands. This Law regulates the integrated management of resources and the protection of the marine and island environment, the rights, obligations, and responsibilities of agencies, organizations, and individuals in the integrated management of resources, and the protection of the marine and island environment of Vietnam. The activities related to environmental protection, management, exploitation, and use of marine and island resources shall be carried out by the provisions of related laws and ensure compliance with the regulations of this Law. The following articles are relating the Development of OWP: Article 3: Term definition, Clause 1: Marine and island resources include living and non-living resources found in the marine water column, seabed, sub-seabed, coastal land areas, archipelagos, islands, periodically submerged shoals, and reefs (hereafter referred to collectively as islands) under the sovereignty, sovereign rights, and jurisdiction of Vietnam. Part 2: SCIENTIFIC RESEARCH ON MARINE AND ISLAND RESOURCES AND ENVIRONMENT . This part stipulates the following Articles: Article 17. Scientific Research Activities on Marine and Island Resources and Environment Article 18. National Science and Technology Program on Marine and Island Resources and Environment

No	Description	Technical regulation contents that influence the Development of OWP
		Article 19. Licensing for Foreign Organizations and Individuals to Conduct Scientific Research in the Marine Areas of Vietnam Article 20. Rights and Obligations of Foreign Organizations and Individuals Conducting Scientific Research in the Marine Areas of Vietnam. The law governing natural resources and the environment of seas and islands does not recognize offshore wind energy as a marine resource. Furthermore, it lacks specific technical regulations about the surveying and development of offshore wind power projects.
2	Law on Environmental Protection No. 72/2020/QH14	The Law on Environmental Protection 72/2020 was promulgated by the 14th National Assembly, dated November 17, 2020. This law regulates environmental protection activities and the rights, obligations, and responsibilities of agencies, organizations, community groups, households, and individuals involved in environmental protection activities. The following articles are relating the Development of OWP: Article 2. Application subject: This law applies to agencies, organizations, community groups, households, and individuals on the territory of the Socialist Republic of Vietnam, including mainland, islands, sea areas, underground, and airspace. Environmental protection in production and business activities is governed under Section 3. ENVIRONMENTAL PROTECTION IN SPECIFIC AREAS, with the following specific Articles: Article 61. Environmental protection in agricultural production. Article 62. Environmental protection in healthcare activities and controlling the impact of environmental pollution on human health. Article 63. Environmental protection in burial and cremation. Article 64. Environmental protection in construction activities. Article 65. Environmental protection in transportation activities. Article 66. Environmental protection in cultural, sports, and tourism activities Article 67. Environmental protection in the exploration, extraction, processing of minerals, and oil and gas activities Article 68. Environmental protection for research facilities, training, and laboratories Article 69. Environmental protection in managing persistent pollutants and the materials, fuels, materials, products, goods, and equipment containing persistent pollutants. Article 70. Environmental protection in the import, temporary import, re-export, and transit of goods. Article 71. Environmental protection in the import of scrap from abroad. There are no technical regulations on environmental protection in surveying, constructing, operating, and dismantling offshore wind power projects.

No	Description	Technical regulation contents that influence the Development of OWP
3	Viet Nam Maritime Code 95/2015/QH13	Viet Nam Maritime Code 95/2015 was promulgated by the 13th National Assembly on November 25, 2015. This Code regulates maritime activities, including provisions on ships, seafarers, seaports, maritime channels, dry ports, maritime transportation, maritime safety, maritime security, environmental protection, state management of marine activities, and other activities related to the use of ships for economic, cultural, social, sports, official duty, and scientific research purposes. The following articles are relating the Development of OWP: Article 105. Ensuring Maritime Safety, Maritime Security, Maritime Labor, and Environmental Protection Clause 3. In maritime channels, at necessary positions along the coast, on islands, in waters with obstacles, other marine constructions, and in port water areas where ships are allowed to operate, maritime signals must be established by the regulations of the Minister of Transport. The Marine code specifically required the provision of marine signals for Marine structures as well as OWP if developed.
4	Decree 58/2017/ND-CP	The Decree 58/2017 was promulgated by the Government on May 10, 2017. This Decree provides detailed regulations on certain aspects of the Vietnam Maritime Code concerning the management of marine activities, including investment in the construction and exploitation of ports, maritime channels, maritime structures, maritime signals, maritime notices, operations of maritime pilots, and the management of ship activities at seaports and within the maritime areas of Vietnam. The following articles are relating the Development of OWP: Article 7: Supervising the construction of other structures in the port water areas Clause 4. For projects that intersect with the port water areas, maritime channels, or constructions that affect maritime activities such as bridges, power lines, cable cars, underground structures, and other similar constructions, during the project proposal process, the investor must send a document to the Vietnam Maritime Administration to request opinions on the necessity, location, anticipated scale of the construction, clearance height, and depth of the construction…. Clause 5. Investors of other constructions not covered under clauses 3 and 4 of this regulation must, during the process of proposing the construction investment, send a document to the regional maritime authority to request opinions on the location and anticipated scale of the construction… Article 8. Maritime Safety Assurance Plan

No	Description	Technical regulation contents that influence the Development of OWP
		Clause 2. Cases that require the approval of a maritime safety assurance plan: Construction of structures that intersect with port water areas, maritime channels, or constructions that affect maritime activities such as bridges, power lines, cable cars, underground structures, drilling platforms, wind power, hydroelectric, thermal power, and other similar constructions. Article 39. Investment and construction of Maritime signal Clause 3. Organizations and individuals are obliged to establish maritime signals when managing and exploiting specialized maritime channels or using the following water areas: d) Areas where cables or pipelines are laid underground, underground constructions, and underground equipment that affect maritime activities. Clause 4. Organizations and individuals, when constructing underground structures, structures that cross maritime channels, or structures that affect maritime activities such as bridges, power lines, cable cars, underground constructions, drilling rigs, wind power, hydroelectric, thermal power, and other similar constructions, are obligated to establish maritime signals to ensure maritime safety. Decree 58/2017 specifically regulates the agreement on location and layout of projects, as well as the provision of maritime warning systems for offshore wind power (OWP) projects
5	Law No. 27/2001/QH10 and Law No. 40/2013/QH13	Law 27/2001 was promulgated by the 10th National Assembly, dated June 29, 2001, on Fire Prevention and Firefighting. Law 40/2013 2001 was promulgated by the 13th National Assembly, dated November 22, 2013, on amending and supplementing some articles of Law 27/2001. These laws regulate fire prevention and firefighting, the establishment of forces, equipment provisioning, and policies for fire prevention and firefighting activities. The following articles are regulating the OWP Development: Article 24. Fire prevention in the production, supply, use of electricity, and electrical equipment and tools Clause 1: At the power plants and substations, proactive measures must be in place to handle the incidents caused by fire . Clause 2: The design, construction, and installation of electrical systems and devices must comply with fire prevention and firefighting safety standards. Clause 3: Electrical equipment and tools used in environments that are hazardous due to fire or explosion risks must be of types that are safe from fire and explosion.

No	Description	Technical regulation contents that influence the Development of OWP
6	Circular 06/2022/TT-BXD	The Circular 06/2022 is issued by the Ministry of Construction, dated November 30, 2022, promulgating the technical regulation QCVN 06:2022/BXD on fire safety for buildings and projects. This technical regulation for superseding QCVN 06:2021/BXD was promulgated by Circular 02/2021/TT-BXD. The technical regulation QCVN 06:2022/BXD consists of 6 parts: Section 1: General regulations. Section 2: Fire-related technical classification. Section 3: Human safety assurance. Section 4: Flame spread prevention. Section 5: Water Supply for Firefighting. Section 6: Firefighting and rescue. Section 7: Organizing implementation. Article 1.1. Scope of regulation, clause 1.1.5 specified that Sections 2 through 6 do not apply to buildings with special occupancies (buildings and constructions associated with technology lines of power generating facilities such as hydroelectricity power plants, thermoelectricity power plants, wind power plants, solar power plants, geothermal power plants, tidal power plants, waste-to-energy plants, biomass power plants, biogas power plants, cogeneration power plants, air traffic control tower, manufacturing facilities or preservation facilities of explosive substances and materials, storage of petroleum, petroleum products, natural gas, flammable gas, and pyrophoric substances, filling stations of gas and oil, flammable liquid, flammable gas; manufacturing facilities or storage of toxic chemicals; national defense and security constructions; underground sections of subways; mines, and buildings with similar features). As of now, no national technical regulations specifically guide fire prevention and firefighting measures for offshore wind power projects.
II	**Technical regulation regarding Management of construction, operation & maintenance, and decommissioning**	
1	Law No. 50/2014/QH13 and Law No. 62/2020/QH14	Law 50/2014 was promulgated on Construction by the 13th National Assembly, dated June 18, 2014. Law 62/2020 was promulgated by the 14th National Assembly, dated June 17, 2020, amending and supplementing some Construction Law 50/2014 articles. These laws stipulate the rights, obligations, and responsibilities of agencies, organizations, individuals, and state management in construction activities. The following articles relate to the development of OWP:

No	Description	Technical regulation contents that influence the Development of OWP
		As of now, no national technical regulations specifically guide fire prevention and firefighting measures for offshore wind power projects. Article 3 provides the interpretations of designs and reports are requested for obtaining approval or appraisal of specialized government authority: Clause 1: Pre-feasibility study report for a construction investment project is a document presenting the preliminary study on the necessity, feasibility, and efficiency of an investment project, which serves as the basis for consideration and decision-making on project investment policies. Clause 2: Feasibility study report for a construction investment project is a document that presents research contents on the necessity, feasibility level, and efficiency of an investment project according to the selected basic design, serving as a basis for consideration and decision-making on investment projects . Clause 41: Basic design is the design developed in the Feasibility Study Report for a construction investment project based on the selected design alternative. It reflects the main technical parameters by the applied standards and technical regulations, serving as the basis for proceeding with the subsequent design stages. Clause 42: Technical design elaborates on the basic design after the construction investment project has been approved. It fully represents the solutions, technical parameters, and materials used by the applied standards and technical regulations, serving as the basis for the development of construction drawing design. Article 6. Application of standards and technical regulations in construction investment. Clause 1. Construction investment activities must comply with national technical regulations. Clause 4. The application of standards must ensure the following requirements: Compliance with the requirements of national technical regulations and relevant legal provisions. Ensure the consistency and feasibility of the applied standard system. Clause 5. The application of new technical solutions, technologies, and materials in construction investment activities must meet the requirements of national technical regulation and relevant legal provisions. Article 51. Requirement for construction investment project: Clause 1. Compliant with the overall planning for socio-economic development, sector development planning, construction planning,

No	Description	Technical regulation contents that influence the Development of OWP
2		land use planning, and plans at the local area where the construction investment project is located. Article 54. The content of the feasibility study report Clause 1. The basic design includes a report and drawings that represent the following contents: đ) A Solution for connecting technical infrastructure inside and outside the project and measures for preventing and protecting against fire and explosion. e) The technical standards and regulations applied, and the results of construction surveys conducted to establish the basic design. Article 78. Requirement for technical design Clause 3. Comply with applicable standards, technical regulations, and legal provisions on the use of construction materials, meet the requirements for functional use, and apply technology (if any); Currently, due to the lack of marine spatial planning, the investment documentation for offshore wind power needs to meet the construction law requirements by Clause 1, Article 51, regarding compliance with related planning. The national standards for OWP are not yet complete, and project developers must apply foreign standards. Proving the conformity of foreign standards with current technical regulations faces many difficulties and consumes time for investors and government authorities.
2	Decree 15/2021/ND-CP	The Decree 15/2021 was promulgated by the Government on March 03, 2021, on the management of construction investment projects. This Decree specifies the detailed implementation of certain contents of the Construction Law of 2014 and the Law amending and supplementing several articles of the Construction Law of 2020 (hereinafter referred to as Law No. 62/2020/QH14) regarding the management of construction investment projects, including project formulation, appraisal, approval, construction design; construction surveying; issuance of construction permits and management of construction order; construction of special structures and implementation of overseas construction investment projects; management of construction operation capacity; forms of management of construction investment projects. The following articles are relating the Development of OWP: Article 3. Interpretation of terms Clause 2. Projects that significantly impact the safety and interests of the community. Appendix X, Item II.5 specified that the energy projects, grade III or higher are projects, that have a significant impact on the safety and interest of the community .

No	Description	Technical regulation contents that influence the Development of OWP
		Article 8: Regulations on the application of international standards, regional standards, foreign standards (referred to as foreign standards); local standards; and new materials and technologies in construction activities. Clause 2. In the case of applying foreign standards: The design report or technical specifications (if any) must evaluate the compatibility, coherence, and compliance with national technical standards. Priority should be given to using foreign standards that have been recognized and widely applied. Article 13. Appraisal of the feasibility study report by the construction government authority. Clause 4. For construction projects financed by other funds, the construction government authorities shall appraise large-scale projects as prescribed in Clause 8 of Article 3, projects with significant impact on the safety and interest of the community, under specialized management according to the provisions of Article 109 of this Decree. Article 14. Application for appraisal of the feasibility study report by the construction government authority. Clause 3. An application for appraisal of the feasibility study report includes an application form for appraisal, feasibility study report, and attached legal document, …. The approval document/decision and enclosed drawings (if any) of one of the following planning types: Construction detailed planning approved by a competent authority; planning of other specialized fields by the planning law; route plan, site location approved by a competent authority for works built by routes; construction zoning planning in case no construction detailed planning is required; Written opinions on fire safety solutions of the basic design; written results of environmental impact assessment by the law on environmental protection (if required under the law on fire safety, and environmental protection); Agreement and certification of technical infrastructure connection of the project; a written approval for the height of the work according to the Government's regulations on the management of the height of aerial obstacles and the airspace control and air defense system in Vietnam (in case the project is not in the area or subject to a request for consultation on the work elevation management surface at the stage of construction planning approval) (if any); Other relevant legal documents (if any) Article 18. Approval of the project and decision to invest in the project

No	Description	Technical regulation contents that influence the Development of OWP
		Clause 3. The investment decision for the project by the investor is reflected in the decision approving the construction investment project, which includes the following main contents. g) The number of design steps, the list of selected standards Article 33. Specifications for construction design documentation Clause 1. The specifications for technical design reports are prescribed as follows: Technical design documents for each project shall include design reports, calculation appendixes, design drawings, construction survey reports, cost estimations, technical specifications, and maintenance procedures (if any). Clause 2. Technical specifications shall be specified as follows: The technical specifications shall comply with technical regulations, standards applied to the approved project, and the construction design requirements. Article 36. Appraisal of designs following basic design by construction government authorities Clause 4, item a) specified that construction government authority under the Ministry in charge of field-based construction works shall appraise the works in projects with significant impact on the safety and interest of the community, including projects with works of a special class, class I; projects located in two provinces or more; Article 37. Application for appraisal of design following basic design to construction government authorities. Clause 3. An application for appraisal of construction design following basic design includes: The enclosed legal documents, including a decision on approval for the construction project together with an approved feasibility study report; a notice of appraisal result of the construction authority and the basic design drawings enclosed with a certification stamp (if any); a report on the construction design assessment result of the assessment consulting contractor certified by the investor (if required); a document on evaluation and approval of fire safety design, result of environmental impact assessment by the law on environmental protection (if required) and other relevant documents; The Decree specifies that the design documents submitted for appraisal by the relevant state authorities, depending on the design phase, must present the list of standards, technical regulations

No	Description	Technical regulation contents that influence the Development of OWP
		applied, technical conditions, and maintenance procedures for the construction... Currently, national standards for OWP (Offshore Wind Power) still need to be fully established for the design, operation, and dismantling phases of the project. This situation forces investors to apply international standards. Proving the compatibility, coherence, and compliance of foreign standards with current technical regulations poses many difficulties and costs the stakeholders much time to work on.
3	Decree 06/2021/NĐCP	The Decree 06/2021 was promulgated by the Government on January 26, 2021, on Quality control and maintenance construction works. This Decree provides detailed regulations on quality management in construction, construction project execution, and maintenance of construction works. This Decree applies to the domestic and foreign agencies, organizations, and individuals engaged in the management of construction quality, the execution of construction projects, and the maintenance of construction works. The following articles are relating the Development of OWP: Article 2. Principle of determining Grade of construction projects The Grade of wind projects is determined based on project capacity specified in Appendix I. Practically OWP with several hundred MW will fall into the Grade I project. Article 4. Specialized construction experiments, monitoring, and surveying of structures Item 1: Specialized construction experiments, monitoring, and surveying of structures are measurement activities carried out during the construction process to determine the technical parameters and location of materials, components, and parts of the structure, serving construction and acceptance of construction works. Item 2: Specialized construction experiments must be conducted by organizations and individuals with capabilities as prescribed by law. Article 5. Comparative testing, construction inspection, testing the load-bearing capacity of structures Clause 1. Comparative testing during the construction process is conducted in the following cases: Specified in technical specifications, contract document; When materials, construction products, and equipment installed in the project, or the project being constructed show signs of not meeting the quality requirements according to the design documents; At the request of the competent government authorities.

No	Description	Technical regulation contents that influence the Development of OWP
		Clause 2. Construction inspection and testing the load-bearing capacity of structures is conducted in the following cases: Specified in the technical specifications, and contract document; When the project has been constructed and shows signs of not meeting the requirements as per the design, or there is insufficient basis for quality assessment and acceptance; As requested by the competent authorities signing the investment project contract under the public-private partnership model (PPP); As required by the competent authorities for inspecting the acceptance process, as specified in Article 24, Section 2 of this Decree; When the project has reached the end of its designed lifespan, and the owner wishes to continue its use; When the project in operation shows signs of danger, not ensuring safety; Construction certification for maintenance work; for inspecting the acceptance process The technical regulations and standards for testing requirements and methods, as well as for monitoring and surveying of OWP (Offshore Wind Power), still need to be completed. This results in potential discrepancies in testing regulations across projects and among competent government authorities. This issue presents challenges and difficulties for investors and state inspectors in enforcing regulations on testing, monitoring, and surveying for OWP.

No	Description	Technical regulation contents that influence the Development of OWP
4	Law 28/2004/QH11, Law 24/2012/QH13 and Law 06/VBHN-VPQH	Law 28/2004 was promulgated on electricity by the 11th National Assembly, dated December 03, 2004. Law 24/2012 was promulgated by the 13th National Assembly, dated November 20, 2012, on amending and supplementing several articles of electricity law. Law 06/VBHN-VPQH was promulgated by the 15th National Assembly, dated January 01, 2022, on Electricity Law. This Law establishes regulations for the planning and investment in electricity development, promotes electric saving, and outlines the framework for the electricity market. It defines the rights and obligations of organizations and individuals involved in electricity-related activities and those using electricity. Additionally, it provides guidelines for the protection of electrical equipment and infrastructure, as well as standards for electrical safety. The following articles are relating the Development of OWP: Article 4. Electricity development policies Clause 2. … ... attract all economic sectors to participate in the investment of the power transmission grid, based on ensuring national defense, security, and according to the electric power development planning, ... non-state economic sectors are permitted to operate the power transmission grid that they invested in Clause 2a. The State holds the monopoly in the following activities: a) load dispatching for the national power system; b) Construction and operation of large power plants are of significant importance in terms of the economy, society, defense, and security; c) Operation of transmission and distribution grids, except for the transmission grid built by non-state economic sectors; Article 11. Investment in the development of electricity Clause 1. Investments in electricity development must align with the established electricity development plans. Projects that need to be included in these plans can proceed only after being submitted to and approved by the relevant planning authority. Clause 2. Electricity project investors must adhere strictly to legal regulations concerning investment, construction, and environmental protection. Clause 3. Entities involved in electricity generation, transmission, and distribution must invest in the construction of electrical substations, meters, and the lines that transmit electricity to these meters to sell electricity. Clause 4. Organizations or individuals undertaking the construction, renovation, or expansion of electrical infrastructure must employ modern technical equipment and technologies that

No	Description	Technical regulation contents that influence the Development of OWP
		meet the technical regulations, industry standards, and Vietnam standards as prescribed by competent authorities. Clause 5. The Ministry of Industry and Trade and provincial People's Committees will periodically publish a list of electricity projects open for investment and those granted investment licenses. Article 18. Formation and development of the electricity market Clause 1. The electricity market is formed and developed at the following levels: a) Competitive electricity generation market; b) Competitive wholesale electricity market; c) Competitive retail electricity market. Clause 2. The Prime Minister will establish conditions and frameworks for the electricity industry to shape and evolve the levels of the electricity market. This includes setting out a development roadmap for the electricity market and conducting periodic reviews and adjustments to accelerate this roadmap in a way that aligns with the changing socio-economic conditions. Under the law, non-state economic entities are allowed to invest in and operate the transmission line grid that they invested in . This policy facilitates and gives convenience to investors in developing electricity projects. The Electricity Law includes regulations on land use for power facilities in Article 12 of this law, but there are no regulations on using sea surfaces for power facilities. Investing in the development of Offshore Wind Power (OWP) requires using sea surfaces. The competitive retail electricity market is specified in the Electricity Law. The Prime Minister determines the conditions and structure of the electricity sector to form and develop levels of the electricity market. Therefore, there is a legal basis for the Prime Minister to issue mechanisms for Direct Power Purchasing Agreements (DPPA), which is one of the important steps that make renewable energy more appealing. Chapter VII: Protection of Electrical Equipment, Electrical Infrastructure, and Electrical Safety. This chapter currently lacks specific regulations for ensuring the safety of submarine cables.
5	Circular No. 02/2019/TT-BCT	The Circular 02/2019/TT-BCT is issued by the MOIT, dated January 1st, 2019, on Wind power project development and power purchase agreement for the wind power projects. The following articles are relating the Development of OWP:

No	Description	Technical regulation contents that influence the Development of OWP
		Article 2. Definitions The on-sea wind turbines are turbines whose foundation center is built beyond the lowest average seawater edge over many years offshore. Article 6. Feasibility study report on wind power project The feasibility study report on the wind power project shall be made by the law regulations on construction investment management and shall have the following contents: Clause 1. The wind measurement results according to Article 5 hereof. Clause 2. Coordination and location; land area for use with term and land area of temporary use; area covers the territorial waters (if the location is on the sea) of the wind power project. Clause 3. Connection plan, evaluation of the impacts of the wind power project connection plan on the power system of the area, and the ability to evacuate the project's capacity. Clause 4. Technical plan and method, and expenditures for dismantling and handling the equipment of the wind power plant after the project ends. Clause 5. Power grid connection agreement; Agreement on the project's location of the competent authority, construction routes, land use area (for onshore projects), land area of used natural resources and territorial waters (for on-sea projects), general layout planning of the project, confirmation document of the competent agency on locations of wind power turbines on the sea (for projects with turbines built on the sea); Vertical clearance approval document of the competent authority. Article 10. The equipment of the wind power project Clause 1. The equipment of the wind power projects shall satisfy Vietnamese technical requirements and standards or IEC standards or equivalent standards. Clause 2. The equipment for the wind power project must not be second-hand, must not have left the factory for more than 5 years, and must have valid Origin and Production Certificates Article 11. Work Safety Clause 1. The scope of the wind power project includes the areas where wind towers, power transmission lines, substations, and other auxiliary items are located. Safety corridor of the wind turbines, safety corridors of the transmission lines, and substations shall comply with the technical standards and regulations on electrical equipment, regulations on safety for high-voltage power grids, and other law regulations on power work safety. Clause 2. The wind power project must be 300m away from the residential area.

