European Commission

Sectoral Study:

Standards, technical regulation and conformity assessment in the Japanese and European offshore wind power market: current implementation and best practices

July 2022

Project reference: EuropeAid/139634/DH/SER/JP
Support facility for the implementation of EU-Japan Economic Partnership Agreement (EPA)

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LIST OF ABBREVIATIONS

ACD	Approved for Committee Draft
ACDV	Approved for CDV
AfN	Accreditation for Nofitication
BELAC	Belgian Accreditation Body
CAB	Conformity Assessment Board
CABs	Conformity Assessment Bodies
CC	Component Certificate
CD	Draft circulated as Committee Draft
CDIT	Coastal Development Institute of Technology
CDV	Committee Draft for Vote
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardization
CGC	China General Certification Center
COFRAC	French Accreditation Body (Comité français d'accréditation)
CPT	Cone Penetration Test
CS	Design evaluation and conformity statement
DAkkS	German Accreditation Body (Deutsche Akkreditierungsstelle)
DANAK	Danish Accreditation Body (Danske Akkrediteringsfond)
DIS	Draft International Standard
DLC	Design Load Case
DS	Danish Standards
DTU	Technical University of Denmark
EA	European Accreditation
EIA	Environmental Impact Assessment
EN	European Standards
ETSI	European Telecommunications Standards Institute
EXCO	Executive Committee
FDIS	Final Draft International Standards
IACS	International Association of Classification Societies
IAF	International Accreditation Forum
IEC	International Electrotechnical Commission
IECRE	IEC conformity assessment framework for renewable energy
ILAC	International Laboratory Accreditation Cooperation
IPAC	Portugal's national accreditation body (Instituto Português de Acreditação)
IS	International Standards

ISO	International Organisation for Standardisation
JAB	Japan Accreditation Board
JEMA	Japan Electrical Manufacturers' Association
JIS	Japanese Industrial Standards
JISC	Japanese Industrial Standards Committee
LRFD	Load and Resistance Factor Design
METI	Ministry of Economy, Trade and Industry
MLA	Multilateral Agreement
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MT	Maintenance Team
NANDO	New Approach Notified and Designated Organisations
NSBs	National Standards Bodies
Ods	Operational Documents
OSW	Offshore Wind
OWP	Offshore Wind Power
PCC	Preparation of Compilation of Comments
PT	Project Team
REI	Renewable Energy Institute
RFDIS	FDIS received and registered
RPUB	Publication received and registered
RVA	The Netherlands national accreditation body (Raad voor Accreditatie)
SC	Sub committee
SMB	Standardization Management Board
SPT	Standard Penetration Test
SWEDAC	Swedish Board for Accreditation and Conformity Assessment
TC	Technical Committee
TP	Type Certificate
TS	Technical Specification
UKAS	National Accreditation Body for the United Kingdom
WG	Working Group

1 Background and scope of the study

1.1 Purpose

The purpose of the study is to give an overview of the current standards, technical regulations, and conformity assessment applicable for offshore wind in Japan, compare it with European use of standards and technical regulation in the area, and identify some areas of best practice that are potentially relevant for the Japanese market.

1.2 Scope

The scope of the study comprises standards and technical regulations in relation to type certification, component certification, as well as project certification. It includes third-party conformity assessment by accredited certified bodies and the processes and regulation in regard to accreditation. It deep dives into the areas that are most relevant for the Japanese market right now. It aims as capturing the whole life cycle of projects, but with an emphasis on the design and permitting phases. Mostly, the scope is on bottom-fixed offshore wind, floating wind is mentioned where relevant and possible. European countries analysed for comparison are France, Germany, Denmark, Belgium, Netherlands, UK (and wherever relevant also Portugal). Compliance to other local regulations, such as environmental impact assessment, administrative permitting procedures, fishing rights, etc. are out of scope of this analysis.

1.3 Approach

The study is undertaken as independent research project by the Technical University of Denmark (DTU) and Renewable Energy Institute (REI), with funding by the European Commission through a contract with consultancy firm Development Solutions. The study approach comprises (1) desktop research and analysis of official documents, regulations, industry standards and process documents, scientific literature, as well as press releases and other 'grey literature' in English, Japanese, and additional European languages; (2) More than ten interviews with relevant stakeholders in Japan and Europe, from which notes were taken and aggregated insights are included in the report.

1.4 Structure

The study is structured in two major parts: the first part (chapters 1-5) deals with technical regulations and standards, and the second part (chapters 6-7) deals with accreditation procedures and certification system for conformity assessment bodies. In each part, we first give a broad introduction to the topic, then describe the Japanese and European system, respectively. We then highlight some differences between the two systems, and then identify best practices from Europe that may potentially be relevant for Japan.

Part I Technical regulations and standards

2 International standards organisation

The ISO (International Organisation for Standardisation) is a worldwide federation of national standards bodies from more than 160 countries. ISO members collaborate in the development and promotion of international standards for technology, scientific testing processes, working conditions, societal issues and more (ISO, 2022). ISO and its members then sell documents detailing these standards. The International Electrotechnical Commission (IEC) is a separate international standards body that establishes standards. It works closely together with ISO. Standards that the ISO and IEC jointly develop are identified by the prefix ISO/IEC.

For offshore wind energy, the IEC standards describe the design requirements of offshore wind turbines and wind farms as well as measurable requirements, reliable tests and reproducible methods. They are documented in the IEC 61400 series. Standards are used for design, construction, testing, inspection, performance, operations, and maintenance monitoring, etc. Standards are important to make sure that an offshore wind farm is safe, reliable and performs as expected.

Standards can be useful for industry in itself and can work as voluntary industry practices. In many cases, a documentation on compliance with standards is desired or necessary (e.g., from business contract partners or regulation). In this case, an external conformity assessment is undertaken. In the end of a successful conformity assessment process (certification process), a conformity certificate is issued. Standards and conformity assessment are mutually dependent as conformity assessment refers to the applicable standards to draw conclusions. ISO/IEC as organisations do not undertake conformity assessments or issue certificates on any particular product or project themselves – they are concerned with defining the rules and procedures of such activities. For this, IEC has a Committee on Conformity Assessment that works on standards related to the certification process. In 2010 the IEC issued the IEC 61400-22 standard to provide a framework for wind energy conformity assessment and testing. Initially, third-party conformity assessment was provided by certification bodies using their own conformity procedures, and rules - to fill in gaps in the standards and align to common structural design review from other industries (e.g., ships, buildings, etc.). The establishment of the IEC conformity assessment framework for renewable energy (IECRE) and its Operational Documents (ODs) in 2014 mitigated this and provided transparency and consistency for the assessment. Consequently, IEC 61400-22 has been withdrawn with effect from 1st of September 2018. However, this does not mean that conformity assessment based on IEC 61400-22 has stopped. IECRE wind certification schemes OD-501 and OD-502 still need to be properly implemented internationally, and many regulations still refer to IEC 61400-22.

The organisation in IEC including the relation between standards and conformity assessment work is illustrated in the figure below.

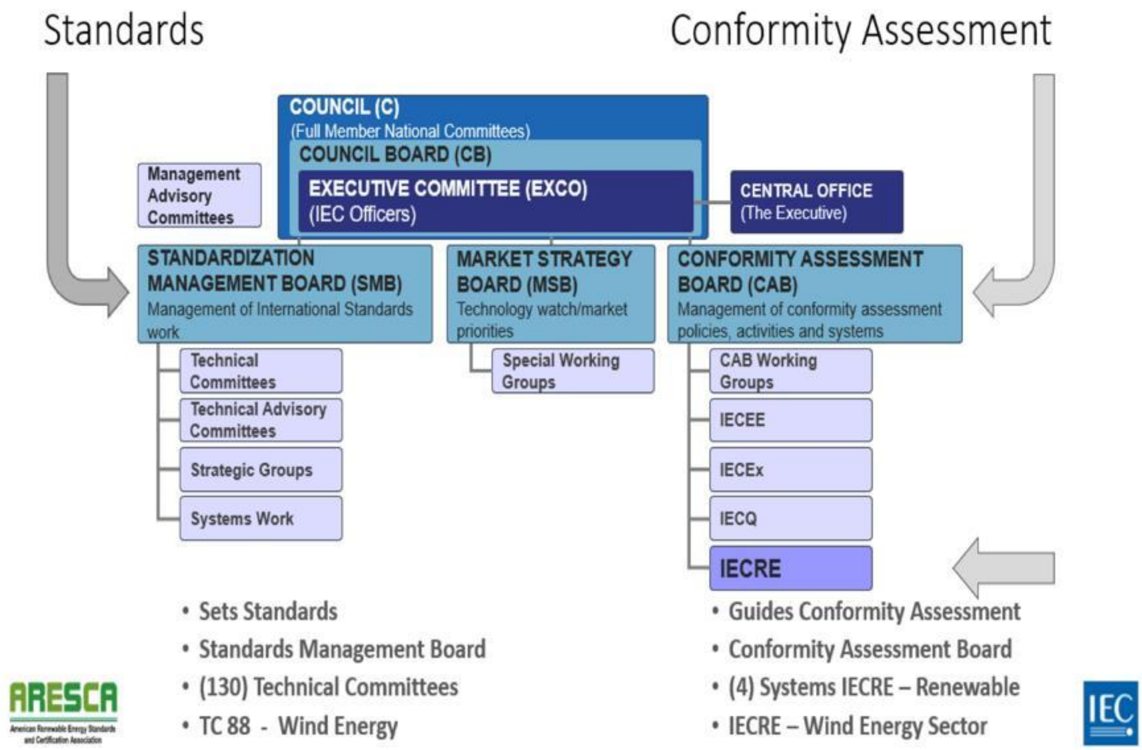

Figure 1 Structure of IEC

Source: ARESCA, American Renewable Energy Standards and Certification Association

The establishment of an international standard for conformity assessment / certification processes under the IECRE enabled multilateral recognitions agreements, which are today frequently used, especially on type and component certification. Countries participate in ISO/IEC work via national standards bodies (NSBs), as well as through input received from liaison organisations. National positions on ISO/IEC work are developed by the NSBs on an ongoing basis.

Relevant Technical Committees (TC) in the ISO/IEC structure are e.g. the 'IEC TC 88 Wind Energy Generation Systems', the 'ISO TC60 Gear' and the 'IEC TC 14 Power Transformers'.

Relevant IEC standards (all handled within the TC88):

- IEC 61400-1 Design requirements
- IEC 61400-2 Small wind turbines
- IEC 61400-3 Design requirements for offshore wind turbines
- IEC 61400-4 Gears for wind turbines
- IEC 61400-(5) Wind Turbine Rotor Blades
- IEC 61400-11, Acoustic noise measurement techniques
- IEC 61400-12-1 Power performance measurements

- IEC 61400-13 Measurement of mechanical loads
- IEC 61400-14 Declaration of sound power level and tonality
- IEC 61400-21 Measurement of power quality characteristics
- IEC 61400-22 Conformity Testing and Certification of wind turbines
- IEC 61400-23 TR Full scale structural blade testing
- IEC 61400-24 TR Lightning protection
- IEC 61400-25-(1-6) Communication
- IEC 61400-26 TS Availability
- IEC 61400-27 Electrical simulation models for wind power generation

Related IEC standards waiting for publication are as below: They will be expectedly published between July 2022 to May 2023.

- IEC61400-50: Wind measurements (publishing schedule 2022-07)
- IEC61400-50-1: Wind measurements application of meteorological mast, nacelle and spinner mounted instruments (publishing schedule 2022-07)
- IEC61400-50-2: Wind Measurement - Application of Ground Mounted Remote Sensing Technology (publishing schedule 2022-07)
- IEC61400-50-4: Use of floating lidars for wind measurements (publishing schedule 2023-05)

3 Overview of Japanese OWP technical regulations and standards

3.1 Laws and Regulations

Among the laws and regulations related to offshore wind power in Japan, the main ones concerning technical standards are presented in the subsections below. Offshore wind farms are required to comply with the technical regulations set by each Act.

3.1.1 Electricity Business Act

Offshore wind power generation facilities fall under the category of Electric Facilities for Business Use under the Electricity Business Act (Article 38, Paragraph 2 of the Electricity Business Act). Electric Facilities for Business Use shall conform to the technical standards established by Ordinances of the Ministry of Economy, Trade and Industry (METI) (Article 39)[12].

3.1.2 Port and Harbour Act

The Support structures for offshore wind power generation facilities are mooring facilities where vessels for maintenance come ashore, and therefore must conform to the technical regulations for port facilities under the Port and Harbour Act and the related ministerial ordinance established by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) (Article 56-2-2).

3.1.3 Ship Safety Act (for floating)

Floating offshore wind facilities are classified as "special vessels" under Article 1, Paragraph 4 of the Ordinance for Enforcement of the Ship Safety Act and are subject to safety regulations based on this Act[3].

3.1.4 Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities and Port and Harbour Act

When offshore wind power generation facilities are installed in the Promotion Zones for the Development of Marine Renewable Energy Power Generation Facilities (hereinafter, the Promotion Zone) under the Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities (hereinafter, the Renewable Energy Sea Area Utilization Act), the project details are described in the Exclusive Occupancy and Use Plan over Public Bidding (hereinafter, the Exclusive Occupancy and Use Plan). The offshore wind power generation facilities and maintenance methods described in the Exclusive Occupancy and Use Plan must conform to the technical regulations specified by the ordinances of METI and MLIT (Article 15, Paragraph 1, Item 3 of the Renewable Energy Sea Area Utilization Act). Article 5 of the ordinance for enforcement of this act specifically defines the regulatory standards, and the MLIT's Notification defines the performance requirements, basics of performance verification and settings, among others[4].

When offshore wind power generation facilities are installed in the areas to be occupied in the waters within the port limits, etc. under the Port and Harbour Act, the details of the project are described in the occupancy plan for public tender. The facilities put out to public tender and their operation and maintenance methods must conform to the technical regulations specified by an ordinance of MLIT (Article 37-5, Paragraph 1, Item

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1 Specifically, there is the "Ministerial Ordinance Establishing Technical Standards for Electrotechnical Technology" that establishes standards for general electrical safety, and the "Ministerial Ordinance Establishing Technical Standards for Wind Power Equipment for Electricity Generation" that establishes standards for the safety performance of wind turbines and supporting structures.

2 In general, technical regulations in the Electricity Business Act are performance requirements, that are clear but abstract. Hence, METI provides "Interpretations" that indicate specific means and numerical values to meet those standards, "Commentaries" explaining the background of ministerial ordinances, the "Interpretation," and supplementary information on the interpretations. This characteristic of technical regulation related to OSW is the same as in other acts and the competent authorities publish explanative documents for these acts as well.

3 The contents of Technical Standard for Floating Offshore wind Power Generation Facilities related to the issues covered in this report are shown in Appendix C.

4 Public Notice of Necessary Matters Concerning Standards for Offshore Renewable Energy Power Generation Facilities or Methods of Maintenance and Management Thereof

3 of the Port and Harbour Act).

3.1.5 Building Standards Act

In 2007, the safety regulations of the Building Standards Act were imposed on support structures for wind power generation facilities with hub heights exceeding 60 m, requiring performance evaluation by a designated performance evaluation body and approval by MLIT. Subsequently, in 2014, the regulations were consolidated from separate assessments based on the Building Standards Act and the Electricity Business Act to safety regulations based on the Electricity Business Act, on the assumption that regulations equivalent to those of the Building Standards Act would be imposed.

Therefore, the Building Standards Act is now not directly applied to offshore wind power generation equipment. However, because of this historical background, the provision of Article 37 of the Building Standards Act and related public notices are referenced with regard to materials and components used in offshore wind power generation equipment.

Specifically, Article 10, Item 9 of the Interpretation of Article 7 of the Ministerial Ordinance Establishing Technical Standards for Wind Power Equipment for Electricity Generation requires conformity to the JIS standards in Appended Table 1 of Notification No. 1446 of the Ministry of Construction in 2000, and its commentary states that "In the case where materials that have been approved by MLIT under Article 37, Item 2 of the Building Standards Act or materials that have mechanical properties, scientific components and other qualities equivalent or superior to those of materials conforming to the Japanese Industrial Standards are used, they are deemed to conform to Article 7 of the Ministerial Ordinance"[5].

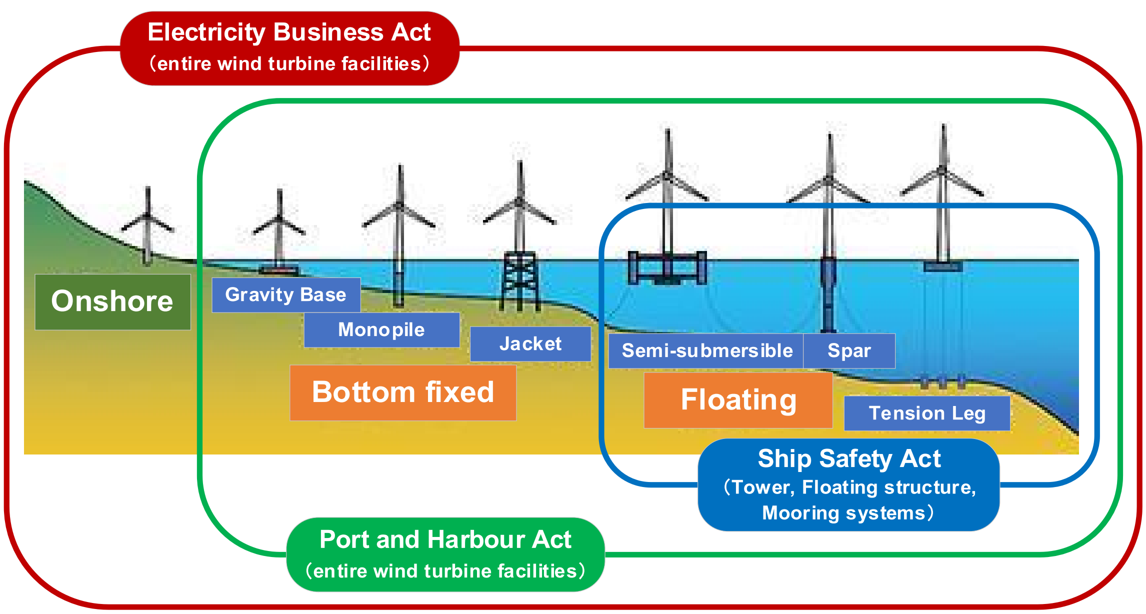

Figure 2 Scope of the Electricity Business Act, Port and Harbour Act, and Ship Safety Act

5 "Annotations of the Explanation of the Ministerial Ordinance Establishing Technical Standards for Wind Power Generation Facilities and Interpretation Thereof" (p. 20).

Source: created by REI based on ClassNK, "Wind Turbine Certification and Related Services" p.27[6]

3.2 Standards

3.2.1 ISO/IEC and JIS

Japanese Industrial Standards (JIS) are established in accordance with ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission) standards. ISO and IEC are applied in Japan as they are, but to facilitate their application in Japan, the major ones that are expected to be used widely in the country are incorporated into JIS standards. Specifically, the Japanese Industrial Standards Committee (JISC) deliberates on JIS drafts proposed by related organizations, and the competent minister establishes or revises them. However, due to translation into Japanese and the addition of supplementary explanations, new or updated JIS standards are not established or updated until several years after the ISO/IEC standards are changed[7]. Supplementary explanations include explanations of terms that are not in common use in Japan and addition of references to the national standards (e.g., earthquakes) where the standards indicate to do so.

For wind energy generation systems, the Japan Electrical Manufacturers Association (JEMA) has established a technical committee on wind energy generation systems as a domestic deliberative body for IEC/TC88 (Technical committees 88), which deliberates, proposes, and votes on approval of draft international standards, and prepares draft JIS for the domestic market.

Based on a proposal from Japan, in IEC61400-1 ED4.0 (Design requirements), in addition to the existing wind turbine classes (I, II, III, and S), Class T (Tropical) was added as a requirement for Japan and Southeast Asia, where typhoon attacks and turbulent flow intensity are significant. In IEC61400-24 ED2.0 (Lightning protection), in addition to the existing requirements of 150 and 300 coulombs, a new requirement of 600 coulombs has been added for regions with high lightning energy.

Table 1 Major international and domestic standards for wind power generation systems

Title	IEC	Current stage	JIS
Wind energy generation systems - Part 1: Design requirements	IEC 61400-1 Ed. 4:2019	IS	JIS C 1400-1:2017 *JIS C 1400-1:20XX*
Wind turbines - Part 2: Small wind turbines	IEC 61400-2 Ed. 3:2013	IS	JIS C 1400-2:2020

6 https://www.classnk.or.jp/hp/pdf/authentication/renewableenergy/en/RD2101_202108_Eng.pdf

7 To speed up the information dissemination after the ISO/IEC publishment, some operational reforms are under discussion, including publishing Technical Specification/Technical Reports earlier than the enactment of JIS standards. (METI, Japanese Industrial Standards Committee, Basic Policy Committee, "Draft Interim Report" (May 30, 2022) https://www.jisc.go.jp/app/jis/general/GnrRoundList?toGnrDistributedDocumentList)

Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines	IEC 61400-3-1 Ed. 1:2019	IS	JIS C 1400-3-2014 *JIS C 1400-3-1:20XX*
Wind energy generation systems - Part 3-2: Design requirements for floating offshore wind turbines	IEC TS 61400-3-2 Ed. 1:2019	TS	*JIS C 1400-3-2:20XX*
Wind energy generation systems - Part 3-2: Design requirements for floating offshore wind turbines	*IEC 61400-3-2 Ed. 1*	PCC	—
Wind turbines - Part 4: Design requirements for wind turbine gearboxes	IEC 61400-4 Ed. 1:2012 *IEC 61400-4 Ed. 2*	IS PCC	—
Wind energy generation systems - Part 5: Wind turbine blades	IEC 61400-5 Ed. 1:2020	IS	—
Wind energy generation systems - Part 6: Tower and foundation design requirements	IEC 61400-6 Ed. 1:2020	IS	*JIS C 1400-6:20XX*
Wind energy generation systems - Part 8: Design of wind turbine structural components	*IEC 61400-8 Ed.1*	PCC	—
Wind energy generation systems - Part 12-1: Power performance measurements of electricity producing wind turbines	IEC 61400-12-1 Ed. 2:2017 *IEC 61400-12-1 Ed. 3*	IS RPUB	JIS C 1400-12-1:2010 *JIS C 1400-12-1:20XX*
Wind turbines - Part 12-2: Power performance of electricity-producing wind turbines based on nacelle anemometry	IEC 61400-12-2 Ed. 1:2013 *IEC 61400-12-2 Ed. 2*	IS RPUB	*JIS C 1400-12-2:20XX*
Wind turbines - Part 13: Measurement of mechanical loads	IEC 61400-13 Ed. 1.1 :2021	IS	—
Wind turbines - Part 22: Conformity testing and certification	IEC 61400-22 Ed. 1:2010 （abolished in August 2018）	IS	JIS C 1400-22:2014 (remains effective)
Wind turbines - Part 23: Full-scale structural testing of rotor blades	IEC 61400-23 Ed. 1:2014 *IEC 61400-23 Ed. 2*	IS ACD	—
Wind energy generation systems - Part 24: Lightning protection	IEC 61400-24 Ed. 2:2019	IS	JIS C 1400-24:2014 *JIS C 1400-24:20XX*
Wind energy generation systems - Part 30: Safety of Wind Turbine Generator Systems (WTGs) - General principles for design	*IEC TS 61400-30 Ed. 1*	PCC	—
Wind energy generation systems - Part 50: Wind measurements	*IEC 61400-50 Ed. 1*	RPUB	—
Wind energy generation systems - Part 50-1: Wind Measurement - Application of Meteorological Mast, Nacelle and Spinner Mounted Instruments	*IEC 61400-50-1 Ed. 1*	RFDIS	—