No	Description	Technical regulation contents that influence the Development of OWP
6		Clause 3. The wind power turbines and wind power towers must be bright in color and must be non-reflective. Article 12. Land use area Clause 1. The land used for the wind power development project shall include land area for surveying and conducting investment studies for the wind power project; land area for permanent use by the wind power project; and land area for temporary use by the wind power project. Clause 2. The land area used for the wind power project must be conformable with the project capacity. The land area used for the wind power project shall not exceed 0.35 ha/MW. The land area for temporary use of the wind power project shall not exceed 0.3 ha/MW. There are no specific definitions yet to distinguish between nearshore and offshore wind power, and no definitions for the sea surface area and the safety corridor of submarine cables for offshore wind power. The feasibility study report requires a plan and technical solution, including the cost of dismantling and disposing of wind power plant equipment after the project concludes. However, currently, there are no guidelines or regulations on the disposal of waste materials from dismantling offshore wind power plant equipment after its service life has ended. There are no regulations regarding safety and the sea surface area usage for offshore wind power projects.
6	Circular No. 25/2016/TT-BCT and Circular 39/2022/TT-BCT	Circular 25/2016/TT-BCT is issued by the MOIT, dated November 30, 2016, on the electricity transmission system. Circular 39/2022/TT-BCT is issued by MOIT, dated December 30, 2022, on amendments and supplements to some provisions of Circular No. 25/2016/TT-BCT and Circular No. 39/2015/TT-BCT. These circulars stipulate operation requirements for the electricity transmission system, load forecast, transmission grid development plan, technical requirements, and procedures for connection of transmission grid, security assessment of power system, and operation of transmission line systems. The following articles are relating the Development of OWP: Article 42 Technical requirements for the wind and solar power plants. This article specifies the operational capabilities of wind power plants concerning frequency, voltage, and load control in both steady and transient states. The requirements are consistent with recognized international standards.
7	Decision 25/ĐTĐL	The Decision 25/ĐTĐL is issued by the Electricity Regulatory Authority of Vietnam (ERAV), dated March 26, 2019, on the

No	Description	Technical regulation contents that influence the Development of OWP
		issuance of procedure for testing and supervision. This procedure specifies the testing and supervising of power plants connecting to the national power system from medium voltage level upwards, ensuring that power plants meet the current technical requirements to be officially operated within the national power system. The following articles are relating the Development of OWP: Article 5. The minimum tests that need to be conducted for wind power plants and solar power plants include the following: Reactive power generation and absorption capability tests; Voltage control capability test; Frequency response capability test; Power quality measurement test. Article 6. SCADA, AGC, FRS/PQ/PMU communication tests The test requirements are consistent with recognized international standards.
III	**Standards and technical regulations**	
1	Law No. 68/2006/QH11	The Law was promulgated by the 11th National Assembly, dated June 29, 2006, on Standards and Technical Regulations. This Law regulates the activities of development, promulgation, and application of standards, development, issuance, and application of technical regulations, assessment of conformity with standards, and technical regulation. The following Articles regulate the development, appraisal, and promulgation of the OWP standards: Subjects of application (Article 2): This Law applies to Vietnamese organizations and individuals, foreign organizations and individuals, and Vietnamese residing abroad who are involved in activities related to the standards and technical regulations in Vietnam.
2	Decree No. 127/2007/ND-CP	The Decree was promulgated by the government, on August 1st, 2007, detailing the implementation of certain provisions of the Law on Standards and Technical Regulations. This Decree specifies the detailed implementation of certain provisions of the Law on Standards and Technical Regulations regarding the development, and promulgation of standards; development and issuance of the technical regulations; assessment of conformity with standards, technical regulations, and the responsibilities of agencies, organizations, and individuals operating in the field of standards and technical regulations. The following Articles regulate the development and promulgation of OWP standards: Article 2. The subjects of activity in the field of standards and technical regulations

No	Description	Technical regulation contents that influence the Development of OWP
		Article 3. Budget for developing standards and technical regulations. Article 4. State policy on the development of activities in the field of standards and technical regulations. Article 5. Dossier for draft national standards Article 6. Review and transform Vietnamese standards into National standards. Article 7. Review and transform Industrial standards into National standards.
3	Decree No. 78/2018/ND-CP	The Decree promulgated by the Government, dated May 16, 2018, amends, and supplements some provisions of Decree No. 127/2007/ND-CP. This circular details the planning, formulation, evaluation, and announcement of national standards; the application of national, international, regional, and foreign standards; and the formulation and announcement of fundamental standards. The Decree supplements the following Articles regulating the development, appraisal, and promulgation of the OWP standards: Article 2a. General requirements for the development of standards and technical regulations. Article 4a. Development, Appraisal, and Promulgation of National Standards.
4	Circular No. 11/2021/TT-BKHCN	The circular was promulgated by the Ministry of Science and Technology (MOST), dated November 18, 2021, detailing the development and application of national standards. The following articles are relating the development, appraisal, and promulgation of OWP standards: Article 4: Preparation and approval of a 5 year and annual plan for the development of TCVNs. Article 5: The sequence and procedures for the development, appraisal, and promulgation of TCVN. The article is to regulate the sequence and procedures for 3 cases of developing TCVN standards as follows: Case 1: TCVNs standards developed by ministries and ministerial-level agencies (excluding the MOST). Case 2: TCVNs standards proposed for development by the organizations and individuals. Case 3: TCVNs standards developed by MOST. Article 6: Formatting and detailing the content of TCVN and archiving the draft TCVN. Article 7: Periodic review, amendment, supplementation, replacement, and cancellation of TCVN, Article 8: Symbolling and numbering TCVN Article 9: Announcing, publishing, and disseminating TCVN.

No	Description	Technical regulation contents that influence the Development of OWP
		The proposed project by the UNOPS/ ETP to develop National Standards (TCVNs) for Offshore Wind Power (OWP) falls under Case 2 of Article 5.

3.4 National Standards on OWP

As of now, Vietnam's national standard system includes seven existing TCVNs on wind power, which are entirely equivalent in content to the corresponding IEC 61400 standards, namely:
Table 2: Wind power National standards issued in Vietnam:

No	National TCVNs	Equivalent IEC standards	Description
1	TCVN 10687-21:2018	IEC 61400-21:2008	Wind turbines — Part 21: Measurement and assessment of power quality characteristics of grid-connected wind turbines
2	TCVN 10687-22:2018	IEC 61400-22:2010	Wind turbines — Part 22: Guidelines for conformity testing and certification
3	TCVN 10687-1:2015	IEC 61400-1:2014	Wind turbines - Part 1: Design requirements
4	TCVN 10687-24:2015	IEC 61400-24:2010	Wind turbines - Part 24: Lightning protection
5	TCVN 10687-12-1:2023	IEC 61400-12-1:2022	Wind turbines - Part 12-1: Power performance measurements of electricity-producing wind turbines
6	TCVN 10687-12-2:2023	IEC 61400-12-2:2022	Wind turbines - Part 12-2: Wind energy generation systems - Part 12-2: Power performance of electricity-producing wind turbines based on nacelle anemometry
7	TCVN 10687-12-4:2023	IEC TR 61400-12-4:2020	Wind turbines - Part 12-4: Numerical site calibration for power performance testing of wind turbines

To comply with Article 4 of Circular No. 11/2021/TT-BKHCN, which elaborates on the development and application of standards, ISSQ sent Letter 5618/ISSQ-DA to STAMEQ on March 8, 2024. This Letter proposed developing 20 TCVN standards for OWPs, as specified in TOR- Annex 2 Proposed list of TCVNs for OWP, described in Appendix 1 of this report. On March 19, 2024, ISSQ received the Letter No. 888/TĐC-TC from STAMEQ regarding ISSQ's proposal to establish 20 Vietnamese Standards (TCVN) for offshore wind power in Vietnam. STAMEQ indicated that the Ministry of Science and Technology (MOST) has already approved a plan to develop three standards in 2024 by Decision No. 3243/QD-BMHCN dated December 27, 2023. The details are as follows:

- Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines;
- Wind energy generation systems - Part 3-2: Design requirements for floating offshore wind turbines;
- Wind energy generation systems - Part 50-3: Use nacelle-mounted lidar for wind measurements.

Among the existing standards, TCVN 10687-1:2015 provides detailed requirements suited to onshore but does not cover requirements for offshore wind turbines, particularly concerning the support structure.

TCVN 10687-1:2015 is fully equivalent to the IEC 61400-1:2014 standard. However, it has been superseded by IEC 61400-1:2019.

TCVN 10687-22:2018, fully equivalent to the IEC 61400-22:2010 standard, was withdrawn on 31st August 2018. It was replaced by the deliverables for the wind sector (WE-OMC) contained in the IECRE Conformity Assessment System.

The standard TCVN 10687-24:2015 is appropriate for offshore wind turbines and wind farms. TCVN 10687-24:2015 is fully equivalent to the IEC 61400-24:2014 standard. This standard has been superseded by IEC 61400-24:2019.

Finally, TCVN 10687-21:2018, equivalent to the IEC 61400-21:2008 standard, has been updated by the IEC 61400-21-1:2019. This standard focuses on measuring and assessing power quality characteristics for grid-connected wind turbines.

The contents addressed in these standards are as follows:

National standard TCVN 10687-21:2018

The TCVN 10687-21:2018, part 21: Measurement and assessment of power quality characteristics of grid-connected wind turbines. The standard was compiled by the National Technical Standards Committee TCVN/TC/E13 on Renewable Energy, proposed by the General Directorate of Standards, Metrology and Quality (STAMEQ), and published by the Ministry of Science and Technology (MOST). The content of this standard is equivalent to the IEC 61400-21:2008 standard. This standard provides a unified method to ensure consistency and accuracy in implementing, testing, and evaluating the electrical characteristics of grid-connected wind turbines. The power quality characteristics include technical specifications, voltage quality (flicker and harmonics levels), response to voltage dips, load control (active and reactive power control), grid protection, and restoration time. This standard can be applied by:

- Wind turbine manufacturers to meet the power quality characteristics;
- Wind turbine purchasers who specify the power quality characteristics;
- Wind turbine operators who may need to verify that the required power quality characteristics have been met;
- Planners or regulatory agencies who may need to accurately and fairly determine the impact of wind turbines on voltage quality to ensure that the installed system is designed with the required voltage quality;
- Wind turbine certification organizations or testing agencies when evaluating the electrical quality characteristics of wind turbines;
- Planners or electric grid regulatory agencies may need to integrate wind turbines into the grid.

This standard provides recommendations for measuring and evaluating the power quality characteristics of grid-connected wind turbines. It benefits all parties involved in the manufacture, planning, installation, licensing, operation, use, testing, and management of wind turbines. All relevant parties should apply the measurement and analysis techniques recommended in this standard to ensure the consistent and accurate development and operation of wind turbines.
The standard aims to facilitate investors, parties participating in implementation and supervision of testing to have a basis for application and evaluation of wind turbines' capability to meet the electrical quality requirements as currently regulated in Article 42, clauses 7 of Circular 25/2016/TT-BCT dated November 30th, 2016 and Circular 39/2022/TT-BCT dated December 30th, 2022, issued by the Ministry of Industry and Trade, regarding transmission systems as well as Article 5, clause 5, Decision 25/QD-DTDL dated March 26th, 2019, by the Electricity Regulatory Authority concerning the issuance of Testing and Test Monitoring Procedures. The standard encompasses the following points:

- Definitions and technical regulations of the quantities needed to characterize the power quality of grid-connected wind turbines;
- Measurement procedures to quantify the power characteristics;
- Procedures for assessing compliance with power quality requirements, including evaluating expected power quality from a wind turbine model when installed at a specific location or group.

Table 3: The detailed content is summarized as follows:

Article	**Description**	**The addressed issues**
1	Scope of Application	Specifies the contents of the standard, and the applicability of the standard related to types, sizes, operating modes, and measurement conditions.
2	Normative references	Specifies the necessary referenced documents required to apply the standard.
3	Terms and Definitions	Provides definitions for terms applied within the standard.
4	Symbols and Units	Specifies the definitions and measurement units for the symbols of technical parameters applied within the standard.
5	Abbreviations	Specifies definitions for the abbreviations applied within the standard.
6	Characteristics Parameters of Wind Turbine Power Quality	This specifies the quantities that must be disclosed to characterize the electrical quality of wind turbines, including the technical specifications of wind turbines (section 6.2), voltage fluctuations (section 6.3 to 6.4), response to voltage dips (section 6.5), load control (section 6.6 to 6.7), grid protection and restoration duration (section 6.8 to 6.9). Some capability characteristics specified in Circular 25/2016/TT-BCT, Article 42 have not been addressed in this standard, as follows: Frequency control; Voltage and cos φ controls; Active and reactive power controls; Overvoltage under-voltage ride-through capabilities.
7	Testing Procedure	This provides general information about the validity of measurements, conditions, and required testing equipment. Sections 7.2 to 7.9 detail the required measurements to determine the characteristic and power quality parameters of the wind turbine that need to be assessed. This includes the technical specifications of the wind turbine (section 7.2), voltage quality (7.3 to 7.4), response to voltage dips (7.5), power control (section 7.6 to 7.7), grid protection, and reconnection (section 7.8 to 7.9).
8	Evaluating Electrical Quality	This details the method for evaluating the expected power quality from a wind turbine or group of wind turbines when installed at a specific location and allows the results to be compared with the requirements in the standard.

National standard TCVN 10687 -1:2015

The TCVN 10687-1:2015, part 1: Design requirements. The standard is compiled by the National Technical Standards Committee TCVN/TC/E1 Electrical Machinery and Apparatus, proposed by the

General Directorate of Standards, Metrology and Quality (STAMEQ), and published by the Ministry of Science and Technology (MOST).

TCVN 10687-1:2015 is entirely equivalent to IEC 61400-1:2014. This standard specifies the essential design requirements applicable to all wind turbines of various sizes with the aim of ensuring the technical integrity of the wind turbines. It establishes an appropriate level of protection against damage from any hazards throughout the expected lifetime. The content of the standard relates to all auxiliary systems of the wind turbines, such as control and protection mechanisms, internal electrical systems, mechanical systems, and support structures.

The IEC 61400-1:2019 standard, which supersedes the 2014 edition, incorporates several significant technical updates, including:

- Extension of Wind Turbine Turbulence Category: Introduction of category A+ in Section 6.2 to account for the conditions observed in tropical cyclones and areas of high turbulence.
- Weibull Distribution for Turbulence: Addition of Weibull distribution to calculate the standard deviation for the Normal Turbulence Model (NTM) in Section 6.3.2.3.
- Updated Design Load Cases (DLC): Modifications in DLC 2.1, DLC 2.2, and DLC 2.5, detailed in Table 2 of Section 7.4.1, to include primary layer control function faults, secondary layer protection function-related faults, and low voltage ride-through scenarios.
- Revision of Partial Safety Factors for Loads: Section 7.6.2.2 details changes in the safety factors applicable to load calculations.
- Revisions in System Requirements: Clauses 8, 10, and 11, respectively, have been revised to update the control and electrical systems and assessments for site-specific conditions.

  The IEC 61400-1:2014 standard and its updated version 2019 do not cover requirements for offshore wind turbines, particularly the support structure. The requirements for offshore installations are specified in the IEC 61400-3 series.

  The detailed content is summarized as follows:

Article	Description	The addressed issues
1	Scope of Application	Summarizes the contents, purposes, and scope of application of the standard.
2	Normative references	Specifies the necessary referenced documents required to apply the standard.
3	Terms and Definitions	Provides definitions for terms applied within the standard.
4	Symbols, Units, and Abbreviations	Specifies the definitions and measurement units for the symbols of technical parameters and definitions for the abbreviation applied within the standard.
5	Principle elements	Presents the technical and design requirements to ensure the safety of structures, mechanical systems, electrical systems, and control systems of wind turbines. This article specifies the following elements: Design methods; Safety classes; Quality assurance; Wind turbine markings.
6	External condition	The content specifies the environmental conditions and electrical systems that could affect the reliability, stability, and operational safety of wind turbines which must be

Article	Description	The addressed issues
		considered when designing wind turbines. The contents are specified as follows: Item 6.2 Wind turbine classes: Wind conditions are specifically defined for wind turbine classes I, II, and III. These specific conditions are not intended to cover offshore wind conditions or wind conditions in tropical storms. Wind turbines in these conditions are generally categorized as special-class wind turbines, and the specific wind condition parameters are determined by the manufacturer. Item 6.3 Wind conditions: Including normal and extreme wind conditions. Item 6.4 Other environmental conditions: Conditions that are not wind-related may exist in the project area and affect the integrity and safety of the wind turbine, such as temperature; humidity; air density; solar radiation; rain, hail, snow, and ice; chemical agents; mechanical agents; salinity; lightning; and seismic activity. This includes environmental conditions under normal and extreme conditions. The content specified in the standard is mostly related to onshore wind power. Environmental conditions characteristic of offshore wind power, such as wave height, tidal levels, seawater salinity, corrosion characteristics, seabed depth, seabed topography, ocean currents, erosion, seawater temperature, and seawater density, are not considered in the standard. This standard recommends that the offshore environment requires surveying and additional consideration.
7	Structural design	The Article stipulates the application in calculating the structural analysis, types of loads, and design load cases corresponding to the safety and stability of the wind turbine structure. The loads considered and calculated include gravitational and inertial loads; aerodynamic loads; drive train loads; and other loads. The Article specifies the load cases for calculating the analysis part's ability to withstand and remain stable, corresponding to wind conditions and other conditions considered in the design as follows: Power production; Power production plus the occurrence of fault; Start-up; Normal shutdown; Emergency stop; Parked (standing still or idling); Parked and fault conditions; Transport, assembly, maintenance and repair.

Article	Description	The addressed issues
		The typical load for offshore wind turbines such as loads from waves, ocean currents, and the depth of the sea column have not been specified in this standard.
8	Control and protection systems	The regulation requires technical specifications for control, protection, and braking systems.
9	Mechanical system	The regulation specifies technical requirements for the mechanical system of wind turbines, including: Hydraulic or pneumatic systems; Main gearbox; Yaw system; Pitch system; Protection functions mechanical brakes; Rolling element bearing.
10	Electrical system	The regulation specifies technical requirements for the electrical equipment systems installed in wind turbines: Protective devices; Disconnection from supply sources; Earth system; Lightning protection; Electrical cables; Self-excitation; Protection against lightning electromagnetic impulse; Power quality; Electromagnetic compatibility.
11	Assessment of a wind turbine for site–specific conditions	The regulation specifies the testing of the capability to ensure the stability and safety of wind turbines designed under assumed conditions in the design when subjected to specific environmental and power system conditions at the installation location of the turbine. The content includes: Assessment of the topographical complexity of the site; Wind conditions required for assessment; Assessment of wake effects from neighboring wind turbines; Assessment of other environmental conditions; Assessment of earthquake conditions; Assessment of power system conditions; Assessment of soil conditions; Assessment of structural integrity by reference to wind data; Assessment of structural integrity by load concerning site-specific conditions. The standards primarily focus on onshore wind power. Environmental conditions characteristic of offshore wind power, such as wave height, tidal levels, seawater salinity, corrosion characteristics, seabed depth, seabed topography, ocean currents, erosion, seawater temperature, and

Article	Description	The addressed issues
		seawater density, are not specifically addressed in the standard.
12	Assembly, installation, and erection	The regulation content for deploying and installing wind turbines includes: Planning; Installation conditions; Site access; Environmental conditions; Documentation; Receiving, handling and storage; Foundation/ anchor systems; Assembly of wind turbine; Erection of wind turbine; Fasteners and attachments; Cranes, hoists, and lifting equipment. There are no specific regulatory contents for the installation of offshore wind turbines yet.
13	Commissioning, operation, and maintenance	The regulation on testing, operation, and maintenance of wind turbines includes: Design requirements for safe operation, inspection, and maintenance; Commissioning instruction; Operation manual; Maintenance manual.

National standard TCVN 10687 -24:2015

The TCVN 10687-24:2015, part 24: Lightning protection. The standard is compiled by the National Technical Standards Committee TCVN/TC/E1 Electrical Machinery and Apparatus, proposed by the General Directorate of Standards, Metrology and Quality (STAMEQ), and published by the Ministry of Science and Technology (MOST).

TCVN 10687-24:2015 is fully equivalent to the IEC 61400-24:2010. This International Standard is dedicated to the lightning protection of wind turbine generators and wind power systems. It specifies the lightning environment for wind turbines and applies it in the risk assessment of the wind turbines. The standard sets forth requirements for the protection of blades, structural components, and electrical and control systems against both direct and indirect lightning effects. Recommended test methods for validating compliance are also included. Furthermore, this standard offers guidance on employing relevant lightning protection, industrial electrical, and EMC standards, including earthing. It provides recommendations for personal safety and outlines approaches for the collection and reporting of damage statistics.

The detailed content is summarized as follows:

Article	Description	The addressed issues
1	Scope of Application	The content specifies the scope of the application, referenced documents, and the purpose of the standard.

Article	Description	The addressed issues
2	Normative references	Specifies the necessary referenced documents required to apply the standard.
3	Terms and Definitions	Provides definitions for terms applied within the standard.
4	Symbols and Units	Specifies the definitions and measurement units for the symbols of technical parameters and definitions for the abbreviation applied within the standard.
5	Abbreviations	Specifies definitions for the abbreviations applied within the standard.
6	Lightning environment for wind turbines	Regulation of lightning current parameters for dimensioning, analyzing, and testing lightning protection systems as defined in the IEC 62305-1 standard. Wherein the maximum current parameter is specified for 4 levels (LPL I ~ LPL IV) corresponding to lightning strokes, including: First short positive stroke; First short negative stroke; Subsequent short stroke; Long stroke; Flash.
7	Lightning exposure assessment	This article guides conducting a lightning exposure assessment for wind turbines, as below: Assessing the frequency of lightning affecting a wind turbine; Assessing the risk of damage.
8	Lightning protection of subcomponents	Regulations on protection measures, design requirements, testing methods, and verification inspection for the following components of wind turbines: Blades; Nacelle and other structural components which are Hub, spinner, Nacelles, Tower, Mechanical drive train and yaw system, Electrical low-voltage systems and electronic systems and installations, Electrical high-voltage (HV) power systems.
9	Earthing of wind turbines and wind farms	Regulations on protective measures and requirements regarding design, execution, and maintenance of earthing systems in wind turbines and wind farms. The designed system can effectively disperse lightning currents to prevent damage to wind turbines and ensure human safety by keeping step and touch voltages within permissible limits. The contents of the article are as follows: General; Equipotential bonding; Structural components; Electrode shape dimensions; Wind farms; Execution and maintenance of the earthing system.
10	Personal safety	Regulations on safety measures for personnel during the installation of wind turbines

Article	Description	The addressed issues
11	Documentation of lightning protection system	This article summarizes all documentation required in the related articles of this standard which includes: General; Documentation necessary during assessment for design evaluation; Site-specific information; Documentation to be provided for LPS inspections; Manuals.
12	Inspection of lightning protection system	Content of the regulations on inspection and maintenance of the lightning protection system for wind turbines in the various processes of the project: Inspection during the production of the wind turbines; Inspection during the installation of the wind turbines; Inspection during the commissioning of the wind turbines and periodic inspections; Inspection after dismantling or repair of main parts.

3.5 Current status of standards applied in nearshore and offshore wind power projects in Vietnam

Since no offshore wind power projects have been developed in Viet Nam, the consortium refers to nearshore wind power projects as being the most relevant to describe the status of standards applied in this area, and the details are as follows:
Application of Standard in design and application for approval and permit

Offshore wind power falls into the category of projects that impact the safety and interest of the community. Under the regulatory framework governing investment and construction management in Vietnam, it is mandatory to undergo a design review process, evaluating both fundamental and technical designs, by a government-competent authority during the project's preparation and implementation phases. In instances where national standards are absent, investors must adhere to international standards. Consequently, investors must navigate the process of obtaining approval to apply these international standards and be compliant with regulatory requirements. This situation potentially leads to variations in design technical criteria among different investors and projects, presenting considerable challenges and obstacles for state regulatory authorities in their design document appraisal efforts in line with regulations.

From its inception to achieving commercial operation, the development process for an offshore wind project involves numerous stages of permit applications and approvals. This process requires the preparation of technical documents that comply with relevant technical regulations and standards as follows:

- Application for survey permit of maritime areas
- Preparation of the pre-feasibility study report, including preliminary design to apply for decision-making or approval of the investment policy for the proposed project[3]
- Compilation of documents for obtaining agreements on connections to transportation and public service infrastructure, approval of the location and height of wind turbine generators, the overall

[3] Law on Investment, No. 61/2020/QH14, Article 33 Application for and contents of appraisal of proposal for Approval of investment policy

project layout, the routes of connection transmission lines, etc., from the relevant authorities as per regulations

- Preparation of document for performing agreement procedure on connecting the power plant to the grid system, relays and automation, SCADA and communication, and power metering with EVN according to the regulations of the decree on transmission systems and related distribution systems
- Preparation of documentation for executing agreement procedures on connecting the power plant to the grid system, relays and automation, SCADA and communication, and power metering systems with EVN, following the regulations stipulated by the related decree on the transmission line and power distribution systems
- Preparation and approval of the environmental impact assessment report with MONRE.
- The document proposing approval for the design solution of the fire prevention and firefighting system was submitted to the Fire Police Department.
- Preparation of the feasibility study report and basic design for submission to specialized construction authorities for appraisal.
- Preparation of documentation for negotiating the power purchase agreement with EVN.
- Preparation of technical design reports to obtain an appraisal from construction authorities is essential for applying for a construction permit.
- Preparation and execution of testing and commissioning for wind turbines, wind farms, and wind power plants.
- Preparation of documentation to obtain approval for setting parameters of wind turbines' control and protection systems with the power system operator, ensuring compliance with the requirements of the relevant decree on transmission and distribution systems.
- Conducting periodic inspections and tests according to regulations related to the power system.
- Documentation for the decommissioning and dismantling plan of the project upon the expiration of its usage period.

The actual application of standards for nearshore wind projects in Vietnam is as follows:

- The geotechnical investigation works for nearshore and offshore wind power projects was conducted by relevant Vietnamese standards (TCVN), European standards (EN, Eurocode), British Standards (BS), and standards from the International Organization for Standardization (ISO) and American Society for Testing and Material (ASTM), such as ASTM D420, ASTM D422-63, ASTM D854-83, ASTM D2850, etc.
- The topographical survey works were carried out according to related circulars, technical regulations, and standards, such as Circular 68/2015/TT-BTNMT, Circular No. 23/2015/TT-BGTVT, Circular 24/2010/TT-BTNMT, TCVN 10336: 2015, QCVN 04:2009/BTNMT, etc.
- The hydro-meteorological survey works were conducted by related circulars and national standards, for example, QCVN 47: 2012/BTNMT, TCVN 10336: 2015, TCVN 12636-3:2019, TCVN 10959:2015.
- The design of pile cap foundations was carried out by technical regulations and national standards such as QCVN 02:2009/BXD, TCVN 10687-1:2015, TCVN 2737-1995, or Eurocodes EN 1991, EN 1992-1-2, or DNV series or Chinese standards; monopile foundations were designed according to international standards such as DNVGL-ST-0126, NB/T 10105-2018, DNVGL-ST-0437, DNVGL-RP-0416, DNVGL-RP-B401, etc.
- The design work for the towers and components of the wind turbine was conducted according to the wind turbine manufacturer's recommended design standards, such as IEC61400-1, EN 1993, EN 14399, and VDI 2230.
- The onshore substation and transmission lines were designed by the Electrical Equipment Regulations, applicable IEC standards, and the design templates of EVN.
- Submarine cables: The design of the cable structure and the selection of cables were based on IEC standards, such as IEC 60502, IEC 60228, IEC 60949, IEC 60287, JB/T 11167, etc. The installation of cables adhered to guidelines from international handbooks, such as DNV GL-RP-0360.

- Calibration, testing, and commissioning works were carried out by the manufacturer's manual and relevant circulars concerning transmission lines and electrical distribution systems, such as Circular 25/2016/TT-BCT, Circular 39/2015/TT-BCT, and Circular No. 39/2022/TT-BCT, etc.
- At present, the National Technical Code for Testing and Acceptance Test for Power Facilities includes regulations specifically for electrical grid equipment, hydropower, and thermal power plants. However, it lacks provisions applicable to wind power plants.
- Decommissioning and dismantling: Currently, Vietnam does not have regulations and guidelines for dismantling and disposal of wind turbine equipment
- Fire protection at present, Vietnam needs to have national standards that explicitly dictate or guide the design of fire protection systems for wind farms, including wind turbines. The fire protection design for wind farms currently follows the NFPA850 standard, "Recommended Practices for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations," specifically Chapter 13 on Wind Turbines. According to Decision No. 4158/QD-BCA-PCCC&CHCN, on approval of the application of fire prevention and firefighting standards, dated June 15, 2023, NFPA850 has been approved for use in Vietnam, permitting the application of this international standard for fire prevention and firefighting measures. This Decision includes NFPA850 among the list of international and foreign fire prevention and firefighting standards authorized for adoption in Vietnam.

The following tables compile the standards applied in the Feasibility Study—Basic Design for recent nearshore wind farms.

Table 4: List of regulations, codes, standards, and guidelines applied for substructure design

No	Code Number	Name	Issuing authority
1	Circular 06/2021/TT-BXD	Regulations on the Classification of Construction projects and guidance for applications in the management of Construction Investment	Vietnam Ministry of Construction
2	QCVN 02:2022/BXD	National Technical Regulation on Natural Physical and Climatic Data for Construction	
3	QCVN 03:2022/BXD	National Technical Regulation on the Classifications of Buildings and Structures for Design	
4	IEC 61400-1	Wind Turbines - Part 1: Design Requirements	International Electrotechnical Commission
5	IEC 61400-3:1	Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines	
6	DNV-ST-0126	Support structures for the wind turbines	DNV American Petroleum Institute
7	DNV-RP-C205	Environmental conditions and environmental loads	
8	DNV-RP-C203	Fatigue design of offshore steel structures	
9	DNV-ST-0437	Loads and site conditions for the wind turbines	
10	DNV-RP-C212	Offshore soil mechanics and geotechnical engineering - Recommended Practices	
11	API RP 2A-WSD (R2020)	Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms – Working Stress Design - 22^{nd} Edition	
12	DNV-RP-B410	Cathodic Protection Design	
13	API SPEC 2W	Steel Plates Produced by Thermo-Mechanically Controlled Processing for Offshore Structures	American Petroleum Institute
14		ABS Guide for Building and Classing: Bottom-Founded Offshore Wind Turbines	

No	Code Number	Name	Issuing authority
		November 2023	American Bureau of Shipping
15	ASTM	American Society for Testing and Materials	ASTM
16	AWS D1.1	American Welding Society	American Welding Society

Table 5: Applicable design standards for technological equipment and grid connection

No	Code Number	Name
1	IEC 61400	Wind Turbines
2	IEC 60050-415	International Electrotechnical Vocabulary - Part 415: Wind turbine generator system
3	IEC 60076 (all parts)	Transformers for wind turbine applications
4	IEC 62305:2006	Protection against lightning
5	IEC 62271	High-voltage switchgear and control gear
6	IEC 60376	Specification of technical grade Sulphur hexafluoride (SF6) and complementary gases to be used in its mixtures for use in electrical equipment
7	IEC 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions
9	IEC 60364 (all parts)	Low-voltage electrical installations
10	IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2kV) up to 30kV (Um = 36kV)
11	IEC 60044	Current transformers
12	IEC-60099	Surge arresters
13	IEC-61892	Mobile and fixed offshore units - Electrical installations
14	ISO 12944-2	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments
15	ANSI/AGMA/AWEA 6006-A03	Design and Specification of Gearboxes for Wind Turbines
16	DNV-OS-D201	Offshore Standard – Electrical Installations
17	DNV-OS-D202	Automation, Safety, and Telecommunication Systems

Table 6: Regulations, codes, standards and guidelines in construction methodologies

No	Code Number	Name	Issuing authority
1	11TCN 18: 2006 11TCN 19: 2006 11TCN 20: 2006 11TCN 21: 2006	Regulations on Electrical Equipment	Vietnam Ministry of Industry
2	QCVN 01: 2008/BCT	National technical regulation on electrical safety	
3	QCVN 02: 2022/TT-BXD	National regulation on natural conditions applicable in construction	

No	Code Number	Name	Issuing authority
4	TCVN 4252: 2012	Procedures for formulation of the building organization design and the building works design	Vietnam Ministry of Industry of Construction Vietnam Ministry of Science and Technology
5	TCVN 4087: 2012	Use construction machinery - General Requirements	
6	TCVN 10317: 2014	Steel pipe piles and steel pipe sheet piles for bridge - Specification for construction and acceptance	
7	TCVN 6170-11: 2020	Fixed offshore platform - Part 11: Fabrication/Construction	
8	TCVN 6170-12: 2020	Fixed offshore platforms - Part 12: Transportation and installation operations	DNV DNV
9	DNV-ST-0054	Transport and installation of wind power plants	
10	DNV-ST-0126	Support structures for wind turbines	
11	DNV-ST-0437	Loads and site conditions for wind turbines	
12	EEMUA Publication 158	Construction specification for fixed offshore structures, 3rd edition	The Engineering Equipment and Materials Users Association
13	API RP 2A-WSD	Planning, Designing, and Constructing Fixed Offshore Platforms— Working Stress Design	American Petroleum Institute
14	API RP 2D	Operation and Maintenance of Offshore Cranes	
15	API RP 2GEO/ISO 19901-4	Geotechnical and Foundation Design Considerations	
16	API RP 2X	Ultrasonic and Magnetic Examination of Offshore Structural Fabrication and Guidelines for Qualification of Technicians	
17	API RP 14F	Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1, and Division 2 Locations	
18	API BULL 91	Planning and Conducting Surface Preparation and Coating Operations for Oil and Natural Gas Drilling and Production Facilities in a Marine Environment	
19	AWS Standards	A, B, D series for welding	American Welding Society

Chapter 4: International policies, regulations, and standards on OWP

The objective of this project and the focus of this comprehensive report are to establish national standards for offshore wind power. Through research, the research team discerned that these standards do not operate in isolation but are integral to the ecosystem governing offshore wind power development. This ecosystem comprises various policies, laws, codes, standards, and regulations, collectively shaping the trajectory of offshore wind power development in each country. Initiatives to foster offshore wind power will expedite industry growth and stimulate the formulation of national standards. Technical challenges usually emerge once projects are rolled out, and the need for standards to define best practices and achieve consensus comes along to ensure smoother implementation for subsequent projects. Understanding the broader regulatory framework that governs offshore wind projects, especially the policies that give rise to the accelerated installations of offshore wind in leading offshore wind markets, to design national standards in harmony with these regulatory requirements is, therefore, essential.

Hence, this chapter is guided by the main research question: "What is the current state of policies, regulations, and standards on OWP internationally?" and the following sub-questions:

a. What are the five suitable reference countries for Vietnam?
b. What are the relevant international and national standards related to OWP?

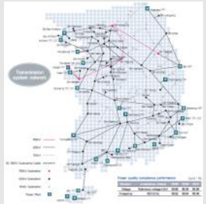
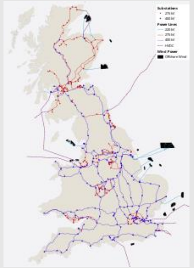
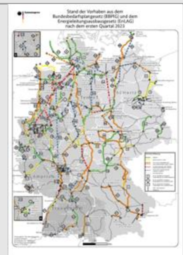
4.1 Five Suitable Reference Countries for Vietnam

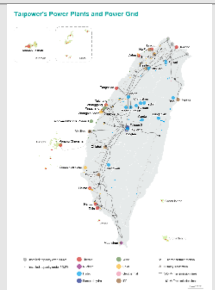
4.1.1 Selection of reference countries

Two Asian countries and three European countries are selected for this case study. These include Taiwan, Korea, the UK, Germany, and the Netherlands. The power systems of the other five selected countries are more comparable in scale to Vietnam's. There are only slight variations in their innate offshore wind potential compared to Vietnam, and they share similarities in power system design (such as Taiwan and the UK) and possess transferable experience from the established offshore oil and gas industries (like the UK and the Netherlands). All five countries represent either emerging or established offshore wind markets, each having developed their own national standards or translation of the international standards to their local context for the offshore wind industry.

Table 7 - Selection criteria for 5 representative countries

Criteria \ Countries	Vietnam	Taiwan	Korea	The UK	Germany	The Netherlands
Geographic potential (technical potential and their proximity to demand centers)	Fixed: 261 GW Floating: 338 GW Total 599 GW	Fixed: 67 GW Floating: 427 GW Total: 494 GW	Fixed: 78 GW Floating: 546 GW Total: 624 GW	Fixed: 439 GW Floating: 1,361 GW Total: 1,800 GW	Fixed: 203 GW Floating: 0 GW Total: 203 GW	Fixed: 211 GW Floating: 0 GW Total: 211 GW
	Potential offshore wind areas are within a reasonable range from demand centers in the North (i.e. Hanoi) and the South (i.e. Ho Chi Minh City).	Since the offshore wind plants are located along the Taiwan Strait (the western coastlines), they are relatively close to the major cities (e.g. Taipei, Taichung, and Kaohsiung) as well as industrial zones and population centers.	Potential offshore wind farm areas are located within reasonable distances from major cities like Seoul, Incheon, Busan	Approximately 83% of the UK's installed capacity is located in the Irish Sea or waters around the English Channel. These areas are relatively close to the major cities and industrial centers situated near the coastline (e.g. Liverpool, Manchester, London, Bristol, etc)	Relatively long distance from the shore. Most projects are beyond 12 nautical miles into the EEZ.	Offshore wind farms are often located in areas such as the North Sea Zone, Borssele, and Hollandse Kust (Holland Coast) and they can be at some distance from the major demand centers such as cities and industrial zones along the coast.
Power system design	A typical north-south power flow consists of two parallel 1,500-km 500-kV transmission lines that link the north and south of the nation, with the center serving as a	Taiwan also possesses power grids that rely heavily on north-south transmission lines. The electrical grid system is linked by three main 345 kV power cables that run from the north to the south	Urban to rural power flow. Transmission lines typically operate at high voltage ranging from 154 kV to 765 kV. The national grid is interconnected	Also North (particularly from Scotland and northern England)-South power flow Contiguous synchronous grid The UK grid is connected to	The German grid has a centralized to decentralized power flow, transitioning from centralized generation to decentralized with increased renewable energy.	Netherlands grid Imports/exports power flow since the Netherlands is a net importer of electricity to countries such as Germany, Belgium, and Norway.

Criteria / Countries	Vietnam	Taiwan	Korea	The UK	Germany	The Netherlands
	transmission link in the middle. Vietnam's power is mostly produced in the central while the north is energy deficient. 	of the country. The Longtan, Chungliao, and Longci ultra-high voltage substations create a centralized grid structure with three main hubs for the northern, central, and southern regions of Taiwan. Taiwan's power is generated mostly in the south—such as at the Hsinta plant outside of Kaohsiung—but needed mostly in the urban centers of the north. The power is moved via a central transmission system.	to North Korea and China. 	neighboring European grids by submarine power cables. 		