Wind energy generation systems - Part 50-2: Wind Measurement - Application of Ground Mounted Remote Sensing Technology	*IEC 61400-50-2 Ed. 1*	RPUB	—
Wind energy generation systems - Part 50-3: Use of nacelle-mounted lidars for wind measurements	IEC 61400-50-3 Ed. 1:2022	IS	—
Wind energy generation systems - Part 50-4: Use of floating lidars for wind measurements	*IEC 61400-50-4 Ed. 1*	ACD	—
Wind energy generation systems - Part 101: General requirements for wind turbine plants	*IEC 61400-101 Ed. 1*	ACD	—

Note: Letters in italic means under deliberation

IS: International Standards, TS: Technical Specification, RPUB: Publication received and registered, FDIS: Final Draft International Standards, RFDIS: FDIS received and registered, ACDV: Approved for CDV, CDV: Committee Draft for Vote, ACD: Approved for Committee Draft, CD: Draft circulated as Committee Draft, PCC: Preparation of Compilation of Comments

Source: created by REI based on the data from IEC, TC 88 dashboard and JEMA[8][9]

3.2.2 Transition to IECRE and Japan's response

The IEC standard on Conformity testing and certification for wind turbines (IEC 61400-22 Ed. 1.0) was discontinued at the end of August 2018 under the policy of separating technical and certification standards and was replaced by IECRE, a certification system for renewable energy equipment including not only wind power systems but also other renewable such as photovoltaic systems[10]. Regarding wind power, 15 countries including Japan participate in its activities. It aims to promote international trade in equipment and services used in the renewable energy sector. The following 10 certification bodies are registered with IECRE.

Table 2 IECRE Certification Bodies in the Wind Energy Sector

Country/Location	**RE Certification Body Name**
China	China Classification Society Certification Co., Ltd. (CCSC)
China	China General Certification Center (CGC)
China	China Quality Certification Centre
France	Bureau Veritas Certification France
Germany	DNV Renewables Certification
Germany	TÜV NORD CERT GmbH

[8] TC 88 Wind energy generation systems
https://www.iec.ch/dyn/www/f?p=103:22:0::::FSP_ORG_ID:1282
https://www.iec.ch/dyn/www/f?p=103:23:0::::FSP_ORG_ID:1282

[9] List of IEC and JIS standards related to wind power generation (as of December 2020) Japan Electrical Manufacturers' Association
https://www.jema-net.or.jp/Japanese/res/wind/kikaku.html

[10] IECRE - RENEWABLE ENERGY- IEC SYSTEM FOR CERTIFICATION TO STANDARDS RELATING TO EQUIPMENT FOR USE IN RENEWABLE ENERGY APPLICATIONS https://www.iecre.org

Germany	TÜV Rheinland Industrie Service GmbH
Germany	TÜV SÜD Industrie Service GmbH
Germany	UL
United Kingdom	Lloyd's Register Verification Limited (new organisational status under review)

Source: IECRE[11]

In Japan, however, JIS C 1400-22:2014, which is equivalent to IEC61400-22 Ed.1.0, remains valid and applies to wind power system, although IECRE is used as a reference. It could be a transitional measure, but the competent authority has not announced yet when IECRE system would be officially applied in the country.

Before IECRE system would be applied, wind turbines obtained type certification under IECRE in other countries would be utilized in Japan under the mutual recognition if the equivalence to IEC61400-22 is confirmed. Regarding the certification body, even after IECRE system will be officially applied, it would be necessary for an entity which wants to operate activities as a certification body in relevant countries to be accredited by the competent accreditation body of each country.

3.3 "Official Explanation"

3.3.1 Official Explanation of Technical Standards for Offshore Wind Power Generation Facilities

Offshore wind farms are required to comply with the technical regulations stipulated by the relevant Acts. Therefore, to reduce the burden on operators and streamline the examination procedures, it is necessary to avoid duplication of procedures and complications due to differences in regulations. From this perspective, the "Official Explanation of Technical Standards for Offshore Wind Power Facilities (March 2020 Edition)" (hereinafter referred to as the "Official Explanation") was published as "an explanation of the unified approach of each Act regarding the technical regulations to which offshore wind power facilities must conform based on the Electricity Business Act, Port and Harbour Act, and the Renewable Energy Sea Area Utilization Act"[12].

The contents of the Official Explanation apply to the examination of the structure of offshore wind power generation facilities, based on the Electricity Business Act, the Port and Harbour Act, and the Renewable Energy Sea Area Utilization Act (p.14)[13]. The "Official Explanation" mainly applies to bottom-fixed offshore wind turbines, and floating offshore wind is separately required to comply to the "Technical Standards for

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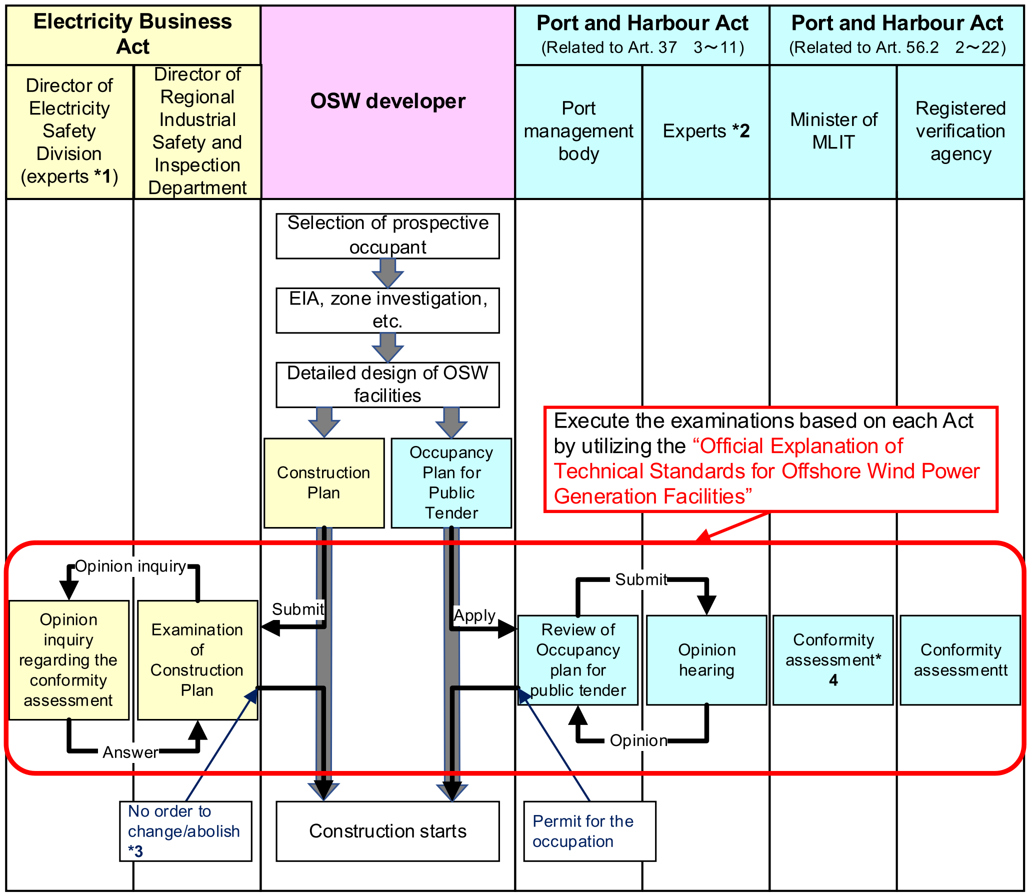
[11] IECRE RE Certification Bodies (RECBs), https://www.iecre.org/dyn/www/f?p=110:7:::::P7_ORG_TYPE:RECB

[12] The contents of the document were discussed by the "Offshore Wind Power Facility Review Committee," a council of METI and MLIT.

[13] Although the main subject of this document is support structures for offshore wind power generation facilities among offshore wind power generation facilities, it is said that offshore wind power generation facilities can be read as offshore transition facilities and observation towers and applied to them respectively. In the design of submarine transmission lines and communication cables, the design methods for support structures covered in this commentary may not be directly applicable, and in such cases, international and national standards and certification standards may be referred to.

Floating Offshore Wind Power Facilities”[14] and to receive inspections based on the Ship Safety Act.

The **Figure 3** shows the flow of conformity assessment by each act. The OSW developers undergo their assessments after they are selected in the tender processes[15].



***1:** Opinion inquiry to experts pursuant to the assessment guideline regarding the installation and change of the Construction Plan of wind power (surely executed for OSW)
***2:** Consider executing opinion inquiry to experts pursuant to Art. 37-5, paragraph(4) of the Act
***3:** Developer cannot start construction until certain period has passed after Construction Plan was received. During this period, the Plan is examined. Minister of METI may order to change or abolish the Construction Plan if it is not conformed to the conditions required by the Act and related regulations.
***4:** Minister of MLIT doesn’t proceed with conformity assessment conducted by a registered verification agency. A registered verification agency assesses only a mooring facility which is designed in considering damages, etc. caused by the action of load received from marine renewable electricity generation facilities, etc.

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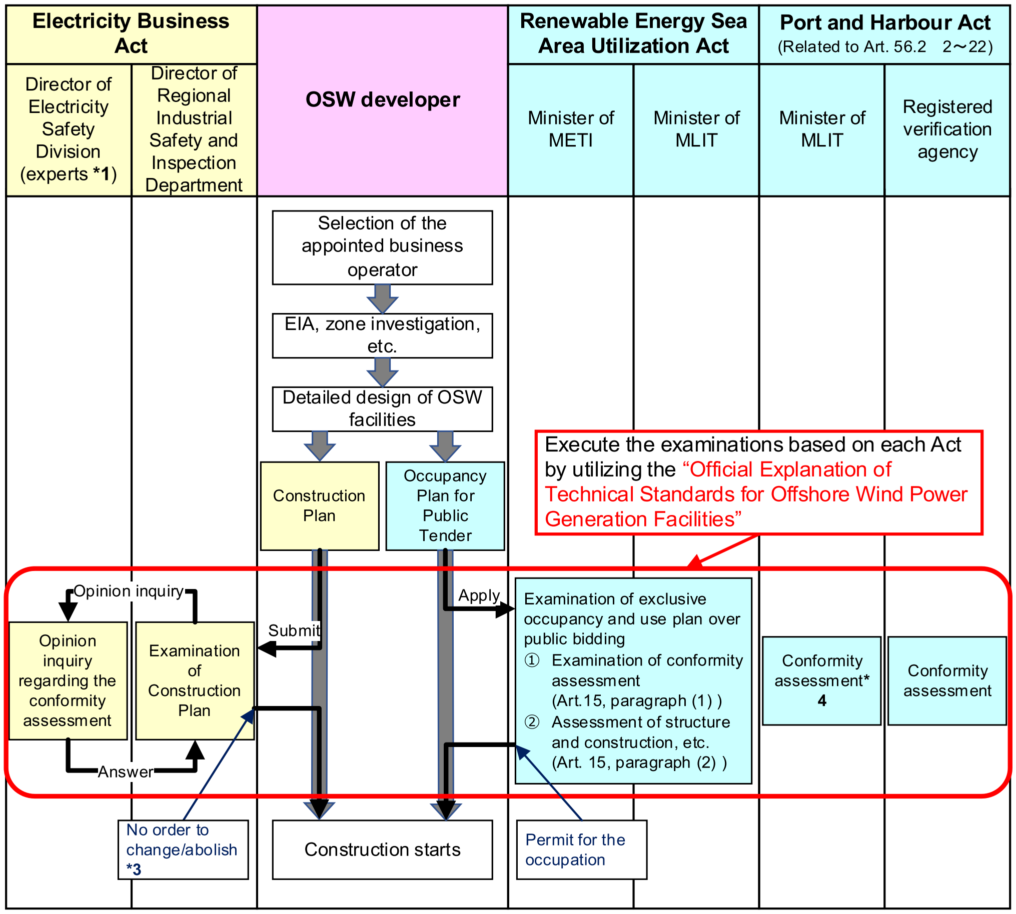
[14] Technical Standard for Floating Offshore Wind Power Facilities March 2020 https://www.mlit.go.jp/common/001331375.pdf

[15] Regarding the project development under the Renewable Energy Sea Area Utilization Act, it may take about five or six years from the stage of Selection of developer to Construction starts, with one to two years or more for detailed design and more than two years for EIA. Design and EIA phases may progress in parallel. It may need about two or three years for the construction.



***1:** Opinion inquiry to experts pursuant to the assessment guideline regarding the installation and change of the Construction Plan of wind power (surely executed for OSW)
***3:** Developer cannot start construction until certain period has passed after Construction Plan was received. During this period, the Plan is examined. Minister of METI may order to change or abolish the Construction Plan if it is not conformed to the conditions required by the Act and related regulations.
***4:** Minister of MLIT doesn't proceed with conformity assessment conducted by a registered verification agency. A registered verification agency assesses only a mooring facility which is designed in considering damages, etc. caused by the action of load received from marine renewable electricity generation facilities, etc.

Figure 3 Flow of examination and the application of the Official Explanation of Technical Standards (in red frame)

(Page 18: Port area Page 19: Offshore Renewable Energy Generation Facilities Promotion Area)

Source: Created by REI, based on Offshore Wind Power Facility Review Committee, "Official Explanation of Technical Standards for Offshore Wind Power Generation Facilities (March 2020 edition)," Figure 1.1.1, p.15

This "Official Explanation" lists the main regulations and guidelines related to the installation of offshore wind power generation facilities. Those include international standards (e.g., IEC61400 series), overseas certification standards (e.g., DNV-GL standards), IALA recommendations, UK Marine Guideline Note (Maritime and Coastguard Agency), and the "Guidelines for Design of Wind Turbine Support Structure and Foundations" (Japan Society of Civil Engineers, JSCE), among others. "In applying them, it is necessary to refer to the latest editions of the respective codes and standards" (p. 30).

The specific contents of the Official Explanation include performance requirements to meet the technical regulations specified in each act, the concept of evaluation of natural conditions affecting offshore wind facilities, and structural design methods. However, "...methods to prove that the technical requirements are met are not limited to those referred to in this Explanation. If there exists a technical basis to ensure a sufficient level of security in light of each ministerial ordinance, it may be adopted in place of the method shown in this Explanation" (p. 18). For example, with regard to the design of support structures, "When adopting a method other than the design method indicated in this Explanation, it is desirable to refer to generally recognized design standards and guidelines for offshore wind power generation facilities" (p. 47).

3.3.2 Official Explanation of Operation and Maintenance for Offshore Wind Power Generation Facilities

Conformity of offshore wind power facilities to regulations is required by law to be verified in the operation and maintenance phase as well. As with the design and construction phase, the operation and maintenance of offshore wind power facilities are subject to multiple laws and regulations (Electricity Business Act, Port and Harbour Act, and Renewable Energy Sea Area Utilization Act). In order to reduce the burden on operators and streamline the review process, the "Official Explanation of Operation and Maintenance for Offshore Wind Power Generation Facilities (March 2020 edition)" was published. In addition to operation and maintenance, this Official Explanation covers matters related to decommissioning (removal).

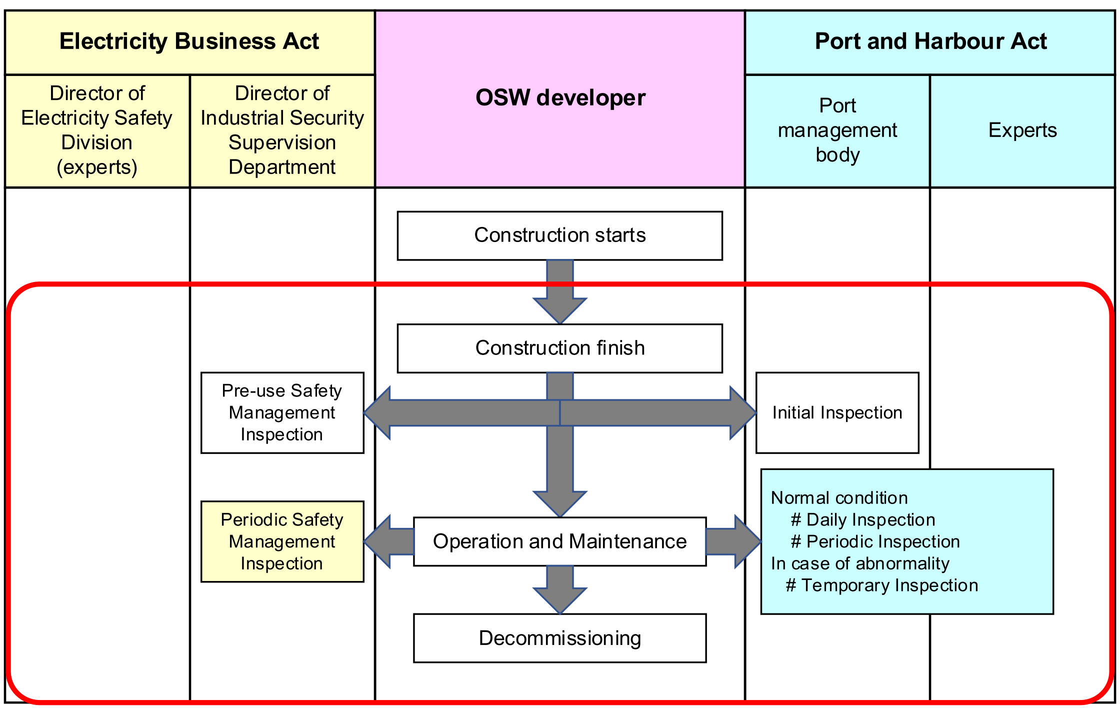


Figure 4 Flow of examination and application of the Official Explanation of Operation and Maintenance (in red frame)

Source: Created by REI based on Offshore Wind Power Facility Review Committee, "Official Explanation of Operation and Maintenance for Offshore Wind Power Generation Facilities (March 2020 edition)," Figure 1.1.1, p.27

3.3.3 The role of standards in the technical regulations

As mentioned earlier, METI and MLIT publish respectively various documents including "Official Explanation" in order to show specific methods for conformity assessment to each regulatory requirement. The

International standards and JIS standards are the referenced information for this objective alongside of the Guidelines published by JSCE, among others.

Due to the speed of technical innovation, it is important for the regulation to follow the latest technology development flexibly. In this sense, METI started a new scheme to incorporate standards developed at the initiative of the private sector into technical regulations since 2020. Under the scheme, METI accredits a Private Standard Evaluation body, which receives a draft standard from a Standard Drafting entity (industrial institution or academia). The Private Standard Evaluation body examines the conformity of the draft to technical regulations, conducts public consultation and publishes as the standards. The ministry controls the accredited body by participating in its meetings and periodic checks. When receiving a report from the accredited body, METI amends the interpretation of the technical regulations, after public consultation based on the Administrative Procedure Act.

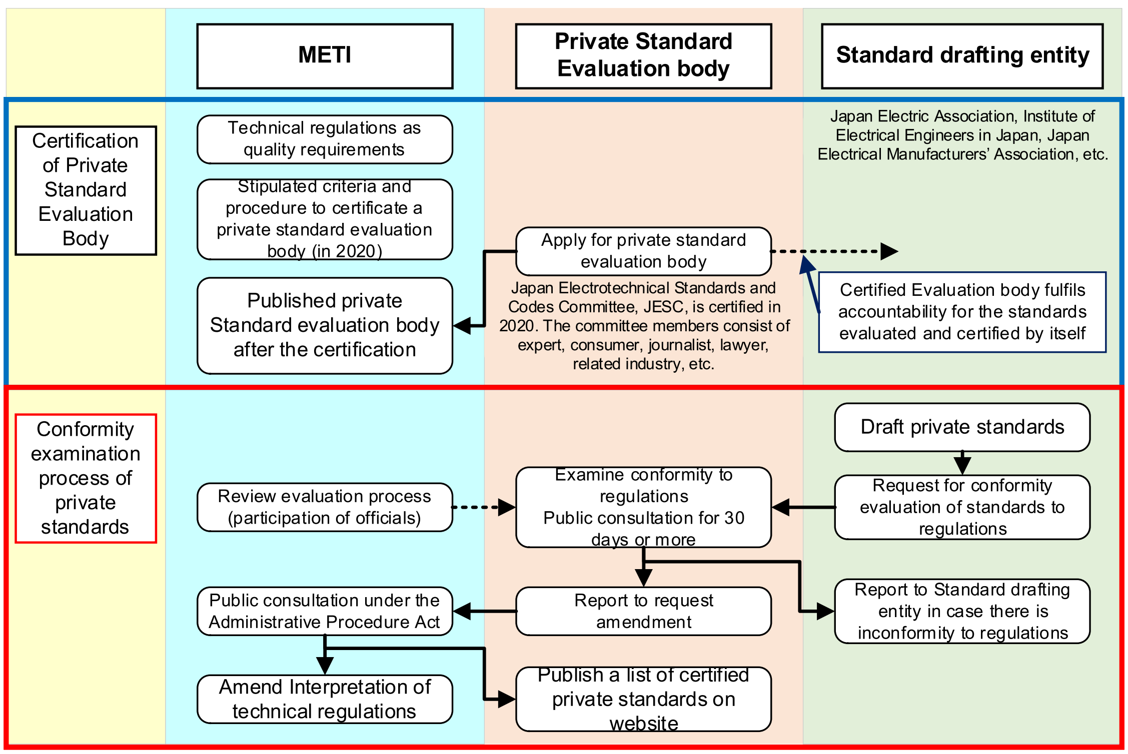


Figure 5 Adoption of technical standards at the initiative of private sector

Source, created by REI based on METI, Industrial Structure Council, Subcommittee on Safety and Consumer Product Safety, "Immediate reform and important issues for the future in the field of industrial safety" (December 21, 2021), Figure 64, p.65

3.4 Examinations on technical regulations and third-party certification procedures

Examination procedures for conformity to related technical regulations have been changing with the introduction and spread of third-party certification. Duplication of certification procedures and regulatory reviews, reworking, and prolonged procedures have become issues. In light of these circumstances, some institutional and operational reforms have been made and discussed, and currently in a transitional period of change.

3.4.1 Examination under the Electricity Business Act

a) Planning Phase

When installing an offshore wind power generation facility, a business operator shall notify METI of the Construction plan (Article 48, Paragraph 1 of the Electricity Business Act). METI shall examine whether the Construction plan conforms to the technical regulations established in the Electricity Business Act, and if it finds that the Construction plan does not conform to the technical regulations, it may order the revision or discontinuation of the Construction plan within 30 days (Article 48, Paragraph 4 of the said Act; the period may be extended, Article 48, Paragraph 5).