Countries / Criteria	Vietnam	Taiwan	Korea	The UK	Germany	The Netherlands
						
Target	6 GW by 2030 70 GW by 2050	13 GW by 2030 55 GW by 2050	14.3 GW by 2030 Net zero carbon emission by 2050	50 GW by 2030 Net zero carbon emission by 2050	30 GW by 2030 70 GW by 2045	21 GW by 2030 38-72 GW by 2050
Track record	The first nearshore wind project went into commission in 2013. The country has no track record in offshore wind projects yet. Extensive experience in the oil and gas industry	Taiwan is a beginner in the industry. 2 demonstration projects were completed. The Formosa I project was the first offshore demonstration wind farm in Taiwan. Completed in 2019, the total generation capacity of Formosa I is 128MW. The Changhua Wind Farm, Taiwan's second demonstration wind	6 demo offshore wind projects were fully commissioned. The first commercial offshore wind power called Jeonam is expected to go into operation in 2024.	The first offshore wind farm called Blyth has been operating since 2000. There are 44 wind farms comprising over 2,500 turbines in operation. The UK is the second-largest offshore wind market in the world. There are two operational floating offshore wind pilot projects:	The first offshore wind farm called Alpha Ventus has been in operation since 2010. There are 23 offshore wind farms comprising over 1,483 turbines in operation. Germany had no other offshore energy industry developed before offshore wind	The Netherlands has been rolling out offshore wind in the North Sea since 2007 The Netherlands has 13 operational offshore wind farms. Additionally, there are several offshore wind farms in the planning stages. The Dutch have had decades of experience in the offshore oil and gas industry

Countries / Criteria	Vietnam	Taiwan	Korea	The UK	Germany	The Netherlands
		farm, was completed in 2021.		1. Hywind Scotland consists of five 6-megawatt turbines, and has been operating since 2017. 2. Kincardine wind farm comprising five 9.5-megawatt turbines, and has been in operation since 2021. Mature oil and gas industry.		
Installed capacity	N/A	2.25 GW (2023)		13.93 GW (2022)	8.47 GW (2023)	4.7 GW (2023)
The presence of national standards for offshore wind	Yes	Yes	Yes	Yes	Yes	Yes
The general trend of adopting international standards or creating new standards		The general tendency to improve rather than develop new standards to ensure international harmonization.	N/A	The general tendency to improve rather than develop new standards to ensure international harmonization.		

Before going into each country separately, it is important to understand that countries might define offshore wind differently from each other. Especially since Vietnam makes a distinction between nearshore and offshore (beyond 6 nautical miles (see paragraph 3.1 for clarifications), it is important to understand the definitions the countries adopt. Table 8 below shows this.

Table 8 - Definition of offshore wind.

Country	Definition of offshore wind
Taiwan	There is a definition of "offshore area" that extends from 3 to 12 nautical miles
Korea	Offshore wind in Korea is assigned a higher weight in the Renewable Energy Certificate (REC) scheme if it is further from the coastline.
The UK	There is a definition of a Renewable Energy Zone (REZ) that is adjacent to the UK's territorial waters extending from 12 out to 200 nautical miles, within which renewable energy installations can be established.
Germany	Only a few projects are in territorial waters (12 nautical miles from the coastline) and most projects are beyond 12 nautical miles and into the EEZ.
The Netherlands	Two strips in the Hollandse Kust area are located 10 to 12 nautical miles off the Dutch coast, the four designated areas lie behind the 12 nautical miles zone (the zone 22 km off the Dutch shore).

4.1.2 Taiwan

In Taiwan, the demand for testing and certification results from incentive policies (Liao et al., 2020). The Taiwanese government has focused on offshore wind since the early 2010s (Tsai, 2021). Key support mechanisms like the Offshore Wind Power Demonstration Incentive Program, Feed-in Tariff policy, and Local Content Requirement were introduced to kick start the industry relatively early.

Based on our research, thanks to the incentive policies, Taiwan now has 131 offshore wind farm projects under development, of which 5 are currently operating, 3 where construction has progressed enough to connect the turbines and generate electricity, 3 are in the build phase, and 9 are either consented or have applied for consent (4COffshore, n.d.).

Similar to the local content requirements, project certification is required for every stage of an offshore wind farm development "to ensure the overall safety and quality of offshore wind farm construction" (BSMI, 2021). Although the incentive policies for the offshore wind industry were laid out quite early, it was not until 2019 that the requirements for project certification were introduced by the Bureau of Standards, Metrology, and Inspection (BSMI) in the "Directions for Demonstration and Guidance on Reviewing Project Certification of Offshore Wind Farm Projects". The Directions were amended recently in 2021, simplifying the working group review stage in the review procedure. By 2024, 6 offshore wind power projects got their review and certification process finalized, ensuring their compliance with requirements stated in the national standards and the strength of wind turbines in resisting high winds from typhoons and seismic activities from earthquakes. Demonstration projects have also been certified according to the national standards (i.e. Offshore Wind Formosa 1).

In the field of certification and standardization in Taiwan, BSMI is a prominent agency whose work in the offshore wind industry includes:

- "Publication of standards for type testing and certification of wind turbines and power measurement techniques (CNS 15176-22)

- Revision of standards for wind turbine design requirements by taking typhoon-related impacts into account (CNS 15176-3)
- Revision of standards for wind turbine design requirements by taking earthquake-related impacts into account" (CNS 15176-1) (BSMI, 2019).

Taiwan's national standards are recognized by the name Chinese Normal Standards (CNS). The major standardization effort observed in the Taiwan case is the incorporation of elements unique to Taiwan (i.e. typhoon and earthquake impacts) to the international standards for wind turbine design. However, it is suggested that there is still room for improvement in the CNS standard. For example, the CNS 15176-1 has been reported to not explicitly recommend the depth of engineering bedrock for offshore wind farms in the country nor having specific requirements for components inside the wind turbines (e.g. switchgear, transformer, converter, etc.) and substations (Kuo et al., 2021; Huang et al., 2021).

Other typical international standards used in Taiwan are DNVGL-SE-0073 or DNVGL-SE-0190 for project certification, DNVGL-ST-0145 for offshore substations, and DNVGL-ST-0359 for power cables.

The National Renewable Energy Certificate Center within the BSMI was officially launched in 2017 with a key mission to issue a Taiwan Renewable Energy Certificate (T-REC), which is an important tool for companies to demonstrate their commitment to Corporate Social Responsibility along with the efforts to protect the environment.

To sum up, for offshore wind projects, project certification using national standards is mandatory in Taiwan.

4.1.3 Korea

The two support schemes that give rise to offshore wind energy in Korea are the Renewable Portfolio Standards (RPS) and Renewable Energy Certificates (RECs).

The Renewable Portfolio Standards (RPS), a successor to the Feed-in Tariff policy, requires Large Power Producers (those exceeding 500MW capacity excluding renewable energy) to supply a fixed amount of their total power production from renewable sources. Large Power Producers can meet their RPS obligations by either installing renewable energy capacity, purchasing these RECs, or securing fixed-price contracts with renewable producers to meet their RPS commitments. Renewable Energy Certificates (RECs) are issued to renewable energy producers based on the amount of electricity generated. The amount of REC issued is greater if the renewable projects foster technological development, consider the environment, and promote related industries. Offshore wind (OSW) projects receive the highest weighted value among various renewable energy sources, in which their weighted value is determined based on the compounded weight value for connection distance and water depth, with additional consideration for domestic production (Carbon Trust, 2023). Local Content Requirements are present in both RECs and bidding schemes, affecting the amount of Renewable Energy Certificates issued and the scoring of the bidding process for contracts with renewable energy producers.

The RECs scheme and the Korean national standards share a connection. Projects are not required to be certified, but no RECs will be issued if they are not. In other words, Korea adopts an incentive-based approach to promote the use of national standards by tying it with the benefit of having RECs for the mandated Renewable Portfolio Standards policy.

The certification system for mid to large-sized wind turbines was introduced and enacted in 2014 to promote the wider adoption of new and renewable energy sources and bolster industry growth. Aligned with the government's policy of certification integration to alleviate the burden on companies and consumer confusion arising from multiple certifications, it transitioned to the Korean Standard Certification system. It was enforced from July 29, 2015. The KS Certification system emerged as an initiative from the Government to differentiate the national standards from the international type certification system focusing on turbine design. The KS certification is based on the international standard family IEC 61400, following the steps (1) design evaluation, (2) type testing, and (3) manufacturing evaluation.

The Korea Energy Agency (KEA) plays a central role in setting standards for offshore wind projects in Korea. KEA oversees the manufacturing evaluation process and ultimately issues KS certificates by consolidating findings from design evaluations and type testing. TÜV SÜD and DNV are the exclusive design evaluation bodies authorized by KEA. They are responsible for granting certifications based on both the KS Certification and the IEC certification scheme. It is also worth noting that Korea does not have regulations to mitigate the risk of having a third party perform certifications.

The KS Certification system has been noted for causing delays, as international wind turbines already certified are subjected to additional testing using national standards. However, the KS Certification scheme serves a dual purpose: ensuring wind turbines are adapted to local conditions and safeguarding the domestic supply chain.

To sum up, in South Korea, the legal frameworks for offshore wind are still evolving and developing, awaiting the issuance of the 2021 Special Act for the Promotion of Wind Power Distribution. While project certification remains optional, its integration with the Renewable Energy Certificates (RECs) incentive makes adopting the scheme a common practice in the industry.

4.1.4 The UK

Similarly, the rapid growth of the offshore wind industry in the UK that brings disruptive changes is also responsible for the need to ensure consistency, reliability, and safety across the sector which manifests in the form of OSW project standardization. The prominent supporting scheme that drives offshore wind expansion in the country in the first place is the Contract for Difference (CfD) policy.

Contracts for Difference is the policy known to have brought about the success of the offshore wind industry in the UK. Ever since it was introduced in the Energy Act 2004, it has acted as a safety net for power prices, compensating the power producers for the difference between a reference market price for electricity and a bid "strike price." While not directly related to technical standards, the CfD scheme incentivizes investment in offshore wind projects, thereby indirectly influencing industry standards by promoting project viability and financial sustainability.

Unlike some jurisdictions where project certification is mandated by regulatory bodies, the market-driven approach is applied to project certification in the UK. As such, there is no approving body for certification and standardization. Component certificates play a crucial role in independently verifying compliance with specific requirements, thereby simplifying their inclusion in projects and integration into overall project certification. Similarly, wind turbine-type certificates streamline their application and integration into project certification. Typically, UK offshore wind power plant certification focuses on design basis and design phases. Although there is no regulation for the requirement of either project or components certification, certification is still being carried out as a good practice when it comes to securing funding from banks and other financial institutions. Other reasons making it unnecessary to mandate certification in the UK are:
- Certification simplifies conducting due diligence and makes the owner and prospective buyer feel more confident going into an offshore wind project. On top of this, with the limited time frame for review, the whole process can be simplified using certification from an independent third party.

- UK health and safety laws are stringent, mandating companies to demonstrate they've implemented adequate measures to safeguard their structures. Since certification primarily targets technical safety across all assets and components, undergoing third-party review serves as evidence of taking reasonable precautions to ensure overall design integrity and safety.
- Offshore wind projects are only getting larger over time, so the incentive to streamline the design and certification is there to ensure project accuracy.

Previously, certification schemes for UK offshore wind power plants included IEC 61400-22 (withdrawn in 2018) and DNVGL-SE-0073 for wind farm certification based on IEC 61400-22. Currently, certifications are conducted under DNV-SE-0190 for wind power plants and the IECRE OD-502 Project Certification Scheme. These schemes adhere to relevant standards like EN, IEC, ISO, and DNV.

The UK's national standards include the adoption of IEC and ISO. This approach enhances the credibility, reliability, and market acceptance of UK offshore wind projects and products since it translates to alignment with global best practices and facilitates interoperability and harmonization across jurisdictions. One of the instrumental factors is the British National Technical Committee PEL/88, which aligns with IEC/TC88 and CENELEC/TC88. PEL/88 not only represents the UK but is also instrumental in shaping international and European standards, for example, the IEC TC 61400-50-4 international standard for floating lidar technology. In general, PEL/88's contributions mainly focus on larger turbines, offshore support structures, wind resource measurements, structural integrity, and aviation safety. It is worth noting that, at the early stage, national standards regarding offshore wind in the UK also focused on the health and safety aspects, which are still in their nascent stage at the international level. Therefore, the UK is currently the forerunner in developing health and safety standards for offshore wind worldwide. Lightning protection is the epitome of such standards.

The UK's wealth of experience in the mature offshore oil and gas industry contributes to the success of developing offshore wind and industry standards. This experience serves as a valuable asset for the offshore wind sector. Cross-sector collaboration and knowledge transfer allow the offshore wind industry to leverage established best practices, technologies, and expertise from the oil and gas sector, particularly in areas such as structural design, foundation engineering, and operational safety.

4.1.5 Germany

The German offshore wind industry is supported by a robust legal framework outlined in the Offshore Wind Energy Act (WindSeeG) § 47 Planfeststellungsverfahren, Sec. 1, item 5. This act, administered by the Federal Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie), delineates the planning approval process. Specifically, item 5 of §47 empowers the Planning Approval Body (in this case, BSH) to request reports from recognized bodies (such as certification bodies).

In Germany, obtaining certifications for offshore wind projects at every stage of development is a legal obligation per BSH regulations. The "Standard Design Minimum requirements concerning the constructive design of offshore structures within the Exclusive Economic Zone (EEZ), BSH7005" is a project certification scheme encompassing requirements and citing relevant standards. Notably, BSH7005 references standards such as DIN EN, DNV, DNV GL, GL, ISO, and NORSOK. Additionally, there is BSH7004 detailing the "Minimum requirements for geotechnical surveys and investigations into offshore wind energy structures, offshore stations, and power cables."

Offshore wind standardization in Germany primarily addresses logistics and marine operations due to the absence of an established offshore energy sector before the presence of offshore wind. Standardization in Germany is overseen by the German Institute for Standardization (DIN), the German

Commission for Electrical, Electronic & Information Technologies (DKE), and the Federal Maritime and Hydrographic Agency (BSH). Two DIN groups work on safety procedures, port operations, and other maritime issues and offshore wind-specific foundations. Meanwhile, there is one DKE group managing standards related to power production from offshore wind technology. Moreover, collaborative efforts extend to DIN's Shipbuilding and Marine Technology Standards Committee (NSMT), which not only supervises marine operations in offshore wind but also aligns with committees concerning inland waterway vessels and small marine vessels to ensure standard consistency. Similar coordination initiatives are pursued with committees dedicated to foundations and turbines.

For offshore wind turbine design, foundations, and environmental impact assessment, the Federal Maritime and Hydrographic Agency (BSH) establishes its standards covering all project phases from design to decommissioning. These standards, developed by expert teams, outline meticulous minimum requirements for mandatory geological, geophysical, and geotechnical site investigations at designated wind farm sites, the prerequisites for offshore wind turbine construction, and ensuring the certification of all installations and structural components, foundations, and environmental impact assessments. They also undergo a stringent certification process, with certification bodies chosen from a predefined list that includes classification societies. different certification bodies may oversee distinct phases of the project, such as design certification, manufacturing, transport, and so forth. Strategic coordination ensures early harmonization of German standards and prevents redundant efforts. BSH, in its role as the overseeing authority for standardization, ensures consistency and takes the responsibility of being the approving agency of standards across all five phases of offshore wind projects: development, design, implementation, operation, and decommissioning. During these phases, BSH often receives support from external experts, such as geotechnical specialists for the development phase or wind turbine experts for the design phase. Some industry experts have suggested that streamlining and expediting the approval process conducted by BSH could offer advantages to the market.

During the design phase, which encompasses site conditions and serves as the foundation for subsequent stages, project developers/owners are required to showcase the preparation of a feasible and compliant catalog of applicable standards and methodologies, along with clarifying site conditions. Additionally, adherence to state-of-the-art practices is mandatory. Standards are established to delineate specifications for components like support structures or wind turbines. Surveillance throughout manufacturing, transportation, and installation processes is essential, with subsequent evaluation and regular inspection mandated during plant operation.

In terms of certification, while component certification requirements are not explicitly outlined in BSH7005, they play a crucial role in independently verifying component compliance with defined requirements. This facilitates smoother integration into projects and streamlines the process for type or project certification. The offshore type certificate is deemed a prerequisite for installing wind turbines in offshore wind farms, as stipulated in BSH7005. Additionally, project certification for wind turbines and substations, including support structures, is mandatory for offshore wind farms, according to BSH7005.

4.1.6 The Netherlands

In the Netherlands, national standards can be recognized by 'NEN' which serves as a comprehensive guideline outlining the agreements, specifications, or criteria that products, services, or methods must adhere to. Unlike laws, which specify legal requirements, standards provide a detailed description of what is expected and how compliance can be achieved. Complying with standards is not explicitly mandated by law or explicitly outlined in offshore wind regulations. However, governmental authorities responsible for overseeing the projects expect developers to adhere to relevant industry standards. In addition, standards play an important role in agreements. Compliance with standards is often included in contracts with investors and insurers. The standards offer parties clarity and confidence.

A NEN-EN or NEN-EN-IEC standard simply means that this European directive is also adhered to in the Netherlands. It is to be read as a European standard used in the Netherlands. No changes have been made to the content of the standards. One specific NEN norm relevant to offshore wind turbine construction is NEN-EN-IEC 61400. This norm outlines technical specifications and guidelines for the design, manufacturing, and installation of wind turbines, including those installed offshore. It covers aspects such as structural design, safety considerations, electrical systems, and environmental conditions, providing a framework for ensuring the reliability and performance of offshore wind turbines while complying with regulatory requirements.

The responsibility for arranging and overseeing standards falls under the Netherlands Standardization Institute, commonly known as NEN. NEN works closely with stakeholders, including industry experts, government agencies, academia, and other standardization bodies, to establish consensus-based standards that reflect best practices, safety requirements, and technological advancements.

The Dutch Standards Committee NEC 88 acts as a national consultation platform for IEC/TC 88 and CLC/TC 88. This committee also has a member who has connections with the Technical University of Delft. This NEC 88 team is actively involved in developing the scope of the TC 88 on an international level, which is to provide a basis for design, quality assurance, and technical aspects for certification. The standards address site-specific conditions, all systems and subsystems of wind turbines and wind power plants, such as mechanical, and electrical systems, support structures, control and protection as well as communication systems for monitoring, centralized and distributed control and evaluation, implementation of grid connection requirements for wind power plants, and environmental aspects of wind power development.

The main reason why international standards are adopted as national standards is legal alignment to ensure that regulations and guidelines for electrical installations align with those of other countries, promoting consistency and harmonization across the world.

Experience From Other Countries

The table below provides a structured breakdown of the case study. This table adopts the work of IRENA, where The UK and Germany were the focus of the study. Data for the Taiwan, Korea, and Netherlands cases was collected from government reports (Taiwan), reports on the same topic in the local language (Korea), a desk study, and interviews with experts in the field (the Netherlands).

	Taiwan	**Korea**	**United Kingdom**	**Germany**	**Netherlands**
Standards development	Demand for national standards comes from international standards for offshore wind turbines IEC 61400-3-1 and DNV-ST-0437 not having local environmental conditions taken into consideration.	A Certification system for large wind turbines (>750kW) was established to differentiate it from a Type Certification already being implemented internationally. The official name of the new system is KS Certification.	Standardization is shaped by experiences from the offshore oil and gas sector. Early focus on health, safety, and environmental guidelines and related standards development. In the area of structures and foundations, international standards were taken over. BSI has promoted standards on design requirements for offshore wind turbines.	Less focus on national standards. Several committees working on standards related to structure/foundation, marine issues (e.g., vessels, port procedures), and turbines (power-producing unit). German national standards developed for technical and environmental regulation (BSH standards).	In addition to adopting international standards, the Netherlands Standardization Institute (NEN) addresses specific requirements or conditions relevant to the Dutch context. The country is known to prioritize health and safety, so changes involve safety requirements and procedures. Other adaptations to standards may incorporate requirements or guidelines related to environmental impact or resource efficiency.
The focus of standardizatio n efforts	Turbines protect against hazards such as typhoons and earthquakes.	Offshore wind turbine design (since the KS Certification is based on the international standard family IEC 61400).	Health and safety, structures and foundations, lessons learned from offshore oil and gas.	Offshore logistics, clear separation but coordination among various standardization working groups.	No information available from the desk study
National standards	Moderate significance since the international standards do not take typhoon and earthquake impacts into account yet.	Minor significance, national standards set out rules for turbine design might be in place to promote the local industry more	Minor significance, related mainly to specific gaps in international standardization, i.e., health and safety.	A significant role for technical regulation and certification of wind farm project development.	Minor significance, there are national standards, however, related mainly to specific gaps in international standardization to meet i.e. Dutch regulation, health, and safety

	Taiwan	Korea	United Kingdom	Germany	Netherlands
	However, there is still room for improvement.	than to improve existing standards.			
	The CNS system is an initiative carried out by the Government. However, the industry was highly encouraged to participate in the development of national standards as a means to develop human resources for the industry (BSMI, 2016).	KS Certification seems to be an initiative by the Government. Both domestic and overseas wind turbine manufacturers and certification bodies were invited to the public hearings on the development of the S Certification Scheme and Standards.	It can be too costly for the industry to follow national standards and to adjust products to each market. Thus, the industry has played an important role in harmonizing and developing international standards.		
Legislation and certification requirements	Mandatory Full project certification of the wind turbines, offshore substation, and power cables is required.	Not mandatory Developers are free to opt for a voluntary project certification, in many cases according to international IEC standards (former IEC 61400-22 or currently IEC RE OD-502). However, if developers fail to have project certification, no RECs will be issued.	Not mandatory However, banks and funding institutions often demand certification for risk mitigation.	Mandatory Germany has developed technical regulations by BSH as a basis for the certification process. BSH standards reference IEC standards	Not mandatory. However governmental authorities are responsible for overseeing the projects and expect developers to adhere to relevant industry standards. In addition, compliance with the standards is often expected and in contracts with investors, insurers comply with the standards.
Regulatory measures	Prescriptive approach, requirements are set in the "Regulation on the review project	Incentive-based approach	Flexible approach, relatively market-driven.	Prescriptive approach, regulating in particular the design, construction, and operation of offshore wind	Very regulated market. The key aspects related to legislation are: - Offshore Wind Energy Act - Environmental Impact

	Taiwan	Korea	United Kingdom	Germany	Netherlands
	certification issued by product CBs in offshore wind farm", issued on 23 September 2019			turbines to reach acceptable levels of safety, reliability, and performance.	Assessments - Safety regulations - Grid-connection requirements - Certification Requirements
Stakeholders		The Government took the initiative to launch the KS Certification System. Domestic and overseas private sector and certification bodies were invited to get involved.	Initially, government, then industry and commercial interests. The public sector is very engaged in health and safety, and environmental protection. There are some disagreements between the finance sector and the industry about risk mitigation and sufficient means to avoid risk.	Public and private actors are equally involved, and both have pushed standardization processes in the sector. The industry has issued relatively few complaints, due likely to functioning certification requirements. Interviewed experts highlighted that standardization can be stricter.	NEN works closely with industry experts, government agencies, academia, and other standardization bodies, to establish consensus-based standards that reflect best practices, safety requirements, and technological advancements.
Approving body	Bureau of Standards, Metrology and Inspection (BSMI)	The Korean Energy Agency (KEA)	N/A	The Federal Maritime and Hydrographic Agency, Bundesamt für Seeschifffahrt und Hydrographie (BSH)	Netherlands Standardization Institute (NEN)
Certification body	Organizations accredited according to ISO/IEC 17065 and related standards				
Floating offshore wind		Of national interest. The Ulsan Floating Offshore Wind Project is set out to be the next largest floating offshore wind farm.	Of national interest. The UK is pushing the topic at the national and international levels, led by Scotland.	At the international level only. Committee members from Germany seconded to the respective Working Group at the IEC.	Fixed foundations are the most logical and least expensive because of the shallow seabed of the country. However, TNO is actively researching possibilities of floating wind turbines and the Dutch design of floating turbines for exports.

4.2 Study tour to two European countries with strong experience in OWP

After thoroughly analyzing and assessing the standards experience and wind power development across five countries (China, Taiwan, UK, Germany, and the Netherlands), we recommend conducting the study tour in two countries: Germany and the Netherlands. Of course, this excursion will undergo reporting, consultation, and approval by ETP/UNOPS and STAMEQ. Our selection of these two countries for the study tour is grounded in the following rationales:

Choosing labs in the Netherlands and Germany over others has several justifiable reasons:

- Leadership in the Offshore Wind Power (OWP) Sector: The Netherlands and Germany are among the few European countries holding leading positions in offshore wind power. They have heavily invested in offshore wind technology and have a long history of supporting the development of this industry. Therefore, labs in these countries possess deep knowledge and practical experience in testing and evaluating standards for OWP.
- Diversity in Infrastructure and Technology: Both the Netherlands and Germany have developed diverse infrastructure in the offshore wind energy sector, allowing the testing of various structures and technologies. This diversity includes wind speeds ranging from low to high, locations from onshore to offshore, and environmental factors such as waves and harsh weather conditions.
- National and International Standards: The Netherlands and Germany play significant roles in establishing and promoting national and international standards for the offshore wind energy sector. Labs in these countries are closely linked with standardization organizations and have extensive experience applying and testing these standards.
- Geographic Convenience: The Netherlands and Germany are centrally located in the European offshore wind power activities, with numerous offshore wind farms and electricity production facilities. Labs in these countries are more accessible. It minimizes costs and travel time compared to selecting other countries, such as Norway or Denmark, which may be farther from offshore areas and industry hubs.

The implementation steps for the study tour will follow the procedures outlined in the Inception Report.

4.3 International Standards

Standardization bodies

An international standards organization produces international standards, and examples are the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO). A special group of standards organizations consists of classification societies and non-governmental organizations that establish and maintain technical standards for ships and offshore structures. In addition, various industry-based standards organizations exist, such as the Institute of Electrical and Electronics Engineers (IEEE). There are also regional standardization organizations such as the European Committee for Standardization (CEN) and European Committee for Electrotechnical Standardization (CENELEC), both recognized by the EU to provide European Standards (EN), and national standardization organizations such as the British Standards Institute (BSI) in the UK, Deutsches Institut für Normung (DIN) in Germany. These organizations are responsible for developing, maintaining, and publishing the respective standards. Typically, the standards are developed and maintained by subject-related committees. The committees are composed of a group of experts, often across countries and companies. In addition, local authorities can publish regulations, requirements, and/or standards such as Bundesamt für Seeschiffahrt und Hydrographie (BSH) in Germany and the Royal Netherlands Standardization Institute (NEN) in the Netherlands.

Table 9 - Standardization bodies that produce standards specific for offshore wind.

Type	**Organization**	**Involvement with the OSW industry**
International standard organizations	International Electrotechnical Commission (IEC)	The Technical Committee TC88 of IEC is responsible for developing wind-related standards. The IEC 61400 series includes a set of standards delineating the specifications for the design, testing, and maintenance of offshore wind turbines and wind farms. These standards encompass various aspects such as design, construction, testing, inspection, performance, operations, and maintenance monitoring. Their purpose is to ensure the safety, reliability, and expected performance of offshore wind farms.
Regional standard organizations	EU: European Committee for Standardization (CEN)	European Standards (EN) used for wind turbine structures are e.g. EN 1993-1- series
	EU: European Committee for Electrotechnical Standardization (CENELEC)	European Standards (EN) used for wind turbines are e.g. EN 61400-series. Technical Committee working on offshore wind CENELEC/TC88
National standardization organizations	UK: British Standards Institute (BSI)	BSI is the national standards body of the UK and develops technical standards such as the BS EN 61400-series The British National Technical Committee PEL/88 PEL/88's contributions have focused on larger turbines, offshore support structures, wind resource measurements, structural integrity, and aviation safety
	Germany: Bundesamt für Seeschiffahrt und Hydrographie (BSH)	Regarding construction projects in the North and Baltic Seas, the BSH is responsible for the spatial planning and the testing and approval of power generation systems (offshore wind turbines), cables, and other systems within the scope of federal responsibility
	Korea: Korean Energy Agency (KEA)	KEA is a public institution formulating national standards, known as Korean Industrial Standards (KS), and incorporates global standards such as those from the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO) to regulate technologies. There are 11 Korean Standards for wind energy as of May 2014 (KEA, n.d.)
	Taiwan: The Bureau of Standards, Metrology and Inspection (BSMI)	BSMI is a state agency that is in charge of setting standards for imported and commercial products in the Taiwanese market. It is also responsible for the standard implementation and certification of offshore wind energy in Taiwan.

Classification societies/ Certification bodies	Denmark: DNV	Complete set of standards and recommended practices for wind power plants including turbines, bottom-fixed and floating support structures, cables, and offshore substations.

Table 9 presents an overview of the technical standards applied during the developmental phases of offshore wind farm projects across five representative countries and Europe. While Eurocodes (EN) are commonly adopted within European jurisdictions, the prevailing standards include those from the International Electrotechnical Commission (IEC) and Det Norske Veritas (DNV) across all regions. Additionally, national standards are currently built based on IEC norms.

The petroleum and marine sector standards are also applied within OWF development in terms of the requirements for the general wind farm structure, specific designs for offshore structures, and preventing corrosion. Due to the extensiveness of the applied standards from various sectors, the documented standards will primarily focus on those directly pertinent to offshore wind farms, in addition to standards from allied sectors that significantly contribute to the OWF project.

Chapter 5: Required standards for OWP development in Vietnam

This Chapter answers the following question: 'What standards are required in Vietnam for OWP to be developed successfully?' and is guided by the following sub-questions:

a. What are the current gaps related to standards for OWP in Vietnam?
b. What is the proposed list of standards for OWP in Vietnam that should be developed?
c. What content needs to be included in the standards for OWP in Vietnam?

5.1 Current gaps related to standards for OWP in Vietnam

As observed in Section 2.3, seven TCVNs related to offshore wind have already been adopted. No gaps exist between the National TCVNs and International Standards for Wind Power because these seven TCVN standards are harmonized with the respective IEC 61400 standards. The gap lies in the absence of technical standards that are in place in countries with significant offshore wind experience. From the comprehensive analysis of current standards of OWP in Vietnam and internationally, the gaps observed are related to the following:

- Preparation of technical documentation for permit application, review/evaluation, and approval. Currently, technical standards are insufficient, leading to obstacles for relevant stakeholders during appraisal and approval procedures.
- Safety standards and manuals for the design, construction, and operation of OWP in Vietnam have not been established.
- Technical design standards for the offshore parts of OWP, such as the wind turbine rotor-nacelle assembly (RNA), the wind turbine support structure (tower and various foundation types such as monopile and jacket), and the electrical infrastructure (submarine inter-array cables, offshore substation, and submarine export cables).

The gaps can be shown in more detail by focusing on the main components of the OWP. It is noted that the matrix below is a generic overview – for example, an offshore wind turbine support structure (tower and foundation) is mainly a steel structure that shall adhere to specific mechanical design codes. Still, it also includes some electrical (the cables) and safety systems (the lift). We provide a generic overview of the gaps in the main standards. Whereas:

ITC: Inspection, Testing & Commissioning
O&M : Operation & Maintenance
NA: Not available
PA: Partially Available
A: Available
NR: Not required
T&I: Transport and Installations
Empty cells are not relevant.

No	Project activities and sections	Survey	Design	T&I	ETC	O&M	Safety
1	Overall national technical regulations	A	NA	NA	NA	NA	NA
2	Bathymetric investigation/ seabed mapping	A				A	
3	Engineering geological/ geotechnical investigation (general requirements,	PA					

No	Project activities and sections	Survey	Design	T&I	ETC	O&M	Safety
	particular methods such as geophysics, drilling, testing, etc.)						
4	Wind speed measurement (metmast, LiDAR, satellite etc.)	PA	PA	PA	PA	PA	PA
5	Wind resource assessment		NA			NA	
6	Oceanological survey and analysis (tide, wave, storm surge, current, etc)	PA	PA	PA	PA	PA	PA
7	Offshore wind turbines	NA	PA		NA	NA	NA
8	Offshore support structure	NA	NA		NA	NA	NA
9	Offshore substations	NA	NA		NA	NA	NA
10	Submarine cables	NA	NA		NA	NA	NA
11	Onshore substations	A	A		A	A	A
12	Onshore cables	A	A		A	A	A
13	Construction (method, vessel, onshore facilities, etc.)		NA	NA	NA		
14	Control and grid connection requirements (grid code, SCADA standard, etc.?)		A		A	A	A
15	Decommissioning						NA

The cells in dark grey indicate critical gaps for the development of OWP. These are:

- Offshore wind turbines: an absence of safety standards for the wind turbines (design, construction, operation, and decommissioning) could involve additional risks for people, the environment, and projects in later phases. Many companies experienced in offshore wind will apply their own HSE standards irrespective of Vietnamese requirements, but to ensure that all people working on OWP return home safely every time, such standards are needed. It also facilitates a safe working environment for OWP and any local Vietnamese content.
- Offshore support structures: an absence of technical standards for carrying out offshore surveys of water and soil means that the technical basis for the design of the structures may need to be completed, insufficient, or unreliable.
- The above also applies to the safety and technical design of offshore substations and cables. For wind turbines and cables, the risk is considered somewhat lower because their technical designs are standardized, and so the most demanding technical codes worldwide apply.

5.2 Proposed list of standards for OWP in Vietnam to be developed

The necessity of national TCVN standards for facilitating offshore wind power development, ensuring that Government Competent Authorities and investors face no significant challenges or difficulties in the application procedures of permit, appraisal, approval, agreement, and acceptance for project documents as per the stipulation of regulations. To achieve this objective, the proposed standards should be in alignment with the regulation regarding the development progress of OWPs. So, the following groups of standards should be developed for offshore sections of OWP projects:

- Survey and Investigation
- Design standards

- Inspection, Testing, and Commissioning
- Health, Safety and Environment (HSE) standards
- Transport and Installation
- Operation and Maintenance, including the Supervisory Control and Data Acquisition (SCADA) systems that enable the monitoring and operation of the wind turbines (WTG) and the electrical infrastructure (HV system). This also encompasses the communication standards necessary for effective monitoring and control.

The Rationale for selecting reference standards will adhere to the following priority hierarchy:

- IEC (International Electrotechnical Commission): This is the highest priority, ensuring conformity with existing Vietnamese standards specific to wind energy.
- International Standards (e.g., ISO): These are adopted following the existing precedence of adapting ISO standards within Vietnam.
- International Regional Standards (e.g., Eurocode): These standards will be considered following international and ISO standards.
- National Standards (e.g., from the UK, Norway, Germany, and China): These will be used when more regionally specific or international standards do not suffice.
- Internationally Recognized Institutional Standard Systems (e.g., DNV): These standards are considered when other higher-priority frameworks are not applicable.

Table 10 - The list of recommended standards for OWPs and respective rationale as follows:

No	Description	Rationale for recommended Standards
I	**Design standards**	
1	Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines	The requirement in TOR – Annex 2[4] The Letter 888/TĐC-TC of STAMEQ, dated March 19, 2024, Comment on the proposal to develop 20 Vietnamese Standards (TCVN) for offshore wind power in Vietnam. The STAMEQ informed that the proposed standard has been approved by MOST by the decision 3243/QD-BKHCN, dated December 27, 2023, on the Approval of the Vietnamese Standards (TCVN) development plan in 2024. Therefore, this standard should be canceled and supplemented by a standard that is necessary for the development of OWP that is recommended herein.
2	Wind energy generation systems - Part 3-2: Design requirements for floating offshore wind turbines	The requirement in TOR – Annex 2 The Letter 888/TĐC-TC of STAMEQ, dated March 19, 2024, Comment on the proposal to develop 20 Vietnamese Standards (TCVN) for offshore wind power in Vietnam. The STAMEQ informed that the proposed standard has been approved by MOST by the decision 3243/QD-BKHCN, dated December 27, 2023, on the Approval of the Vietnamese Standards (TCVN) development plan in 2024. Therefore, this standard should be canceled and supplemented by a standard that is necessary for the development of OWP recommended herein.

[4] The proposed list of TCVNs for OWP is specified in Annex 2 of Terms of Reference. For detail, please refer appendix 1 of this report.

No	Description	Rationale for recommended Standards
3	Wind turbines - Part 4: Design requirements for wind turbine gearboxes	The requirement in TOR – Annex 2 The Reference the standard should be IEC 61400-4:2012. This standard outlines the minimum requirements for the specification, design, and verification of gearboxes in wind turbines. It applies to enclosed, speed-increasing gearboxes for horizontal axis wind turbine drivetrains with a power rating exceeding 500 kW. It provides the essential specifications and methodologies for the engineering, design, testing, and operational performance of wind turbine gearboxes to ensure their reliability and efficiency. The standard is relevant for wind turbines installed both onshore and offshore. This standard covers various aspects including load assumptions, design and application guidelines, testing methods, and the requirements for gearbox components such as gears, bearings, and housings. It aims to ensure that gearboxes can withstand the operational conditions they will face in the field, thereby reducing the risk of failures and extending the service life of wind turbines. This standard is crucial for manufacturers, designers, and engineers involved in the development and maintenance of wind turbines.
4	Wind energy generation systems - Part 5: Wind turbine blades	The requirement in TOR – Annex 2 The Reference the standard should be IEC 61400-5:2020. This standard specifies the design requirements for wind turbine blades. The standard provides detailed guidelines for the structural design of wind turbine blades, including the materials used, load calculations, and validation procedures. The standard outlines the processes for ensuring that wind turbine blades are adequately designed to handle various operational loads and environmental conditions they will encounter throughout their service life. This includes addressing the static and fatigue strengths of blade materials and structures and ensuring an appropriate safety margin. The standard also includes considerations for the aerodynamic and acoustic performance of the blades, methods for testing structural reliability, and requirements for documentation and reporting. This comprehensive approach is intended to help manufacturers produce more reliable, efficient, and durable wind turbine blades, thus enhancing overall turbine performance and safety. The purpose of this standard is to serve as a technical reference for designers, manufacturers, purchasers, operators, third-party organizations, and material suppliers. Additionally, it defines the requirements for certification.
5	Wind energy generation systems - Part 6: Tower and foundation design requirements	The requirement in TOR – Annex 2 It should be noted that IEC 61400-6:2020 specifies the requirements and general principles for assessing the structural integrity of onshore wind turbine support structures,

No	Description	Rationale for recommended Standards
	For OWP, this standard is proposed to be replaced by Support Structures for Offshore Wind Turbines which is developed by referring to DNV-ST-0126	including foundations. Therefore, IEC 61400-6:2020 would not be an appropriate reference document for the development of TCVN standards for towers and foundations of Offshore Wind Power (OWP) projects. The design requirements for support structures of Offshore Wind Turbines are specified in the proposed TCVN Part 3-1 and Part 3-2, for fixed and floating offshore wind turbines, respectively. DNV-ST-0126 Support Structures for Wind Turbines should be considered as an appropriate reference document for the development of TCVN standards for towers and foundations of OWP. DNV-ST-0126: Developed by DNV (Det Norske Veritas), this standard provides a comprehensive guideline for the design of wind turbine structures, with a focus on the structural design and evaluation of wind turbine support structures. The standards include detailed methodologies for structural assessment and also incorporate broader considerations including load calculations and the verification processes. The standard delves deeper into specific engineering practices, structural details, and methodologies that typical of a comprehensive approach to maritime and offshore engineering standards. The TCVN standard on support structures for offshore wind turbines, developed by referring to DNV-ST-0126, will enhance the capabilities of the domestic supply chain concerning the support structures of offshore wind turbines.
6	Wind energy generation systems – Part 29: Marking and lighting of wind turbines	The reference standard should be IEC 61400-29:2023 The standard is a part of IEC 61400, which is a Technical Specification, that provides technical practice for aviation lighting and marking of wind turbines in both onshore and offshore domains. This document serves as a guideline for designers, suppliers, purchasers, and regulators. This will improve situational awareness for airspace users, maintain the safety of aircraft flying in the vicinity of wind turbines, and provide additional tools to assist with the reduction of environmental impacts consistent with aviation safety objectives.
7	Offshore Substations for Wind Farms	The reference standard should be DNV-OS-J201 This standard provides general safety principles, requirements, and guidance for offshore substations associated with OWP projects. The objective of this standard for: Provide a nationally acceptable standard for the safe design of offshore substations; Promote a holistic, risk-based approach to the health and safety of personnel, environmental protection, and

No	Description	Rationale for recommended Standards
		safeguarding of the installation, considering economic consequences; Define minimum design requirements for installations and supplement these with options for improving safety; Serve as a guideline for designers, suppliers, purchasers, and regulators serve as a contractual reference document between suppliers and purchasers; Specify requirements for offshore installations subject to government authorities's verification and acceptance of the project.
8	Corrosion protection of offshore wind turbines	The reference standard should be DNVGL-RP-0416 This standard provides principles, technical recommendations, and guidance for the design and construction, and in-service inspection of corrosion protection systems for the structure of offshore wind turbines and offshore substations. The objectives of this recommended practice are to: Provide a nationally acceptable level of safety by defining minimum requirements for corrosion protection systems (in combination with referenced standards, recommended practices, guidelines, etc.); Serve as a reference document between suppliers and purchasers related to design, construction, installation, and in-service inspection; Serve as a guideline for designers, suppliers, purchasers and regulators; Specify procedures and requirements for corrosion protection systems; Serve as a basis for verification of the scope and application of corrosion protection systems.
9	Cathodic protection of offshore wind structures	The reference standard should be EN-ISO 24656:2022 This standard specifies the requirements for external and internal cathodic protection for offshore wind farm structures. It is applicable for structures and appurtenances in contact with seawater or seabed environments. This document addresses: Ddesign and implementation of cathodic protection systems for new steel structures; Assessment of residual life of existing cathodic protection systems; Design and implementation of retrofit cathodic protection systems for improvement of the protection level or life extension of the protection; Inspection and performance monitoring of cathodic protection systems installed on existing structures, and; Guidance on cathodic protection of reinforced concrete structures.