The procedures for technical regulation conformity assessment are stipulated in the "Guidelines for Examination of Construction Plans for Establishment or Modification of Wind Power Plants" (METI, Minister's Secretariat, Director-General for Technology Policy Coordination and Industrial and Product Safety, May 2021). According to this, the operator is required to submit (1) the documents specified in Appended Table 3 of the Ordinance for Enforcement of the Electricity Business Act (regarding the outline of electric facilities), (2) the type certificate of the wind turbine, (3) the Wind farm certificate[16] for the local site conditions, (4) the Wind farm certificate for both or either the specified support and foundation under the local site conditions. The Director of a Regional Industrial Safety and Inspection Department will confirm whether the equipment and materials used are "general equipment" or "special equipment". If the requirements for "general equipment" are satisfied, construction work may begin. The Director of a Regional Industrial Safety and Inspection Department may request the opinion of the Director of the Electric Power Safety Division as to whether the equipment falls under the category of special equipment. If the equipment falls under the category of special facilities, the Director of the Electric Power Safety Division will ask for the opinion of the Expert Committee for Safety Examination of New Energy Power Generation Facilities (established in the Electric Power Safety Division to consult with the Director of the Electric Power Safety Division of METI, hereinafter, METI Expert Committee) and confirm the conformity of the equipment. Once the conformity is confirmed, the construction of the special facilities can be started.

[16] According to the explanation of ClassNK, one of the certification bodies in Japan, the "Wind farm certification" evaluates "the environmental conditions on the site where the wind farm is to be constructed and verified that the strength and safety of the wind turbine and support structure are secured in terms of the design based on the environmental conditions", and " is unique to Japan and is intended for use in the Construction Plan Notification review under the Electricity Business Act" (see below for details). Compared to full project certification, it is equivalent to the site suitability evaluation (Site suitability evaluation in IECRE OD-502 Edition 1.0)

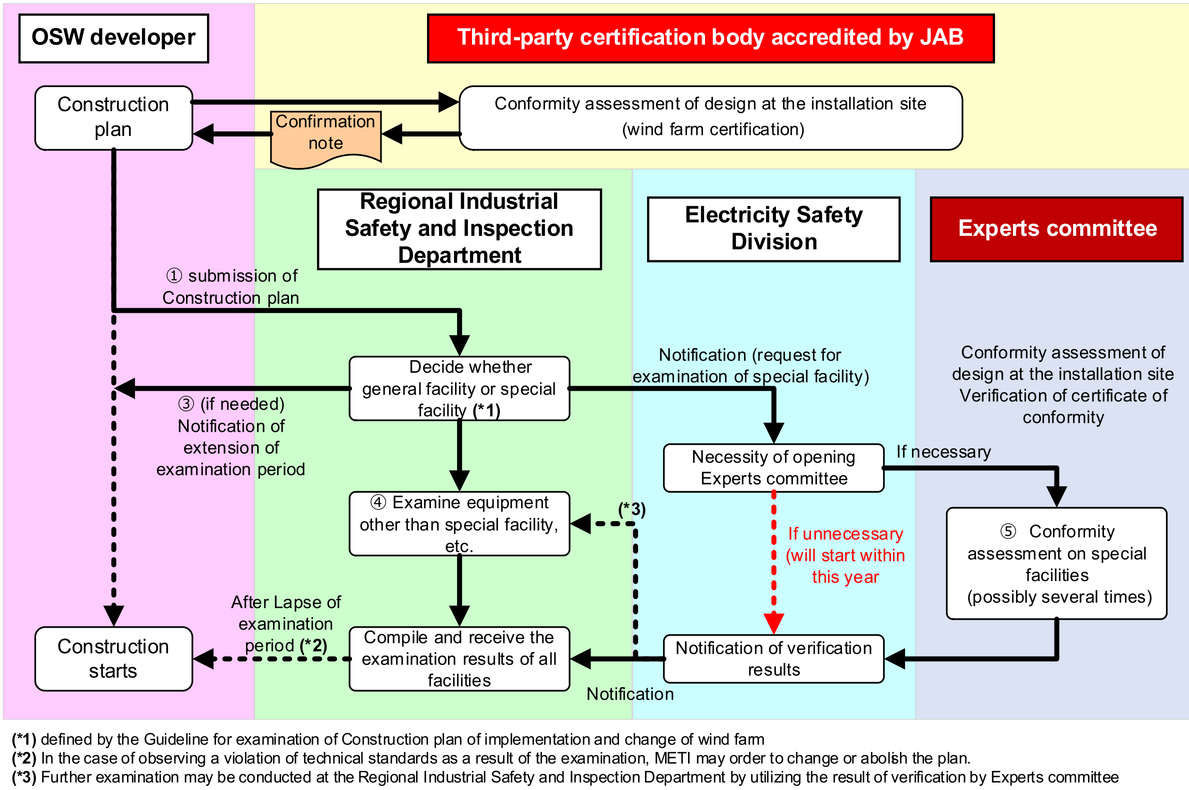


Figure 6 Current review process for conformity assessment in construction plans for OSW

Source ：Created by REI, based on METI, "Examination under the Electricity Business Act to promote the introduction of offshore wind power generation facilities" (September 21, 2021) p.1[17]

In the procedures before the guidelines' revision in May 2021, a "Wind farm certification" was positioned as a pre-review of the METI Expert Committee, and the procedures for a "Wind farm certification" and those of METI were duplicated. The revision of the guidelines has opened the way to avoid duplication of procedures by omitting the METI Expert Committee meeting through the acquisition of third-party certification. However, the current guidelines are limited to onshore wind turbines, and offshore wind power generation facilities are still required to hold an expert meeting as "special facilities".

In this regard, METI has discussed an arrangement as a further streamlining measure to make it unnecessary for wind farm certified facilities to hold an expert meeting (all facilities will be classified as general facilities) by involving the METI Expert Committee members in the assessment process of "Wind farm certification" at third-party certification bodies. METI announced in September 2021 that the measure would be to be implemented within 2021.

On top of that, in 2022, METI has also proposed to establish a new body for conformity assessment to replace METI's examination process (including the METI Expert Committee review) with the review by the new body.

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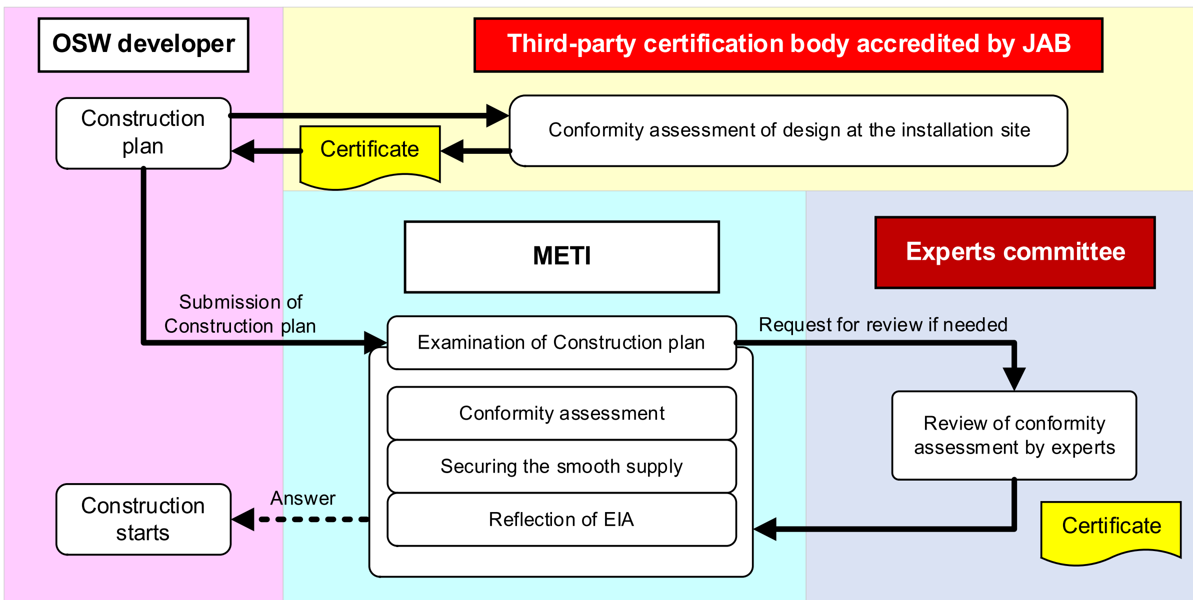
17 https://www8.cao.go.jp/kisei-kaikaku/kisei/conference/energy/20210921/210921energy06.pdf

According to the bill for amendment of the Electricity Business Act[18], the new body, registered by METI, conducts conformity assessment of the "Special Electric Facilities[19]", which would assumably include OSW. METI registers mandatorily the applicant entity if it meets all the criteria for registration, some of which includes involving two or more experts in the assessment process. The registration shall be renewed every three years. As the bill delegates to a ministerial ordinance to specify the scheme detail, including the method in which the body shall perform, it is not clear how this new scheme would be coordinated with the third-party certification system.



[18] The bill was passed at the Diet in June 2022.
[19] "Special Electric Facilities" are defined as those specified by an Ordinance of METI as requiring a particularly safe structure against loads and external forces.

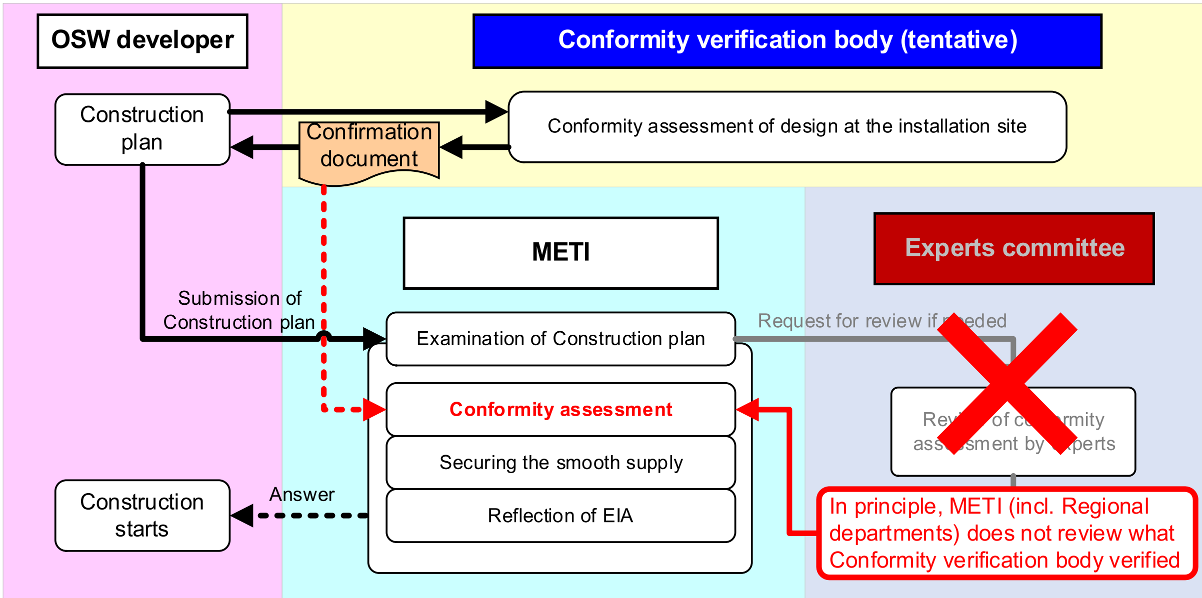


Figure 7 Comparison between current and new review process for conformity assessment in construction plans for OSW (Page 24: current process, Page 25: new process)

Source : Created by REI, based on the report "Immediate actions for institutionalization in the field of industrial safety and important issues for the future," METI, Industrial Structure Council, Industrial Safety and Consumer Product Safety Committee (December 21, 2021)[20], Figure 60, p.60

b) Pre-commercial operation phase

Before starting to use an offshore wind power generation facility, the operator shall conduct a Pre-use Safety Management Inspection (Article 51 of the Electricity Business Act). Specifically, before the start of use, the operator shall conduct a self-inspection of the relevant Electric Facilities for Business Use, record the results of the inspection, and preserve them. The self-inspection shall confirm that the construction work has been performed in accordance with the Construction plan and that the work conforms to the technical regulations[21]. In addition, the operator shall submit the system for conducting a pre-use self-inspection to undergo examination by METI.

c) Operation and maintenance phase

The operators must maintain offshore wind power generation facilities to ensure that they comply with technical regulations (Electricity Business Act, Article 39, Paragraph 1), and offshore wind power generation facilities are subject to periodic inspections (Electricity Business Act, Article 55, Paragraph 1, Item 2; Ordinance for Enforcement of the Electricity Business Act, Article 94, Item 10). The inspection frequency is

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[20] https://www.meti.go.jp/shingikai/sankoshin/hoan_shohi/pdf/20211221_1.pdf

[21] Interpretation of Pre-use Self-inspection and Pre-use Self-confirmation Methods (p. 43) https://www.meti.go.jp/policy/safety_security/industrial_safety/law/files/20200729shiyoumae.pdf

six months or one year, depending on the part of the wind turbine[22][23][24].