No	Description	Rationale for recommended Standards
10	General requirements for wind turbine plants *(Under development by Technical Committee TC88)*	The reference standard should be IEC 61400-101 This standard specifies the essential general requirements to ensure the safety, reliability, performance, testing, and interaction with electrical power networks engineering integrity, performance, and safety of wind turbine energy plant systems comprising one or more offshore wind turbines during the full life from design to decommissioning. This standard is concerned with the design of all subsystems of wind turbine plants energy systems such as design conditions and site assessment, loads, control and protection mechanisms, internal electrical systems, mechanical systems, and support structures, with tests, measurements, and validation as well as with manufacturing, transport and installation, operation and maintenance and finally decommissioning. This standard will serve as a basis for designers and government competent authorities referring to the progress of designing, appraisal, approval, and acceptance of OWP projects. However, the IEC 61400-101 standard, which is currently under development by Technical Committee TC88, has not yet been published.
11	Submarine power cables – Test methods and requirements	The reference standard should be IEC 63026 This standard specifies test methods and requirements for submarine power cables with extruded insulation and their accessories intended for use in power transmission systems at rated voltages from 6 kV (Um = 7.2 kV) up to 60 kV (Um = 72.5 kV). It covers aspects such as material properties, electrical testing, mechanical testing, and thermal testing to ensure reliability and safety in their application. This standard will serve as a guideline for designers and contractors on the testing and commissioning of submarine cable systems for offshore wind power (OWP) projects.
12	Subsea cables for wind power plant	The reference standard should be DNVGL-ST-0359 This standard specifies the requirements for subsea power cable installations during all phases of a subsea power cable project with a focus on the evaluation of renewable energy applications in shallow water and landfall. The objectives of this standard are to: Support developers of wind power plants and their contractors for the certification application. It helps to clarify requirements related to the certification of subsea power cables and their accessories for offshore wind power plants; Define minimum requirements and scope for third-party evaluation of the design, manufacturing, transport, installation, and operation of power cable components and projects;

No	Description	Rationale for recommended Standards
		Provide a common platform for communicating the scope and extent of key activities during subsea power cable certification projects in renewable energy applications, e.g., with government competent authorities' approval.
13	Ships and marine technology – Offshore wind energy – Port and marine operation	The reference standard should be ISO/DIS 29400 This Standard provides comprehensive requirements and guidance for the planning and engineering of port and marine operations, encompassing all documents and works related to such port and marine operations, e.g. the design and analysis of the components, systems, equipment, and procedures required to perform port and marine operations, as well as the methods or procedures developed to carry them out safely. This Standard is intended to be comprehensive, covering all relevant information related to port and marine operations necessary for installation, offshore commissioning works, operation and maintenance, component exchange, repair operations, and decommissioning or redeployment of offshore wind farms. This Standard will serve as the basis for designers and government competent authority referring to the progress of designing, appraisal, approval, and acceptance of port and marine operation for the OWP project.
II	**Inspection, testing, and commissioning**	
1	Wind turbines – Part 11: Acoustic noise measurement techniques	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-11:2012 This standard offers guidance on the measurement, analysis, and reporting of complex acoustic emissions from wind turbine generator systems. Its purpose is to establish a uniform methodology that ensures consistency and accuracy in the measurement and analysis of acoustical emissions by these systems. The standard is designed to benefit parties involved in the manufacturing, installation, planning, permitting, operation, utilization, and regulation of wind turbines. Adopting such a standard could limit the performance of conventional offshore wind turbines, which are typically engineered for optimal energy output.
2	Wind turbines - Part 13: Measurement of mechanical loads	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-13:2021 This standard specifies the procedures for measuring fundamental structural loads on wind turbines, aimed at validating load simulation models. It prescribes specific requirements and recommendations for site selection, signal selection, data acquisition, calibration, data verification, measurement load cases, capture matrix, post-processing, uncertainty determination, and reporting. The standard is critical for verifying the structural integrity and durability of wind turbines. It helps manufacturers and developers assess whether their wind turbines meet the

No	Description	Rationale for recommended Standards
		required safety and performance standards, supporting the optimization of design and the assurance of long-term operation. This standard is invaluable for engineers, designers, and researchers in the wind energy sector, contributing to the development of safer, more efficient wind energy systems.
3	Wind turbines - Part 14: Declaration of apparent sound power level and tonality values	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-14:2005 This standard provides guidelines for declaring the acoustic noise emission values of wind turbines. It specifies procedures for measuring and reporting the sound level generated by a wind turbine. The standard aims to ensure transparency in declaring the noise emissions and facilitates comparison between different wind turbines. It also helps manufacturers, developers, and planners in assessing compliance with noise regulations and guidelines applicable to specific locations where wind turbines are installed. Adopting such a standard could limit the performance of conventional offshore wind turbines, which are typically engineered for optimal energy output.
4	Wind turbines - Part 23: Full-scale structural testing of rotor blades	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-23:2014 This standard provides guidelines for full-scale structural testing of wind turbine blades and for the interpretation and evaluation of achieved test results. It outlines detailed procedures to ensure that the tests accurately reflect real-world operational conditions and effectively evaluate the structural performance and durability of the blades. The standard aims to facilitate the development, validation, and certification of wind turbine blades by providing a consistent and systematic approach to testing. This is crucial for manufacturers to verify blade designs, enhance safety, improve reliability, and increase the operational lifespan of wind turbines.
5	Wind energy generation systems - Part 26-1: availability for wind energy generation systems	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-26-1:2019 This standard defines an information model from which time-based, and production-based availability indicators for services can be derived and reported. This standard, which is part of a sub-series addressing availability performance, provides definitions and methodologies for calculating the time-based availability of wind turbines, distinguishing between operational and non-operational states. The standard is essential for manufacturers, operators, and investors, as it offers a clear and consistent method for assessing the reliability and efficiency of wind turbines. By quantifying availability, stakeholders can make informed decisions regarding maintenance strategies, warranty conditions, and operational optimizations. It's a crucial tool for

No	Description	Rationale for recommended Standards
		enhancing the economic viability and performance assessment of wind energy projects.
6	Wind energy generation systems - Part 27-1: Electrical simulation models – Generic models	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-27-1:2020 This standard defines standard electrical simulation models for wind turbines and wind power plants. It establishes standard procedures and requirements for creating generic simulation models of wind turbines and wind power plants intended for use in power systems and grid stability analyses. The standard aims to ensure consistency and accuracy in the models used for assessing the impact of wind power on the overall power system, which is crucial for grid planning, operation, and reliability analysis. It covers various aspects of model validation, parameterization, and the application of models in different system studies. This standard is widely used by engineers and researchers involved in the integration of wind energy into power grids.
7	Wind energy generation systems - Part 27-2: Electrical simulation models – Model validation	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-27-2:2020 This standard specifies procedures for the validation of electrical simulation models for wind turbines and wind power plants, intended to be used in power system and grid stability analyses. It focuses on the validation process to verify that the models are appropriate for studies of power system integration and grid interaction. This standard is crucial for manufacturers, grid operators, and system planners, as it ensures that the models used in simulations truly reflect the behavior of wind turbines under various operating conditions and interactions within the power system. The standard helps enhance the reliability of wind power integration studies and supports the efficient and stable operation of power systems with high penetrations of wind energy.
8	Wind energy generation systems - Part 50-3: Use of nacelle-mounted lidar for wind measurements	The requirement in TOR – Annex 2 The Letter 888/TĐC-TC of STAMEQ, dated March 19, 2024, Comment on the proposal to develop 20 Vietnamese Standards (TCVN) for offshore wind power in Vietnam. The STAMEQ informed that the proposed standard has been approved by MOST by the Decision 3243/QD-BKHCN, dated December 27, 2023, on the Approval of the Vietnamese Standards (TCVN) development plan in 2024. Therefore, this standard should be canceled and supplemented by a standard that is necessary for the development of OWP that is recommended herein.
9	Wind energy generation systems - Measurement and assessment of electrical characteristics - Wind turbines	The reference standard should be IEC 61400-21-1:2019 TCVN 10687-21:2018 is fully equivalent to the IEC 61400-21:2008 standard. However, it has been superseded by IEC

No	Description	Rationale for recommended Standards
		61400-21-1:2019. So, the content of TCVN 10687-21 should be updated accordingly. This standard includes the following new items concerning 61400-21: Frequency control measurement; Updated reactive power control and capability measurement; Including voltage and cos φ control; Inertia control response measurement; Overvoltage ride through test procedure; Updated unde-voltage ride-through test procedure based on Wind Turbine capability.
10	Wind energy generation systems - Measurement and assessment of electrical characteristics - Wind power plants	The reference standard should be IEC 61400-21-2 The standard defines the measurement and test procedures for quantifying the electrical characteristics as the basis for the verification of compliance of the power plant, including: Power quality aspects - Steady state operation; Dynamic response (Undervoltage and overvoltage fault ride-through); Disconnection from the grid (Grid protection) defines a uniform functionality test and measurement procedure for the power plant controller, as a basis for the unit test of the power plant controller. This standard establishes the foundation for power system operators and investors to verify the compliance of OWP plants with technical regulations regarding electrical transmission lines, such as those outlined in Circular 25/2016/TT-BCT.
11	Power performance measurements of electricity-producing wind turbines	The reference standard should be IEC 61400-12-1 This standard specifies a procedure for measuring the power performance characteristics of a single wind turbine and applies to the testing of wind turbines of all types and sizes connected to the electrical power network. This document provides a measurement methodology that requires the measured power curve and derived energy production figures to be supplemented by an assessment of uncertainty sources and their combined effects. This standard serves as a guideline for designers, suppliers, purchasers, and regulators regarding wind turbines.
III	**Supervisory Control and Data Acquisition (SCADA)**	
1	Wind energy generation systems - Part 25-1: Communications for monitoring and control of wind power plants - Overall description of principles and models	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-25-1:2017 This standard provides a comprehensive overview of the principles and models employed in the communication between components of wind power plants, such as wind turbines, and operators like SCADA systems. This standard provides the overall framework, definitions, system architectures, and general requirements for the

No	Description	Rationale for recommended Standards
		communications between wind power plant components such as wind turbines and other electrical systems. The purpose of this standard is to facilitate the effective integration and management of wind power plants in the energy grid, providing a common platform for the interoperability of various systems. The standard aids in enhancing the efficiency, reliability, and safety of wind power plant operations. This is crucial for optimizing performance and maintenance, and for ensuring consistent and accurate data exchange across different parts and stakeholders of wind energy projects.
2	Wind turbines - Part 25-2: Communications for monitoring and control of wind power plants - Information models	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-25-2:2015 This standard specifies the information model of devices and functions related to wind power plant applications. The standard details the information models, which are crucial for defining the structured data and interfaces that are exchanged between different parts of a wind power plant's control system. By defining a standardized approach to information modeling, the standard enables more effective and efficient monitoring, control, and automation of wind power plants. It allows for systems from different manufacturers to communicate and operate seamlessly with each other, enhancing the overall manageability and performance of wind power installations. This standard is critical for developers, operators, and manufacturers of wind power equipment who need to ensure that their systems can integrate and function within broader power grid infrastructures.
3	Wind turbines - Part 25-3: communications for monitoring and control of wind power plants - Information exchange models	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-25-3:2015 This standard defines services of the model of the information exchange of intelligent electronic devices in wind power plants. The standards are critical for the practical implementation of the theoretical models developed in previous standards. It provides the necessary guidelines and specifications for system integrators and developers to ensure that their products can communicate effectively within the wind power sector and with other components of the energy system. This facilitates more effective management and operation of wind power plants and contributes to the overall reliability and efficiency of power systems integrating renewable energy sources.
4	Wind energy generation systems - Part 25-4: Communications for monitoring and control of wind	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-25-4:2016 This standard specifies the specific mappings to protocol stacks encoding the messages required for the information

No	Description	Rationale for recommended Standards
	power plants – Mapping to communication profile	exchange between a client and a remote server in wind power plants. The standard plays a crucial role in defining how specific functionalities within wind power plants are implemented in a standardized way, ensuring reliable and efficient communication. This part of the standard is particularly important for system developers and integrators focusing on ensuring that their systems are compliant and capable of smooth operation within the complex environment of modern power systems.
5	Wind energy generation systems - Part 25-5: Communications for monitoring and control of wind power plants - Compliance testing	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-25-5:2017 This standard specifies standard techniques for testing compliance of implementations and specific measurement techniques to be applied when declaring performance parameters. The standard is vital for manufacturers, developers, and operators of wind power plants as it provides the framework for verifying that the communication aspects of their equipment are up to standard and can effectively integrate into broader wind power plant systems. It enhances reliability, efficiency, and the overall performance of wind power operations.
6	Wind energy generation systems - Part 25-6: Communications for monitoring and control of wind power plants - Logical node classes and data classes for condition monitoring	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-25-6:2016 This standard specifies the information models related to condition monitoring for wind power plants and the information exchange of data values related to these models. The standard is crucial for developers, manufacturers, and integrators in the wind energy sector. It helps ensure that all components of a wind power plant's communication system are implemented correctly and can interact efficiently, supporting the reliable and effective operation of wind power facilities.
7	Wind energy generation systems - Part 25-71: Communications for monitoring and control of wind power plants – Configuration description language	The requirement in TOR – Annex 2 The reference standard should be IEC 61400-25-71:2019 This standard describes how to extend the IEC 61400-25 series with the IEC 61850-6 Substation Configuration Description Language (SCL) file format for describing communication-related to Intelligent Electronic Device (IED) configurations of a wind turbine, wind power plant controller, meteorological mast, etc. The standard is particularly valuable for system engineers, architects, and developers involved in the design and implementation of communication systems in wind power plants. Providing a standardized approach to using advanced systems modeling languages, helps enhance the design, clarity, and efficiency of these critical systems, ensuring they

No	Description	Rationale for recommended Standards
		meet the operational demands and integration needs of modern wind energy projects.
8	Condition monitoring and diagnostics of wind turbines	The reference standard should be ISO 16079-2:2020 This document specifies the implementation of a condition monitoring system for wind turbines, with a particular focus on monitoring the drivetrain. Guidance for practical implementation of the failure mode symptoms analysis (FMSA) is provided, as well as guidance for specifying best practices and minimum recommendations regarding the condition monitoring system used for failure mode detection, diagnostics, and prognostics of the direct drive, and geared wind turbine drivetrain, including: Main bearing(s); Gearbox, if applicable; and Generator (mechanical aspects). The document serves as a guideline for designers, suppliers, purchasers, and operators
IV	**Survey standard**	
1	Wind energy generation systems: Wind measurement	The reference standard should be IEC 61400-50:2022 The standard provides a general introduction to the options that are available for wind measurement. Its purpose is to ensure that wind measurements and the evaluation of uncertainties in those measurements are carried out consistently across the wind industry and that wind measurements are carried out such that the uncertainties can be quantified and that those uncertainties are within an acceptable range.
2	Ground Investigations – Minimum requirements for geotechnical surveys and investigations into offshore wind energy structures, offshore stations and power cables	The reference standard should be the Standard Ground Investigations of the Federal Maritime and Hydrographic Agency (BSH) This standard provides guideline which describes the minimum requirements regarding geotechnical surveys and investigations as well as field and laboratory studies including geotechnical assessments as part of the design basis for the structural components of an offshore wind farm as well as monitoring construction and operations.
V	**Safety standards**	
1	Wind turbines - Protective measures - Requirements for design, operation and maintenance	The reference standard should be EN 50308:2005 This standard specifies requirements for protective measures relating to the health and safety of personnel, relevant to the commissioning, operation, and maintenance of wind turbines. Requirements are specified regarding: Hardware provisions being a part of the turbine such as platforms, ladders, and lighting; Manuals and warning signs to accommodate safe and quick operation, inspection, and maintenance.

No	Description	Rationale for recommended Standards
		The requirements and/or measures specified account for the hazards: Of mechanical origin such as falling, slipping, or locking in, – of thermal origin (fire) such as burns by flames or explosions; Of electricity such as contact with live parts; Generated by noise such as stress and loss of hearing; Generated by neglecting ergonomic principles in machine design such as unhealthy postures or human errors. The document serves as a guideline for designers, suppliers, purchasers, and operators
2	Wind energy generation systems. Safety of wind turbine generators. General principles for design	The reference standard should be IEC 61400-30:2023 This standard is a Technical Specification, that specifies the essential health and safety requirements related to the design of wind turbines with horizontal axes. The document serves as a guideline for designers, suppliers, purchasers, and regulators.
VI	**Installation & Erection**	
1	Ships and Marine Technology - Offshore Wind Energy	The reference standard should be ISO 29400:2020 This standard provides comprehensive requirements and guidance for the planning and engineering of port and marine operations. Its content is intended to be comprehensive, covering all relevant information related to port and marine operation and maintenance, component exchange, repair operations, and decommissioning or redeployment of offshore wind farms. This document applies to port and marine operations for offshore structures, including: Lattice structure foundations made from steel; — concrete Gravity base structures (GBS); Piled steel foundation or mixed steel and concrete foundation structures; Subsea templates and similar temporary structures or installation aids; Steel or mixed material towers, nacelles, and blades form part of the wind turbine generators (WTG); Floating turbines moored to the seabed; Self-elevating offshore units for offshore substations or offshore accommodations platforms; Launching systems at sea from quayside or onshore; array cables within the wind farms as well as export cables connecting the wind farms to the grid. This document is also applicable to modifications of existing structures, e.g. installation of additional modules, exchange of components or decommissioning, and to marine operations during the service life of the windfarm related to the technical maintenance works.

No	Description	Rationale for recommended Standards
2	Transportation and installation of offshore wind turbines	The reference standard should be DNVGL-ST-0054 This standard provides general safety principles, requirements, and guidance for the transport and installation of offshore wind power plants. The objective of the standard is to provide an approach to ensure the structural integrity of the wind power plant assets and components during transport, installation, and decommissioning operations. Further objectives of this standard are: To serve as a guide for designers, suppliers, purchasers, and regulators for the safe design and execution of Transportation & Installation procedures based on a risk-based approach to serve as a contractual reference document between suppliers and customers.
3	Floating offshore wind turbine installations	The reference standard should be DNVGL-RU-OU-0512 This standard presents the rules for the classification of floating offshore wind turbine installation, the terms and procedures for assigning and maintaining classification, including a listing of the applicable technical references to be applied for classification. This document covers the classification of unmanned floating offshore wind turbine installations of the following design types: Ship-shaped installations; Barge/pontoon installations; Column-stabilized installations; Cylindrical installations; Deep draught floating installations; Tension leg installations; Floating installations other than above.

ISSQ has submitted a proposal to STAMEQ for the development of 20 TCVNs specifically for Offshore Wind Power (OWP) projects, as detailed in the Terms of Reference (TOR), Annex 2. To ensure all parties are properly aligned and to maintain the quality and schedule of the project, it is crucial to adopt the standards listed in the TOR, Annex 2. Additionally, we propose replacing three overlapping TCVNs, which another entity has already registered, with three new standards. This revision will help avoid duplication and is aligned with the objectives of the National Power Development Plan VIII, focusing specifically on the strategic implementation of offshore wind power projects.

Regarding three standards listed in the TOR, Annex 2 that overlap with those approved by Decision 3243/QD-BKHCN of MOST:

- Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines;
- Wind energy generation systems - Part 3-2: Design requirements for floating offshore wind turbines;
- Wind energy generation systems - Part 50-3: Use of nacelle-mounted lidar for wind measurements;

The consortium proposes to replace these overlapping standards with other ones that will serve as appropriate technical guidelines for designers, investors, and authorities during the project preparation phases, as follows:

- Wind energy generation systems. Safety of wind turbine generators. General principles for design. The reference standard would be IEC 61400-30:2023.
- Update TCVN10687-1:2015 (IEC 61400-1:2014 - Wind turbines - Part 1: Design requirements) version according to IEC 61400-1:2019
- Update TCVN10687-24:2018 (IEC 61400-24:2010- Wind turbines - Part 24: Lightning protection) version according to IEC 61400-24:2019
- Offshore Substations for Wind Farms. The reference standard would be DNV-OS-J201.
- Submarine power cables – Test methods and requirements. The reference standard is IEC 63026

Among the five options listed above, we will finalize three alternative options to replace 3 overlapping TCVN standards. The proposed standard portfolio we suggest is modified based on feedback regarding the necessity of standards and suggestions from STAMEQ. The proposed list of standards has been defended by ISSQ at the technical council of STAMEQ and has been approved.

5.3 Contents to be covered in the proposed TCVNs

The objectives of the national TCVN standards for offshore wind power (OWP) are to serve as:

- Reference documents for developers, investors, and authorities in the processes of applying for permits, agreements, appraisals, approvals, and acceptance of OWP projects.
- Guidelines for designers, suppliers, purchasers, operators, and regulators in the development, implementation, and operation of OWP plants.

The proposed standards for OWPS in this stage are the standards in the list that will be submitted to STAMEQ for approval. The contents to be covered in the TCVNs for OWPs concerning the reference respective standards would be:

No	Description	The contents to be addressed	Note
I	**Design standards**		
1	Wind turbines - Part 4: Design requirements for wind turbine gearboxes	This standard outlines the minimum requirements for the specification, design, and verification of gearboxes in wind turbines with the following main items: 1. Scope 2. Normative references 3. Terms, definitions and conventions 4. Symbols, abbreviations and units 5. Design for reliability 6. Drivetrain operating conditions and loads 7. Gearbox design, rating, and manufacturing requirements 8. Design Verification 9. Operation, service, and maintenance requirements 10. Annexes	TOR – Annex 2[5]

[5] See Appendix 1. Of this report for the overview of standards from TOR – Annex 2.

No	Description	The contents to be addressed	Note
2	Wind energy generation systems - Part 5: Wind turbine blades	This standard defines the minimum set of requirements for the design and manufacturing of wind turbine blades with the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Notation 5. Design environmental conditions 6. Design 7. Manufacturing requirements 8. Blade Installation, operation and maintenance	TOR – Annex 2
3	Wind energy generation systems - Part x: Support Structures for Offshore Wind Turbines	This standard specifies general principles and guidelines for the structural design of wind turbine structures, towers, and foundations. The document covers the following main items: 1. Scope 2. Normative references 3. Terms, definitions and abbreviations 4. Procedural requirements 5. Design principles 6. Site conditions and loads 7. Steel structures 8. Concrete structures 9. Grouted connections 10. Geotechnical design 11. Scour and scour prevention for offshore structures 12. In-service inspection, maintenance and monitoring 13. Annexes	TOR – Annex 2
4	Wind energy generation systems – Part 30: Safety of wind turbine generators. General principles for design	This Technical Specification (TS) specifies the Essential Health and Safety Requirements (ESHR) related to the design of horizontal Wind Turbine Generator (WTG), with rotor area ≥200 m2. This document focuses on requirements for safe operation, inspection, maintenance, installation and decommissioning. The content covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Principal elements 5. Control system 6. Isolation of energy sources 7. Electrical systems 8. Mechanical systems	Proposed to replace Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines

No	Description	The contents to be addressed	Note
		9. Working environment 10. Lighting systems 11. Fire protection 12. Emergency, escape and evacuation 13. Information for use 14. Annexes	
5	Offshore Substations for Wind Farms	This standard provides general safety principles, requirements, and guidance for offshore substations associated with OWP projects. This standard will: Serve as a guideline for designers, suppliers, purchasers, and regulators serve as a contractual reference document between suppliers and purchasers; Specify requirements for offshore installations subject to government authorities' verification and acceptance of the project . The content covers the following main items: 1. Scope 2. Normative references 3. Terms, definitions and abbreviations 4. Formal safety assessment 5. Arrangement principles 6. Structural design 7. Electrical design 8. Fire and explosion protection 9. Access and transfer 10. Emergency response 11. Construction 12. In-service inspection and maintenance 13. Annexes	Proposed to replace Wind energy generation systems - Part 3-2: Design requirements for floating offshore wind turbines
II	**Inspection, testing, and commissioning**		
1	Wind turbines - Part 11: Acoustic noise measurement techniques	This standard provides a uniform methodology that will ensure consistency and accuracy in the measurement and analysis of acoustical emissions by wind turbine generator systems. The document covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Symbols and units 5. Outline of method 6. Instrumentation 7. Acoustic measurements and measurement procedures 8. Non-acoustic measurements 9. Data reduction procedures	TOR – Annex 2

No	Description	The contents to be addressed	Note
		10. Information to be reported 11. Annexes	
2	Wind turbines - Part 13: Measurement of mechanical loads	This standard describes the measurement of fundamental structural loads on wind turbines for the load simulation model validation. The document covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Symbols, units, and abbreviations 5. General 6. Test requirements 7. Determination of calibration factors 8. Data verification 9. Processing of measured data 10. Uncertainty estimation 11. Reporting 12. Annexes	TOR – Annex 2
3	Wind turbines - Part 14: Declaration of apparent sound power level and tonality values	This standard gives guidelines for declaring the apparent sound power level and tonality of a batch of wind turbines with the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. General 5. Declaration 6. Information to be reported 7. Annexes	TOR – Annex 2
4	Wind turbines - Part 23: Full-scale structural testing of rotor blades	This standard defines the requirements for full-scale structural testing of wind turbine blades and for the interpretation and evaluation of achieved test results. The content covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Notation 5. General principles 6. Documentation and procedures for test blade 7. Blade test program and test plans 8. Load factors for testing 9. Test loading and test load evaluation 10. Test requirements 11. Test results evaluation 12. Reporting 13. Annexes	TOR – Annex 2

No	Description	The contents to be addressed	Note
5	Wind energy generation systems - Part 26-1: availability for wind energy generation systems	This standard defines an information model from which time-based, and production-based availability indicators for services can be derived and reported. The content covers the following main items: 1. Scope 2. Normative references 3. Terms, definitions and abbreviation terms 4. Information model 5. Information categories 6. Annexes	TOR – Annex 2
6	Wind energy generation systems - Part 27-1: Electrical simulation models – Generic models	This standard defines standard electrical simulation models for wind turbines and wind power plants. The content covers the following main items: 1. Scope 2. Normative references 3. Terms, definitions, abbreviation and subscripts 4. Symbols and units 5. Functional specification of models 6. Formal specification of modular structures of models 7. Formal specification of modules 8. Annexes	TOR – Annex 2
7	Wind energy generation systems - Part 27-2: Electrical simulation models – Model validation	This standard specifies procedures for the validation of electrical simulation models for wind turbines and wind power plants, intended to be used in power system and grid stability analyses. The content covers the following main items: 1. Scope 2. Normative references 3. Terms, definitions, abbreviations, and subscripts 4. Symbols and units 5. Functional specifications and requirements for validation procedures 6. General methodologies for model validation 7. Validation of wind turbine models 8. Validation of wind power plant models 9. Annexes	TOR – Annex 2
8	Submarine power cables – Test methods and requirements	This standard specifies test methods and requirements for submarine power cables with extruded insulation and their accessories intended for use in power transmission systems at rated voltages from 6 kV (Um = 7.2 kV) up to	Proposed to replace Wind energy generation systems - Part 50-3:: Use of nacelle-mounted

No	Description	The contents to be addressed	Note
1		60 kV (Um = 72.5 kV). It covers aspects such as material properties, electrical testing, mechanical testing, and thermal testing to ensure reliability and safety in their application. This standard will serve as a guideline for designers and contractors on the testing and commissioning of submarine cable systems for offshore wind power (OWP) projects. The content covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Voltage designations, materials, and rounding numbers 5. Cable construction 6. Cable Characteristics 7. Accessory characteristics 8. Test conditions 9. Routines tests on cables and accessories 10. Sample tests on cables 11. Sample tests on accessories 12. Type tests on cable systems 13. Electrical tests after installation 14. Annexes	lidar for wind measurements
III	**Supervisory Control and Data Acquisition (SCADA)**		
1	Wind energy generation systems - Part 25-1: Communications for monitoring and control of wind power plants - Overall description of principles and models	This standard provides a comprehensive overview of the principles and models employed in the communication between components of wind power plants, such as wind turbines, and operators like SCADA systems. The content covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Abbreviated terms 5. Overall description of IEC 61400-25 6. Wind power plant information model 7. Wind power plant information exchange model 8. Mapping to communication protocols 9. Annexes, if any	TOR – Annex 2
2	Wind turbines - Part 25-2: Communications for monitoring and control of	This standard specifies the information model of devices and functions related to wind power plant applications. The content covers the following main items:	TOR – Annex 2

No	Description	The contents to be addressed	Note
	wind power plants - Information models	1. Scope 2. Normative references 3. Terms and definitions 4. Abbreviated terms 5. General 6. Wind power plant logical node classes 7. Common data classes 8. Annexes	
3	Wind turbines - Part 25-3: communications for monitoring and control of wind power plants - Information exchange models	This standard defines services of the model of the information exchange of intelligent electronic devices in wind power plants. The content covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Abbreviated terms 5. General 6. Information exchange models overview 7. Operational functions 8. Management functions 9. The ACSI for wind power plant information models 10. Annexes	TOR – Annex 2
4	Wind energy generation systems -Part 25-4: Communications for monitoring and control of wind power plants – Mapping to communication profile	This standard specifies the specific mappings to protocol stacks encoding the messages required for the information exchange between a client and a remote server in wind power plants. The content covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Abbreviated terms 5. General Overview 6. Annexes	TOR – Annex 2
5	Wind energy generation systems - Part 25-5: Communications for monitoring and control of wind power plants - Compliance testing	This standard specifies standard techniques for testing compliance of implementations and specific measurement techniques to be applied when declaring performance parameters. The content covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Abbreviated terms 5. Introduction to compliance testing 6. Device-related compliance testing 7. Performance tests 8. Annexes	TOR – Annex 2
6	Wind energy generation systems - Part 25-6: Communications for monitoring and control of wind power plants -	This standard specifies the information models related to condition monitoring for wind power plants and the information exchange of data values related to these models. The content covers the following main items:	TOR – Annex 2

No	Description	The contents to be addressed	Note
	Logical node classes and data classes for condition monitoring	1. Scope 2. Normative references 3. Terms and definitions 4. Abbreviated terms 5. General 6. Logical nodes for wind turbine condition monitoring 7. Common data classes for wind turbine condition monitoring 8. Common data class condition monitoring measurement (CMM) attribute definitions 9. Annexes	
7	Wind energy generation systems - Part 25-71: Communications for monitoring and control of wind power plants – Configuration description language	This standard describes how to extend the IEC 61400-25 series with the IEC 61850-6 Substation Configuration Description Language (SCL) file format for describing communication-related to Intelligent Electronic Device (IED) configurations of a wind turbine, wind power plant controller, meteorological mast, etc. The content covers the following main items: 1. Scope 2. Normative references 3. Terms and definitions 4. Abbreviated terms 5. SCL introduction 6. SCL use cases in the wind power domain 7. Mapping specific configuration 8. Annexes	TOR – Annex 2

Chapter 6: Development of the list of National Standards

This Chapter answers the following question: 'How to develop the proposed list of Standards for OWP in Vietnam?' And is guided by the sub-questions:
What is the Consortium's approach to developing the standards?
What is a suitable roadmap for developing the standards?

6.1 Approach to develop the standards

This section elaborates upon the approach that the consortium takes towards the development of the standards. First, it explains how technical teams are formed that will be consulted throughout all deliverables of the project.

6.1.1 Technical teams

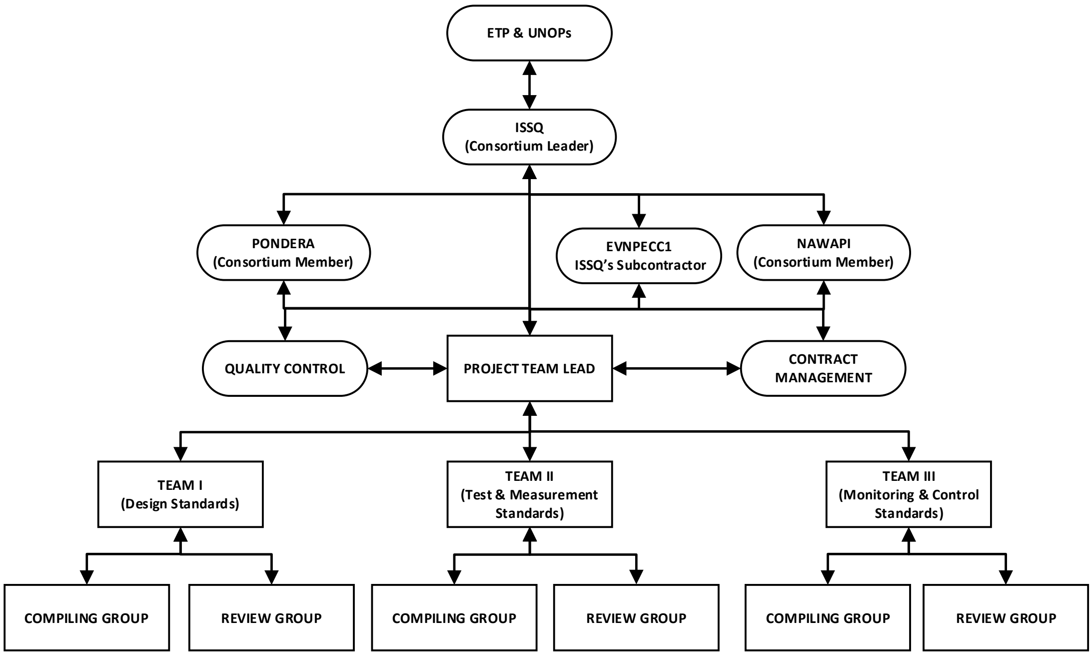
The national TCVN standards for offshore wind power (OWP) will be developed by a technical team with referencing international standards, and the knowledge and experience of countries with advanced expertise in OWP development. These standards are designed to follow technical regulations and are tailored to Vietnam's unique geographical, climatic, technical, and technological characteristics, ensuring they safeguard national interests without any adverse impact.

Regarding project deliverables as specified in the Terms of Reference (TOR) and the consortium's proposal, a technical team has been established with the following roles:

- Deliverable 3: Compiling the draft of national standards for OWP according to the list agreed with STAMEQ
- Deliverable 4: Providing technical assistance to Consortium members during the two hybrid-mode workshops, gathering and analyzing feedback from stakeholders participating in the workshops, and preparing workshop reports.
- Deliverable 5: Absorbing knowledge and experience from countries with strong expertise in offshore wind power during participation in international trips. Preparing the reports regarding lessons learned and recommendations for TCVNs on OWPs in Viet Nam.
- Deliverable 6: Participating in the international laboratory test and preparing the report on testing principles, practical application of TCVNs, and categorization of mandatory and optional standards.
- Deliverable 7: Refining the final draft of the TCVNs for OWPs based on comments and feedback from various stakeholders, in close consultation with STAMEQ.
- Deliverable 8: Providing technical clarification, as needed, during the appraisal of STAMEQ's progress and the promulgation procedure of MOST. Revising and resubmitting draft standards for appraisal and promulgation by MOST, if necessary.
- Deliverable 9. Providing technical assistance to Consortium members during the final stakeholder workshop, gathering and analyzing feedback from stakeholders participating in the workshops, and preparing the final workshop report.

6.1.2 Team members' organizations chart

Regarding Annex 2, which outlines the proposed list of TCVNs for OWPs, and Item 7, which presents the recommended list of national standards detailed in this report, the standards are categorized into three groups: Group I encompass design standards for OWPs, Group II covers test and measurement standards, and Group III includes monitoring and control standards. Therefore, the technical team should be organized into three respective teams, each aligned with members possessing relevant knowledge and experience in the corresponding area. The technical team members organization chart as follows:



6.1.3 Members of Technical Teams

The project team lead

The project team lead is kept consistent with the technical proposal, form D, section 1, item 3.3. Management structure and project management controls. There are three persons in the project team lead as follows:

- Project team lead: Mr. Tran Thai Hai (from EVN-PECC1), who meets the requirements, understands the local context possesses insightful technical knowledge and regulatory expertise, and has extensive experience in the development and implementation of power projects.
- Deputy project team lead: Mr. Vu Van Dien, from ISSQ, who possesses insight knowledge and regulatory expertise, and has extensive experience in the development of national standards.
- Deputy project team lead: Mr. Ngo Kien Cuong, from PONDERA, possesses extensive technical knowledge and has a long-standing track record in the development, implementation, commissioning, and maintenance of power projects.

Technical team members

The technical team members have been selected from the key individuals identified in Section 4.5, "Key Consultants," of the first deliverable (the Inception Report), as well as in Section 3, "Key Personnel Proposed," of the technical proposal, Form D. These key consultants are allocated to three distinct teams based on their relevant background knowledge and expertise, ensuring a match between their skills and the team's focus areas. The responsibility allocation for compiling and review based on the core expertise of each consortium partner. The details of the technical teams are as follows:

Whereas:

- Comp. = Compiling
- Rev. = Reviewing
- R = Responsible allocated

No	Name	Company	Team I (Design standards)		Team II (Testing & Measurement)		Team III (Monitoring & Control)	
			Comp.	Rev.	Comp.	Rev.	Comp.	Rev.
1	Tran Thai Hai	EVNPECC1	R				R	
2	Vu Van Dien	ISSQ	R		R			
3	Ngo Kien Cuong	Pondera		R		R		R
4	Pham Thanh Dam	ISSQ	R		R			
5	Bart Ummels	Pondera		R		R		R
6	Albert Ploeg	Pondera		R		R		R
7	Mark Van Doom	Pondera		R		R		R
8	Bui Thanh Hung	ISSQ	R		R			
9	Bui Xuan Thong	NAWAPI		R		R		
10	Nguyen Ngoc Ha	NAWAPI		R		R		
11	Nguyen Quang Huy	ISSQ	R		R		R	
12	Nguyen Binh Phong	NAWAPI		R		R		
13	Le Tien Thanh	ISSQ			R		R	
14	Ha Duy Hieu	ISSQ			R		R	
15	Le Quang Huy	EVN-PECC1	R		R			
16	EVN-PECC1 Team	EVN-PECC1	R		R		R	

6.1.4 Responsibilities of Technical Teams

The project team lead

The responsibilities of a project team lead encompass a broad range of tasks and duties aimed at ensuring the project's successful deliverables. The duties of the project team lead are as follows:

- Determining international standards and technical regulations to serve as reference documents when compiling draft national standards.
- Led the teams compiling draft national standards, refining the final draft of national standards, and preparing the reports of the project.
- Participating in progress meetings, hybrid workshops, and international labs.
- Planning and scheduling activities to align with contract milestones for each deliverable.
- Monitoring and controlling the progress of deliverables to ensure they are on track.
- Building and maintaining a cohesive team, assigning tasks based on the skills and experiences of team members.
- Acting as the primary point of contact both within the project team and between the team and stakeholders.
- Identifying potential risks that could affect the timeline and quality of deliverables and developing strategies to mitigate these risks for smooth project execution as outlined in item 5 of the delivered Inception Report.
- Addressing and resolving any issues or conflicts that arise throughout the project.
- Engaging with stakeholders as outlined in the item 3.6 of the delivered inception report to understand their needs and expectations, keep them informed about the progress of the project and address their concerns.
- Ensuring the draft national standard complies with all relevant laws and regulations.

Technical team member – Compiling groups

The responsibilities of the technical team members (compiling groups) are as follows:

- Supporting the team lead in identifying and selecting international standards and technical regulations that will serve as benchmark references for drafting national standards, ensuring alignment with global best practices.
- Engaging in drafting and refining national standards. Take responsibility for preparing reports as assigned.
- Weekly submit the draft standards to the review groups and provide feedback.
- Actively participating in progress meetings, engaging in hybrid workshops, and attending international laboratories as required, contributing to the project's success through collaborative effort and knowledge exchange.
- Utilizing specialized expertise to efficiently execute project tasks and creatively solve challenges, driving forward project objectives with skill and innovation.
- Working closely with team members across different disciplines to collaboratively meet project goals, fostering a supportive and productive team environment.
- Ensuring that the draft national standard adheres to all applicable legal and regulatory requirements while also meeting scheduled activities and milestone deadlines, maintaining high standards of quality and timeliness.