Meanwhile, project certification is not widespread in Japan. The reasons for this are: the technical regulations conformity assessment based on the Electricity Business Act focuses on safety; METI, rather than a third-party certification body, has been conducting site suitability assessments for the climatic, geological, and seismic conditions of the construction site for wind turbines with type certification; Pre-use Safety Management Inspections and periodic inspections are legally required; insurance companies and financial institutions have not made obtaining project certification a condition for contracting or financing, although marine warranty survey (MWS) is one of the conditions for contracting or financing. In addition, the cost of obtaining project certification has been pointed out as a factor.

Recently, a new inspection scheme, so-called "Advanced Safety Implementation system" using smart technologies was proposed by METI and the bill for the amendment of Electricity Business Act to implement it has passed. According to the bill, a certified business operator by METI shall conduct self-inspection using advanced technologies and will be exempted from undergoing examinations by METI. This new system will be expected to reduce administrative burdens and to facilitate for the capable business operator to undertake the O&M by using their own know-how.

3.4.2 Examination under the Port and Harbour Act

a) Planning Phase

For safety inspections based on the Port and Harbour Act, the Coastal Development Institute of Technology (CDIT)[25], a verification agency registered by MLIT, conducts the conformity verification inspections. CDIT is responsible for confirming conformity with technical regulations with respect to port facilities (the Ordinance for Enactment of Port and Harbour Act, Article 28-2).

☐ Target Facilities

- Outer facilities
- Mooring facilities *1
- Roads and bridges
- Fixed and track-type cargo handling equipment *2
- Waste landfill revetments

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[22] Official Explanation of Operation and Maintenance for Offshore Wind Power Generation Facilities, p. 73. Note that Article 94-2, Paragraph 1, Item 5 of the Ordinance for Enforcement of the Electricity Business Act stipulates that the inspection frequency is within a period not exceeding three years, but the details are determined by the Interpretation of this ordinance.

[23] There are also provisions for periodic inspections under the Renewable Energy Sea Area Utilization Act and the Port and Harbour Act.

[24] Interpretation of the periodic inspection method by the operator prescribed in Article 94-3, Paragraph 1, Items 1 and 2 of the Ordinance for Enforcement of the Electricity Business Act (p. 11)
https://www.meti.go.jp/policy/safety_security/industrial_safety/law/files/20210414teiken-kaisyaku.pdf

[25] Coastal Development Institute of Technology https://www.cdit.or.jp/

- Beaches
- Green space and open space *2

※1

1. Mooring facilities with a water depth of 7.5 m or more
2. Mooring facilities for mooring vessels carrying dangerous goods, passenger ships or car carriers
3. Mooring facilities with seismic resistance to level 2 earthquake motion
4. Mooring facilities equipped with offshore renewable energy power generation facilities, etc.

※2 Only those facilities that are specified as large-scale earthquake-resistant facilities in the port plan for the port in question.

In order to avoid duplication of procedures for the Wind farm certification and the verification under the Port and Harbour Act, the assessment documents have been standardized and a joint assessment has been started by a third-party certification body (Nippon Kaiji Kyokai, ClassNK) and a registered verification body (CDIT). This concept could be applied to the procedure of other third-party certification bodies by a bilateral agreement with CDIT, even though there has been no case until now that other body conduct the certification process.

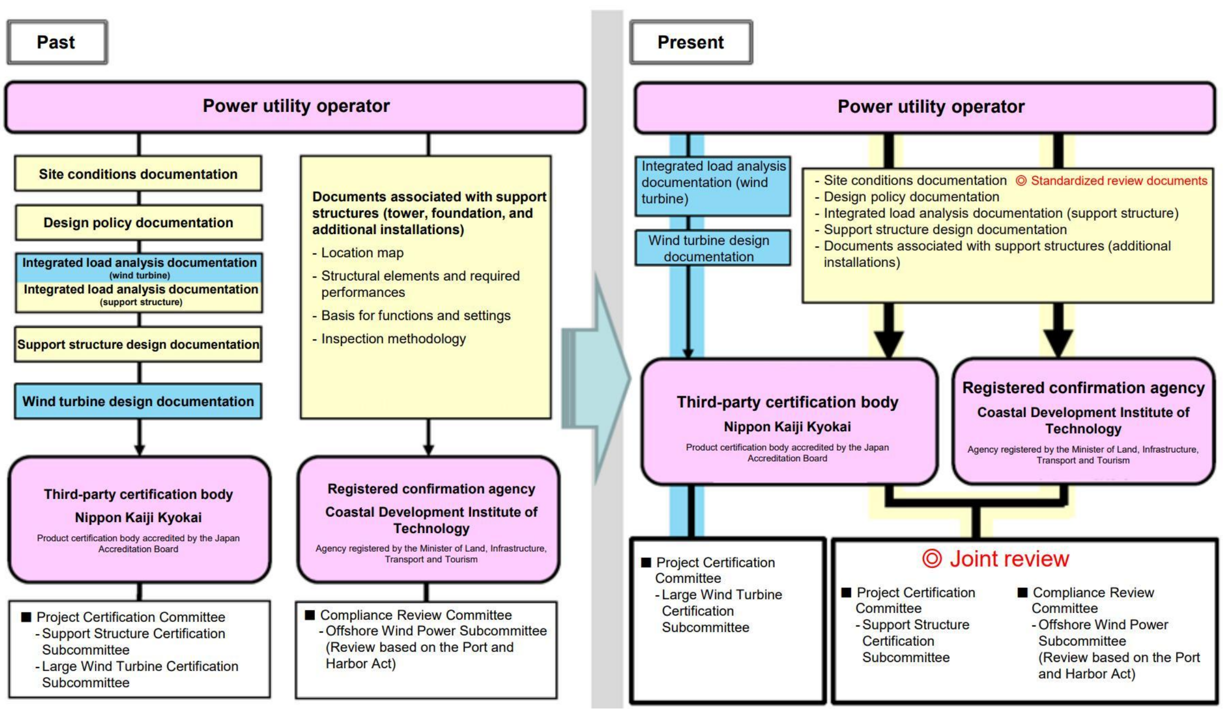

Figure 8 Unification of the procedure of conformity verification under the Port and Harbour Act and a third-party certification for

wind power generation facilities[26]

Source：ClassNK, "ClassNK Wind Turbine Certification and Related Services"(August 2021) p.29

b) Pre-commercial operation phase

The Initial inspection and diagnosis is conducted by an operator at the completion stage immediately after construction or improvement, or at the stage of formulating an operation and maintenance plan for an existing facility, in order to grasp the initial state of operation and maintenance not only for the facility as a whole, but also for each component and ancillary equipment ("Guidelines of the Inspection and Diagnosis for Port Facilities" revised March 2021, MLIT, Ports and Harbours Bureau).

The contents of the Initial inspection and diagnosis are the same as those of the Periodic inspection and diagnosis. The Initial inspection and diagnosis for new construction should preferably be conducted within two years of completion of construction, but the initial condition may be ascertained based on the results of quality and form inspections at the time of completion of construction.

c) Operation and Maintenance Phase

The operator must maintain mooring facilities to ensure that they comply with technical regulations (Article 56-2-2 of the Port and Harbour Act), and offshore wind power generation facilities are subject to periodic inspections. The Port and Harbour Act applies to underwater sections of offshore wind power facilities, and the frequency of inspection ranges from one year to ten years, depending on the section.[27]

3.4.3 Examination under the Ship Safety Act and Classification survey

a) Planning Phase

Under the Ship Safety Act, floating offshore wind power generation facilities fall under the category of special vessels (Article 1, Paragraph 4 of the Ordinance for Enforcement of the Ship Safety Act, and the public notice stipulating vessels with special structures or facilities in Article 1, Paragraph 4 of the Ordinance for Enforcement of the Ship Safety Act), and survey details regarding the floating facilities and tower as support structures follow the technical regulations for floating offshore wind power generation facilities. The survey is conducted by the District Transport Bureau. However, floating offshore wind power generation facilities that have undergone a classification survey by ClassNK, a classification society registered by MLIT as stipulated in Article 8 of the Ship Safety Act, are deemed to have undergone and passed a survey by the

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[26] 6th Meeting of Electrical Safety System Working Group, Electricity Safety Subcommittee, Subcommittee on Safety and Consumer Product Safety, Industrial Structure Council
Document 3: Review of Construction Plan Examination to Promote the Introduction of Offshore Wind Power Generation Facilities METI June 2021
https://www.meti.go.jp/shingikai/sankoshin/hoan_shohi/denryoku_anzen/hoan_seido/pdf/006_03_00.pdf

[27] Official Explanation of Operation and Maintenance for Offshore Wind Power Generation Facilities, p. 73 and following. Inspection and Diagnostic Guidelines for Port Facilities, July 2014 (partially modified in June 2008), Ports and Harbours Bureau, MLIT.

District Transport Bureau[28].

ClassNK has several experiences of classification survey for floating OSW project in Japan (in Kyushu and Fukushima) and issued the guidelines for classification survey for floating OSW originally in 2012. Namely, ClassNK defines offshore wind power generation facilities as offshore wind power generation vessels in Part P of the Rules for the Survey and Construction of Steel Ships. The "Guidelines for Floating Offshore Wind Turbines – Classification Survey –" (December 2021) is the revised version based on the latest regulations and standards such as Technical Standards for Floating Offshore Wind Power Generation(Safety Policy Division, Maritime Bureau, MLIT, March 2020), IEC TS 614003-2 (2019), and other parts of the Rules for the Survey and Construction of Steel Ships.

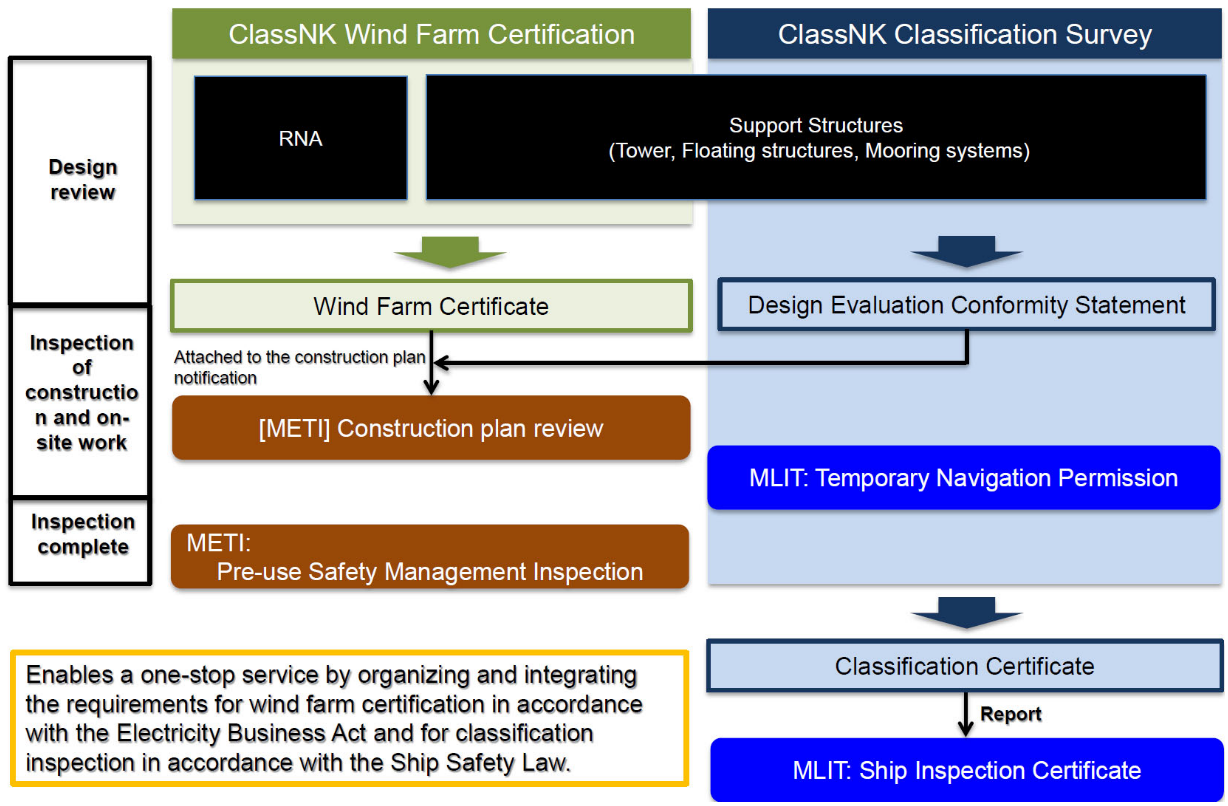


Figure 9 Compliance with laws and regulations for offshore wind turbines

Source : ClassNK, "ClassNK Wind Turbine Certification and Related Services [Public website version], August 2021, p.33[29]

[28] Legally, it seems possible for an entity other than ClassNK to get registered by MLIT as a "Classification Society" defined in the Ship Safety Act. There are no provisions to limit the number of classification societies in this Act, even though customarily there is only one classification society in each country. A "Classification Society" in this act might be equivalent to a Recognized Organization, acting on behalf of the flag administration for inspections and surveys.

[29] https://www.classnk.or.jp/hp/pdf/authentication/renewableenergy/en/RD2101_202108_Eng.pdf

Ship inspections based on the Ship Safety Act are shown in the figure below, while ClassNK's classification inspections are divided into two main categories: registration inspections and periodic inspections.

Table 3 Ship inspections based on the Ship Safety Act

Type of inspection	Contents
Manufacturing inspection	Inspection that manufacturers undergo when manufacturing vessels 30 meters or more in length
Periodic inspection	A detailed inspection to be carried out when the ship is put into service for the first time or when the ship's inspection certificate expires.
Interim inspection	Simple inspection taken between periodic inspections. It is subdivided into three types: Type 1 Interim Inspection, Type 2 Interim Inspection, and Type 3 Interim Inspection, and the type of vessel determines which inspection the vessel is subject to.
Temporary inspection	Inspection to be performed when alterations, repairs, or new equipment are made.
Temporary navigational inspection	Inspection to be made when a vessel is temporarily put into service without a vessel inspection certificate
Preliminary inspection	Inspection of equipment, etc. listed in Paragraph 1, Article 2 of the Ship Safety Law, when the ship to be installed is not specified (If the equipment, etc. passes the inspection, the above inspection is omitted).

Source : MLIT webpage, "Proper implementation of vessel inspections (Overview) [30]

In the planning stage, the same inspections as those for ordinary vessels, such as structural inspections, water pressure tests, and watertightness tests, are conducted as registration inspections, and the tower is also inspected during fabrication and assembly.

b) Pre-commercial operation phase

After the construction of the floating structure is completed, a stability test will be conducted. Since it is difficult to conduct a stability test in the sea area where the floating structure will be installed, it is acceptable to conduct a stability test before the wind turbine is installed and add the effect of the wind turbine to the results of the test. In the installation site, a tension test of the mooring line of the floating facility, a check of the control system of the wind turbine, and a check of the operational status of the equipment are conducted. The tower will also be inspected when it is mounted on the floating facility.

[30] https://www.mlit.go.jp/maritime/maritime_fr8_000018.html

c) Operation and Maintenance phase

There are three types of periodic inspections: annual inspections, interim inspections every two to three years, and periodic inspections every five years.

Annual inspections are in principle document checks. For interim and periodic inspections, an inspection plan and inspection procedures are prepared in advance, and the inspections are conducted based on the plan and procedures after obtaining approval from ClassNK. In the interim inspection, the visible area is inspected, while in the periodic inspection, the inside of the floating structure and underwater structures are also inspected.

4 International and European standards

4.1 Overview of the structure for international and European standardisation

European Standards can be adopted by one of three standards organisations: European Committee for Standardisation (CEN), European Committee for Electrotechnical Standardization (CENELEC), and European Telecommunications Standards Institute (ETSI). European Standards must be transposed into a national standard in all EU Member States. In case of conflicts, the EN supersedes any national standard. EN standards can be adopted in direct reference to ISO (by CEN) and IEC (by CENELEC), then they have the prefix “EN ISO” or “EN IEC”. They international standards may also be adopted with amendments. When an EN standard is adopted as national standard, the name is prefixed by the country-specific abbreviation, e.g. “DIN EN ISO”. In the area of electrical and electronic standards, close to 80% of European standards are in fact IEC International Standards (IEC, 2022). In Denmark for wind energy, for example, the option for national annexes (i.e. deviation from international and EN standards) has not been used so far.

4.1.1 Mirror committees in the international standardisation work

Countries participate in ISO/IEC work via national standards bodies (NSBs), as well as through input received from liaison organisations. National positions on ISO/IEC work are developed by the NSBs on an ongoing basis. For this, most NSBs establish national mirror committees (NMCs). The mirror committees function in a way so that there is a national system of committees and working groups that are organised in the same way as the ISO/IEC on the one hand, and the CEN/CENELEC on the other (in Europe).

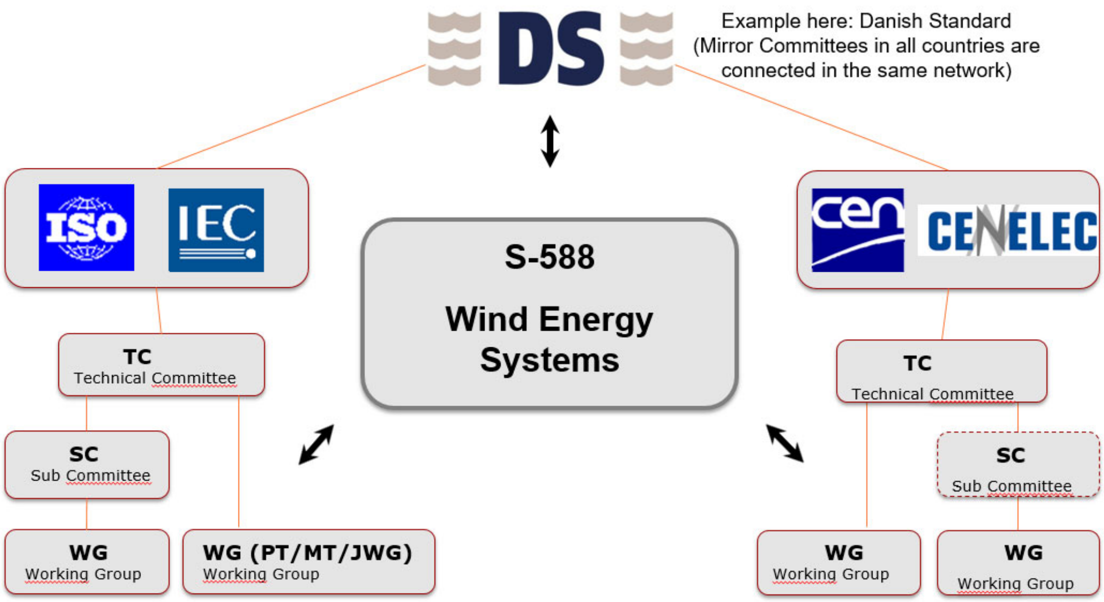


Figure 10 The case of Danish Standard organization

Source: Danish Standard

In Denmark, for example, the Committee 'S-588 Wind Energy Systems' is organised in 13 sub-committees that reflect all areas of the international relevant committees: U-01 Design and safety, U-02 Procedures for measurements, U-03 Communication, U-04 Gear boxes, U-05 Testing and Certification of Wind Turbines – Rules and procedures, U-06 Electrical main components, U-07 Noise, U-08 Lightning protection, U-09 Rotor blades, U-10 Availability, U-11 Electrical test and simulation models, U-12 Protective measures, U-13 IECRE Renewable energy certification – Wind Energy Sector. The Danish S-588 has 30 members from a broad range of stakeholders, including equipment manufacturers, developers, consultants, several universities, the Danish Transmission System Operator Energinet, and the Danish Energy Agency (who is responsible for drafting regulation in the area). The sub-committees meet 2-4 times each year. Membership in S-588 costs between 2,250 EUR and 3,500 EUR per year, with a higher price for larger companies and commercial stakeholders, and a lower price for e.g. universities. Not-for-profit organisations can participate without fee. Members of the Danish S-588 then participate in the relevant international committees, including the 'IEC TC 88 Wind Energy Generation Systems', the 'ISO TC60 Gear', the 'IEC TC 14 Power Transformers', the 'CENELEC TC 88 Wind Turbines'.

Denmark is also operating agent of the overall international IEC TC 88 and hosts its secretariat. The IEC TC 88 is structured in Working Groups (WG), Maintenance Teams (MT) and Project Teams (PT). Of interest here may be:

- WG 3 Design requirements for offshore wind turbines
- WG 15 Assessment of site specific wind conditions for wind power stations
- MT 1 Design requirements for wind turbines

- PT 61400-3-2 Design requirements for floating offshore wind turbines
- PT 61400-6 Tower and foundation design
- PT 61400-8 Design of wind turbine structural components
- PT 61400-30 Safety of Wind Turbine Generator Systems (WTGs) – General principles for design
- PT 61400-50-3 Use of nacelle mounted lidars for wind measurements
- PT 61400-101 General requirements for wind turbine plants

4.1.2 Adoption of international standards

The ISO/IEC system adopts changes through a multi-layered consensus-based process. They follow a six-stage process for developing standards: (1) Proposal stage, in which industry associations or consumer groups make a request; (2) Preparatory stage, in which a working group or Technical Committee(TC) prepares a working draft of the new standard; (3) Committee stage (optional) for review and commenting by the parent committee; (4) Enquiry stage, where the Draft International Standard (DIS) is distributed amongst members for comments and ultimately voting (if no technical changes made); (5) Approval stage, in which the Final Draft International Standard is prepared and voted on by all members; (6) Publication stage. These processes are lengthy and can easily take 5-7 years.

In many areas of standards adoption, Europe subscribes to the principle of “Parallel Voting”, whereby the same draft standard is simultaneously voted for adoption at international level (within ISO/IEC processes) and at European level (within the Technical Committees of CEN/CENELEC/ETSI). This ensures a smooth and faster process.

However, there have also been voiced doubts about the fact that there seems to be an expectation that National Committees vote positively almost by default, and suggestions that they use the “Abstain” option too little. Concerns have e.g., been raised in regards to EN IEC 60079-13 and the pre-existing EN 50381 for Transportable Ventilated Rooms. Here, an ad-hoc Working Group had been set up headed by Norway in 2018 to investigate issues, only after the IEC norm had already been adopted in the EN system. This is a relevant issue for offshore operations, in particular regarding concerns about explosion safety requirements as these could make the rooms uninhabitable for environmental reasons.