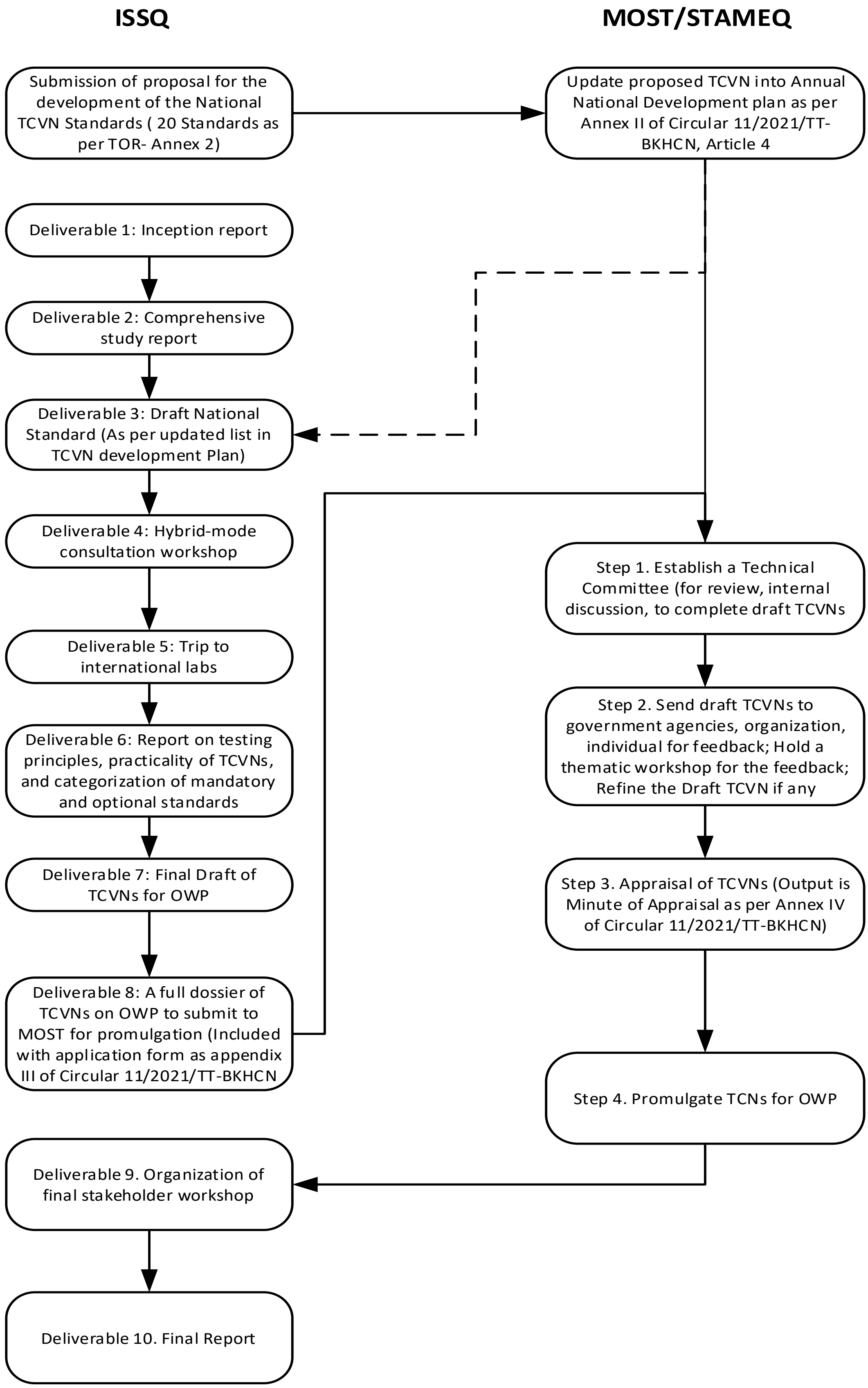
Technical team member – Review groups

The responsibilities of the technical team members (Review Groups) are to review and provide feedback on draft standards to ensure adherence to the following criteria:

- The presentation and content of the submission must comply with the national standard regulations TCVN 1-2:2008.
- The draft standards must conform to referenced international standards.
- The standards must comply with relevant technical regulations.
- The standards should be suitable for Vietnam's geographical, climatic, technical, and technological characteristics.
- The use of "Vietnamese technical terminology" in the standard should be appropriate and in line with current regulatory documents.
- The standards must ensure that there are no regulations that could potentially harm national interests or limit the competitive capability of the domestic supply chain.
- Recommend state-of-the-art practices and knowledge transfer techniques from leading offshore wind power (OWP) countries with advanced expertise, if any.

6.2 Roadmap to develop the standards

To develop the proposed national standards, the roadmap will be created by project deliverables and Circular No. 11/2021/TT-BKHCN, which details the development and application of standards. This process will be outlined in the following flowcharts:


ISSQ
MOST/STAMEQ
Submission of proposal for the development of the National TCVN Standards (20 Standards as per TOR- Annex 2)
Update proposed TCVN into Annual National Development plan as per Annex II of Circular 11/2021/TT-BKHCN, Article 4
Deliverable 1: Inception report
Deliverable 2: Comprehensive study report
Deliverable 3: Draft National Standard (As per updated list in TCVN development Plan)
Deliverable 4: Hybrid-mode consultation workshop
Step 1. Establish a Technical Committee (for review, internal discussion, to complete draft TCVNs
Deliverable 5: Trip to international labs
Step 2. Send draft TCVNs to government agencies, organization, individual for feedback; Hold a thematic workshop for the feedback; Refine the Draft TCVN if any
Deliverable 6: Report on testing principles, practicality of TCVNs, and categorization of mandatory and optional standards
Deliverable 7: Final Draft of TCVNs for OWP
Step 3. Appraisal of TCVNs (Output is Minute of Appraisal as per Annex IV of Circular 11/2021/TT-BKHCN)
Deliverable 8: A full dossier of TCVNs on OWP to submit to MOST for promulgation (Included with application form as appendix III of Circular 11/2021/TT-BKHCN
Step 4. Promulgate TCNs for OWP
Deliverable 9. Organization of final stakeholder workshop
Deliverable 10. Final Report

The referenced standards draw from a variety of sources, including the IEC 6400 series, as well as standards from ISO, IEC, EN, DNV, and others. The priority hierarchy is described in Section 5.2. These standards incorporate modern technology that affects critical components, impacting the safety, stability, and operational availability of offshore wind turbines (WTGs). Subsequently, the selected reference standards are adapted to fit the TCVN framework. Based on the standard of short-listed references, the technical team will eventually provide a detailed schedule for the project, an updated organizational chart, and a division of tasks among technical teams. The preliminary reference standards for developing national TCVNs standards are as the following table:

No	Proposed National TCVNs		Preliminary reference standards	
	Notation	Description	Notation	Description
I	**Wind energy generation systems design standards**			
1	TCVN xxxxx-4:20xx	Wind turbines - Part 4: Design requirements for wind turbine gearboxes	IEC 61400-4:2012	Wind turbines –Part 4: Design requirements for wind turbine gearboxes
2	TCVN xxxxx-5:20xx	Wind energy generation systems - Part 5: Wind turbine blades	IEC 61400-5:2020	Wind energy generation systems –Part 5: Wind turbine blades
3	TCVN xxxxx-x:20xx	Wind turbines - Part 1: Design requirements	IEC 61400-1:2019	Wind energy generation systems - Part 1: Design requirements
4	TCVN xxxxx-x:20xx	Wind turbines – Part 24: Lightning protection	IEC 61400-24:2019	Wind turbines - Part 24: Lightning protection.
II	**Wind energy generation systems on test and measurement of performance standards**			
5	TCVN xxxxx-11:20xx	Wind turbines - Part 11: Acoustic noise measurement techniques	IEC 61400-11:2012	Wind turbines – Part 11: Acoustic noise measurement techniques
6	TCVN xxxxx-13:20xx	Wind turbines - Part 13: Measurement of mechanical loads	IEC 61400-13:2015	Wind turbines – Part 13: Measurement of mechanical loads
7	TCVN xxxxx-14:20xx	Wind turbines - Part 14: Declaration of apparent sound power level and tonality values	IEC 61400-14-2005	Wind turbines – Part 14: Declaration of apparent sound power level and tonality values
8	TCVN xxxxx-23:20xx	Wind turbines - Part 23: Full-scale structural testing of rotor blades	IEC 61400-23-2014	Wind turbines – Part 23: Full-scale structural testing of rotor blades
9	TCVN xxxxx-24:20xx	Wind turbines - Part 24: Lightning protection) according to IEC 61400-24:2019	IEC 61400-24:2019	Wind turbines - Part 24: Lightning protection)
10	TCVN xxxxx-26-1:20xx	Wind energy generation systems - Part 26-1: availability for wind energy generation systems	IEC 61400-26-1-2019	Wind energy generation systems – Part 26-1: Availability for wind energy generation systems

No	Proposed National TCVNs		Preliminary reference standards	
	Notation	Description	Notation	Description
11	TCVN xxxxx-27-1:20xx	Wind energy generation systems - Part 27-1: Electrical simulation models – Generic models	IEC 61400-27-1-2020	Wind energy generation systems – Part 27-1: Electrical simulation models – Generic models
12	TCVN xxxxx-27-2:20xx	Wind energy generation systems - Part 27-2: Electrical simulation models – Model validation	IEC 61400-27-2-2020	Wind energy generation systems – Part 27-2: Electrical simulation models – Model validation
13	TCVN xxxxx-xx:20xx	Submarine power cables – Test methods and requirements	IEC 63026	Submarine power cables – Test methods and requirements
III	**Communications for monitoring and control of wind power plants**			
14	TCVN xxxxx-25-1:20xx	Wind energy generation systems - Part 25-1: Communications for monitoring and control of wind power plants - Overall description of principles and models	IEC 61400-25-1-2017	Wind energy generation systems – Part 25-1: Communications for monitoring and control of wind power plants –Overall description of principles and models
15	TCVN xxxxx-25-2:20xx	Wind turbines - Part 25-2: Communications for monitoring and control of wind power plants - Information models	IEC 61400-25-2-2015	Wind turbines – Part 25-2: Communications for monitoring and control of wind power plants - Information models
16	TCVN xxxxx-25-3:20xx	Wind turbines - Part 25-3: communications for monitoring and control of wind power plants - Information exchange models	IEC 61400-25-3-2015	Wind turbines – Part 25-3: Communications for monitoring and control of wind power plants - Information exchange models
17	TCVN xxxxx-25-4:20xx	Wind energy generation systems - Part 25-4: Communications for monitoring and control of wind power plants – Mapping to communication profile	IEC 61400-25-4-2016	Wind energy generation systems – Part 25-4: Communications for monitoring and control of wind power plants – Mapping to communication profile
18	TCVN xxxxx-25-5:20xx	Wind energy generation systems - Part 25-5: Communications for monitoring and control of wind power plants - Compliance testing	IEC 61400-25-5-2017	Wind energy generation systems – Part 25-5: Communications for monitoring and control of wind power plants – Compliance testing
19	TCVN xxxxx-25-6:20xx	Wind energy generation systems - Part 25-6: Communications for monitoring and control of wind power plants - Logical node	IEC 61400-25-6-2016	Wind energy generation systems – Part 25-6: Communications for monitoring and control of wind power plants – Logical node

No	Proposed National TCVNs		Preliminary reference standards	
	Notation	Description	Notation	Description
		classes and data classes for condition monitoring		classes and data classes for condition monitoring
20	TCVN xxxxx-25-71:20xx	Wind energy generation systems - Part 25-71: Communications for monitoring and control of wind power plants – Configuration description language	IEC 61400-25-71-2019	Wind energy generation systems – Part 25-71: Communications for monitoring and control of wind power plants – Configuration description language

Chapter 7. Conclusions and recommendation

The comprehensive study report addresses the critical need for establishing national standards for Offshore Wind Power (OWP) in Vietnam by identifying the current gaps in standards related to OWP. This includes an assessment of how these gaps affect the overall progress of developing OWP projects by regulations. The identified technical gaps stem from extensive research and analysis of the current state of policies, regulations, and standards for OWP in Vietnam, alongside research and study on international policies, regulations, and standards from leading countries in OWP.

The data for this analysis were gathered through a desk study from trusted sources[6]. Additionally, information from relevant programs/projects on Offshore Wind National Standards, including the Guidelines on Environmental and Social Impact Assessment for Wind Power Projects in Vietnam (GIZ/MoIT 2018), the wind and wave energy potential assessment report by MONRE, and surveys conducted in five benchmark countries has enriched our findings.

Findings in section 3.4 shows that Vietnam's national standard system includes 7 existing TCVNs on wind power, which are entirely equivalent in content to the corresponding IEC 61400 standards. Among them are 4 standards: TCVN 10687-1:2015, TCVN 10687-21:2018, and TCVN 10687-24:2015. Their primary IEC standards have been superseded by the 2019 versions. Therefore, the corresponding TCVN 10687 standards should be updated accordingly.

As observed in section 5.1, no significant gaps exist between the National TCVNs and reference International Standards for Wind Power. The gap lies in the absence of technical standards regarding the preparation of technical documents for permit application, appraisal, and approval by government competent authority, safety standards and manuals for the design, construction, and operation of OWP, and technical design standards for the offshore parts of OWP. Critical gaps for the development of OWP are:

- Safety standards of the wind turbines relating to design, construction, operation and maintenance, and decommissioning.
- Technical standards for carrying out offshore surveys for wind turbine support structures.
- The absence of national safety and technical design standards for offshore substations and submarine cables; the risk is considered lower because their technical designs are standardized and so the most demanding technical codes apply worldwide.

Analysis in section 3.3 demonstrates that national TCVN standards are needed for facilitating offshore wind power development, ensuring that Government Competent Authorities and investors face no significant challenges or difficulties in the application procedures of permit, appraisal, approval, agreement, and acceptance of project documents as per the stipulation of regulations. To achieve this objective, the proposed standards should be in alignment with the regulation regarding the development progress of OWPs. The following groups of standards should be developed for offshore sections of OWP projects:

- Survey and Investigation
- Design
- Inspection, Testing, and Commissioning
- Health, Safety and Environment (HSE)
- Transport and Installation.

[6] These sources include www.ThuVienPhapLuat.vn for Vietnamese regulations and technical standards, www.dnv.com/rules-standards, and https://standards.iteh.ai/catalog/standards for international standards

- Operation and Maintenance, including the Supervisory Control and Data Acquisition (SCADA) systems that enable the monitoring and operation of the wind turbine and generators (WTG) as well as the electrical infrastructure (HV system). This also encompasses the communication standards necessary for effective monitoring and control.

Following the gap, the report outlines a set of recommended standards for Offshore Wind Power (OWP) in Vietnam in section 5.3. These standards are designed to act as reference materials for developers, investors, and authorities engaged in the various stages of permitting, agreement, appraisal, approval, and acceptance of OWP projects. Additionally, the standards offer guidance for designers, suppliers, purchasers, operators, and regulators throughout the development, implementation, and operational phases of OWP facilities.

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Appendix 1. List of TCVNs for OWP as specified in the TOR – Annex 2

No	TCVN	Description
I	**Wind energy generation systems** **Design standards (5 TCVNs)**	
1	Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines	This part specifies additional requirements for the assessment of the external conditions at an offshore wind turbine site and specifies essential design requirements to ensure the engineering integrity of fixed offshore wind turbines. Its purpose is to provide an appropriate level of protection against damage from all hazards during the planned lifetime.
2	Wind energy generation systems - Part 3-2: Design requirements for floating offshore wind turbines	This part is a technical specification, that specifies additional requirements for assessment of the external conditions at a floating offshore wind turbine (FOWT) site and specifies essential design requirements to ensure the engineering integrity of FOWTs. Its purpose is to provide an appropriate level of protection against damage from all hazards during the planned lifetime. This document focuses on the engineering integrity of the structural components of a FOWT but is also concerned with subsystems such as control and protection mechanisms, internal electrical systems, and mechanical systems.
3	Wind turbines - Part 4: Design requirements for wind turbine gearboxes	– Outlines minimum requirements for specification, design, and verification of gearboxes in wind turbines. It is not intended for use as a complete design specification or instruction manual, and it is not intended to assure the performance of assembled drive systems. – Guides the analysis of the wind turbine loads in relation to the design of the gear and gearbox elements. – Also included is guidance on the engineering of shafts, shaft hub interfaces, bearings, and the gear case structure in the development of a fully integrated design that meets the rigors of the operating conditions. – Guidance on the operation and maintenance of the gearbox.
4	Wind energy generation systems - Part 5: Wind turbine blades	The purpose of this document is to provide a technical reference for designers, manufacturers, purchasers, operators, third-party organizations, and material suppliers, as well as to define requirements for certification. This part specifies requirements to ensure the engineering integrity of wind turbine blades as well as an appropriate level of operational safety throughout the design lifetime. It includes requirements for: Aerodynamic and structural design; Material selection, evaluation, and testing; Manufacture (including associated quality management); Transportation, installation, operation, and maintenance of the blades.
5	Wind energy generation systems - Part 6: Tower and foundation design requirements	This part specifies requirements and general principles to be used in assessing the structural integrity of onshore wind turbine support structures (including foundations). The scope includes the geotechnical assessment of the soil for generic or site-specific purposes.
II	**Wind energy generation systems on test and**	

No	TCVN	Description
	measurement of performance standards (8 TCVNs)	
6	Wind turbines - Part 11: Acoustic noise measurement techniques	This part guides the measurement, analysis, and reporting of complex acoustic emissions from wind turbine generator systems.
7	Wind turbines - Part 13: Measurement of mechanical loads	This part describes the measurement of fundamental structural loads on wind turbines for the load simulation model validation. The standard prescribes the requirements and recommendations for site selection, signal selection, data acquisition, calibration, data verification, measurement load cases, capture matrix, post-processing, uncertainty determination, and reporting. Informative annexes are also provided to improve understanding of testing methods.
8	Wind turbines - Part 14: Declaration of apparent sound power level and tonality values	This part gives guidelines for declaring the apparent sound power level and tonality of a batch of wind turbines.
9	Wind turbines - Part 23: Full-scale structural testing of rotor blades	This part defines the requirements for full-scale structural testing of wind turbine blades and for the interpretation and evaluation of achieved test results. The standard focuses on aspects of testing related to an evaluation of the integrity of the blade, for use by manufacturers and third-party investigators. The following tests are considered in this standard: - static load tests; - fatigue tests; - static load tests after fatigue tests; - tests determining other blade properties. The purpose of the tests is to confirm to an acceptable level of probability that the whole population of a blade type fulfills the design assumptions.
10	Wind energy generation systems - Part 26-1: Availability for wind energy generation systems	The purpose is to provide standardized metrics that can be used to create and organize methods for availability calculation and reporting according to the user's needs. The document provides information categories, which unambiguously describe how data is used to characterize and categorize the operation. The information model specifies category priority for discrimination between possible concurrent categories. Further, the model defines entry and exit criteria to allocate fractions of time and production values to the proper information category.
11	Wind energy generation systems - Part 27-1: Electrical simulation models – Generic models	This part defines standard electrical simulation models for wind turbines and wind power plants. The specified models are time-domain positive sequence simulation models, intended to be used in power system and grid stability analyses. The models are applicable for dynamic simulations of short-term stability in power systems
12	Wind energy generation systems - Part 27-2: Electrical simulation models – Model validation	This part specifies procedures for validation of electrical simulation models for wind turbines and wind power plants, intended to be used in power system and grid stability analyses.
13	Wind energy generation systems - Part 50-3:	The purpose of this part is to describe procedures and methods that ensure that wind measurements using

No	TCVN	Description
	Use of nacelle-mounted lidar for wind measurements	nacelle-mounted wind lidars are carried out and reported consistently and according to best practices.
III	**Communications for monitoring and control of wind power plants (7 TCVNs)**	
14	Wind energy generation systems - Part 25-1: Communications for monitoring and control of wind power plants - Overall description of principles and models	This part gives an overall description of the principles and models on the communications between wind power plant components such as wind turbines and actors such as SCADA (supervisory control and data acquisition) systems.
15	Wind turbines - Part 25-2: Communications for monitoring and control of wind power plants - Information models	This part specifies the information model of devices and functions related to wind power plant applications. In particular, it specifies the compatible logical node names and data names for communication between wind power plant components. It includes the relationship between logical devices, logical nodes, and data.
16	Wind turbines - Part 25-3: communications for monitoring and control of wind power plants - Information exchange models	This part specifies an abstract communication service interface describing the information exchange between a client and a server for: Data access and retrieval; Device control; Event reporting and logging; Self-description of devices (device data dictionary); Data typing and discovery of data types.
17	Wind energy generation systems - Part 25-4: Communications for monitoring and control of wind power plants – Mapping to communication profile	This part specifies the specific mappings to protocol stacks encoding the messages required for the information exchange between a client and a remote server for: Data access and retrieval; Device control; Event reporting and logging; Publisher/subscriber; Self-description of devices (device data dictionary); Data typing and discovery of data types.
18	Wind energy generation systems - Part 25-5: Communications for monitoring and control of wind power plants - Compliance testing	This part specifies standard techniques for testing compliance of implementations, as well as specific measurement techniques to be applied when declaring performance parameters. The use of these techniques will enhance the ability of users to purchase systems that integrate easily, operate correctly, and support the applications as intended.
19	Wind energy generation systems - Part 25-6: Communications for monitoring and control of wind power plants - Logical node classes and data classes for condition monitoring	This part specifies the information models related to condition monitoring for wind power plants and the information exchange of data values related to these models, focusing on condition monitoring.
20	Wind energy generation systems - Part 25-71: Communications for monitoring and control of wind power plants – Configuration description language	The purpose of this part is to formally and efficiently exchange wind turbine and wind power plant intelligent electronic device capability descriptions, and system descriptions between intelligent electronic device engineering tools and the system engineering tool(s) of different manufacturers in a compatible way. This part is also intended to provide report configuration and alarms as well as interface information from a wind power plant.