4.2 Overview of EU standards, certification, and technical regulation

4.2.1 EU Legislation

Regulation on European standardisation (EU) 1025/2012 defines a national standard as a standard that manufacturers can use to comply with national product safety laws and policies. According to Regulation (EU) 2019/515, when a product meets a local standard of an EU Member State, other Member States must accept the product on their markets as well. This is unambiguous as national standards must not contradict EN standards.

Although the compliance to standards is often voluntarily, this is not necessarily the case for products and services that are publicly procured (as offshore wind energy typically is – through government support schemes). This is, because EU Directives on public procurement stipulate that all public invitations to tender and all public contracts in the European construction industry must accept the Eurocodes (Schuppener and Ruppert, 2009). A regulatory framework enforcing the use of the Eurocodes in Public Procurement exists (or will be implemented) in 41% of the countries analysed in a 2015 study, with another 17% of the countries considering that the Eurocodes are well-placed in the Public Procurement without having a particular Regulatory Framework.

If proposing an alternative design, one must demonstrate that is technically equivalent to an EN Eurocode solution. The reference to Eurocodes as well as the flexibility in compliance can be e.g. seen here:

> *"(42) The technical specifications drawn up by purchasers should allow public procurement to be opened up to competition. To this end, it should be possible to submit tenders which reflect the diversity of technical solutions. Accordingly, it should be possible to draw up the technical specifications in terms of functional performance and requirements and, where reference is made to the European standard or, in the absence thereof, to the national standard [...] To demonstrate equivalence, tenderers should be permitted to use any form of evidence. Contracting entities should be able to provide a reason for any decision that equivalence does not exist in a given case."* [DIRECTIVE 2004/17/EC]

It is relevant to note that only in some countries parts of an offshore wind project are defined as construction structures and hence have to comply with the Eurocodes. Other parts of the wind turbine fall under the Machinery Directive.

The European Machinery Directive is relevant for wind turbines, including the tower, blades, gearbox, and everything else in the tower and nacelle, which are considered to be machines under Directive 2006/42/EC. Regulations apply to completed and partly completed machinery, interchangeable equipment, machine related safety components, lifting accessories, chains, ropes and webbing, and removable mechanical transmission devices. The detailed guide to the Machinery Directive by the European Commission is helpful to gain understanding of its application[31].

A main point resulting from the Directive is that all wind turbines installed in the EU should be CE marked (machinery elements), which is in effect the assurance that the wind turbine complies with the essential health and safety requirements of EU law. In all cases, the manufacturer must compile information confirming how the machine complies with these requirements.

In addition, it is quite common for national technical regulations to refer to international and European standards to help avoid that the law becomes too detailed or descriptive and to allow the law to stay current as standards are regularly reviewed and updated (IEC, 2022).

[31] https://ec.europa.eu/docsroom/documents/24722/attachments/1/translations/en/renditions/native

4.2.2 Certification in the EU

A way to show compliance to standards and technical regulation is through certification. Certification is an independently unbiased assurance of the safety of the product or service. Certification can be mandated by legislation. But it is also often demanded by the market, for example by lenders or insurers. For financial and insurance entities, certification reduces due diligence costs, and for owners it can in general reduce transaction cost and lower the technical risk exposure, ultimately lowering cost of capital and improving project performance. Therefore, certification is often undertaken even if not mandated by regulation.

For government agencies and regulators, requiring certification according to certain industry standards can be an efficient and cost-effective way of ensuring that public safety concerns have been addressed.

Certification can be distinguished in three areas relevant for offshore wind:

- Type certification – includes a design bases evaluation, a design evaluation, a type testing, a manufacturing evaluation, and a final evaluation of a wind turbine according to specific standards and technical requirements relating to safety, reliability, performance, testing, and interaction with electrical power networks (IEC 61400, IECRE, GL2010, DNV GL 2015). Some optional phases such as foundation design and manufacturing evaluation may apply.
- Component certification – includes the same procedures as type certification applied to major components (blades, gearbox) according to the same specific standards and technical requirements as type certification.
- Project certification – consists in the verification of wind farm design and states whether it meets site-specific conditions. It includes a soil investigation, a review of measuring campaigns, an evaluation of energy yield reports, an assessment of marine conditions a verification of load-case definitions. All the steps are further described below, in section 3.2.1.

Below is an overview of the general certification requirements for offshore wind in key European countries:

Table 4 General certification requirements for offshore wind in key European countries

	Component certification	Type certification	Project certification
France	Certificates can facilitate the integration into type and project certification. Tender document requires the use of type certified turbines according to FN EN 61400	The developer must use turbines that respect European Union norms (NF EN 61400) and that have been previously certified by a body who received an accreditation by a member State, in order to provide guarantees	Tender specified project certification requirements. In general: Project Certification according to IEC 61400-22.

		regarding design, manufacturing and performances.	
Germany	Certificates can facilitate the integration into type and project certification	Prerequisite for approval and project certification, IEC 61400-22 or IECRE OD-501 applicable (also DIN EN 61400, DNVGL-SE)	Mandatory under BSH7005 for wind turbines and substation incl. support structures
Denmark[32]	Certificates can facilitate the integration into type and project certification	Mandatory under Executive Order no. 73 (2013), referring to IECRE OD-501:2018	Mandatory under Executive Order no. 73 (2013), referring to IECRE OD-502:2018. Project certification must be applied for by the project owner
UK	Certificates can facilitate the integration into type and project certification	Certificates can facilitate the integration into project certification	Project certification is common practice
Belgium			Project certification is mandatory and must be carried out under national and international norms.
Netherlands			Project certification is mandatory as stipulated in Water Decree of April 13th 2015. All international norms can be used.
Sweden			Project certification according to IEC 61400-22 and ISO standards.

Besides certification, offshore wind farms are subject to a long list of technical, environmental and safety regulations. Below, we mention several major areas of this regulation with some European examples.

Wind turbines need to have a lighting system that can be required to be different between turbines located on the periphery on the farm or inside the farm, as is the case in France. Lighting may also vary between

[32] https://cas.ens.dk/home/legislation-and-standardisation/

night and day, and each element of the turbine (nacelle, tower, blade) has specific regulations. Furthermore, every European country has set rules on colour markings: as an example, in Belgium blades, tower and nacelle must have red bands if tip height of turbines exceeds 150m.

The helihoist has to fulfil some requirements: the size of the platform of has to be either a square of 4m x 4m or a circle with a diameter of at least 5m in Denmark, for instance. Some other regulations regarding weight tolerance, static discharge, railing, and friction characteristics also apply.

Technical regulations also include inspection, maintenance, and safety. Each country set rules on maintenance intervals on every part of the turbine: blades, drivetrain, nacelle, tower, foundations, electrical system, equipment under pressure, elevator, etc. Regular checks are done regarding people's safety: harness, lifejacket, safety kits, safety lighting, etc. Finally, an emergency service plan must be defined by the wind farm operator.

Transportation systems are also under a set of rules: operating conditions of helicopters (clouds, visibility, wind…) as well as marine safety rules, including certification of crew members (they need to hold a certificate of competency in Denmark and Germany, for instance).

Some regulations also apply on park layout. They include turbine spacing, considerations for neighbouring parks, vessel traffic and distances from exclusion zones (archeology sites, pipelines, etc.).

Data is always required to be shared with third parties. Each country has to set the party responsible for storing environmental data.

Concerning environmental regulations, surveys are to be done before, during and after construction. They make a focus on birds, sea mammals, soil conditions, fauna and flora growth on foundations, etc. Underwater noises are to be controlled: some countries like Germany set a noise threshold and obligatory noise reduction measures.

Finally, regulation on the decommissioning of wind farms is strict in all countries: foundations, cables and scour protections need to be removed in order to restore the seabed to former conditions.

In the following, we describe several areas of certification and regulation that are of particular interest for the comparison between Europe and Japan.

4.2.3 Elements of project certification

In European countries, project certification is a long process that starts early before construction and that may last during the entire life of a project. Project certification processes are typically not described in detail in regulation, but the documentation by certification bodies themselves gives a good picture of the typical process and activities undertaken. Different certification bodies describe their own processes. We are here referring to the representative DNV process. According to DNV-SE-0190, there are five mandatory phases and some other that are optional, as shown on the following figure, extracted from the same document.

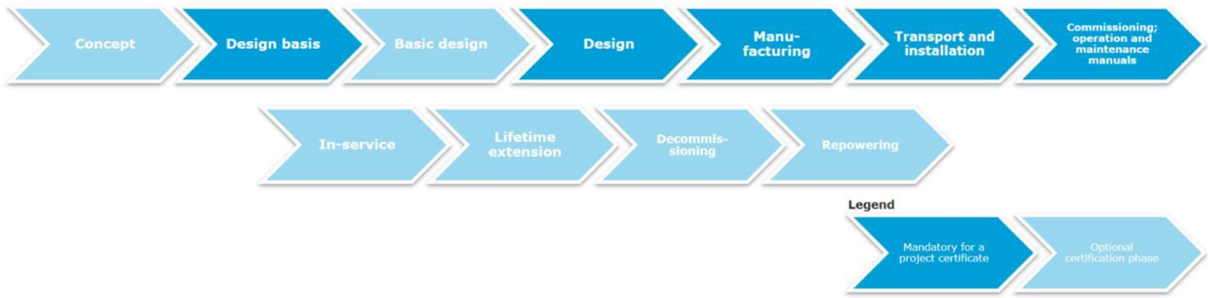


Figure 11 Typical European project certification phases

Source: DNV

Each phase is here further detailed:

- Concept: covers the concept development at the beginning of the wind power project.
- **Design basis**: covers the site conditions and the basis for design. It includes: soil investigation, design basis of project related assets (wind turbines, foundations, substations, power cables, etc.), review of measuring campaigns, evaluation of energy yield reports, assessment of maritime conditions and verification of design load cases.
- Basic design: covers the generic design documentation for a subsequent detailing and implementation.
- **Design**: covers the steps necessary to achieve final design approval. This includes the site-specific design approval of the integrated structural system of the project related assets, the verification of load calculations.
- **Manufacturing**: covers the surveillance during manufacturing of the project related assets.
- **Transport and installation**: covers the surveillance during transport and installation of the project related assets.
- **Commissioning, operation and maintenance manuals**: involves all follow-up evaluation and on-site inspections during the implementation and start of operation of the power plant.
- In-service: involves follow-up evaluation and periodic on-site inspections after start of operation.
- Lifetime extension: covers continued operation of a wind power plant beyond its initial design lifetime.
- Decommissioning: contains the planning and execution of a wind power plant decommissioning and removal.
- Repowering: covers the renewal and reinstallation (typically partially or completely upgrading) of a wind power plant at a former power plant site.

Typically, the quality system evaluation is limited to the verification that quality systems of the different OEMS / operators are certified according to ISO 9001. On-site inspections on random sampling can be conducted A wind farm "Project Design" certificate can be obtained to demonstrate assessment of the site-specific design and site assessment, without the evaluation of transportation, construction, and testing.

Germany embarked on a special path as compared to other European countries in regard to project certification and permitting procedures. While other countries refer more directly to ICRE and leave much room to manoeuvre to the industry itself, Germany has developed its own unified 'offshore wind standard'. Germany's specific offshore standard BSH 7005 collects and describes in detail all the standards and regulations that apply specifically for the offshore area.

The German BSH 7005 (2015)

Standard Design – Minimum requirements concerning the constructive design of offshore structures

Germany has, as the only one of all European countries created its own unified 'offshore wind standard'. At the beginning of the 2000s, the German industry experienced barriers due to different type certification requirements in Germany for loads and structural strength, and a complicated process to have tower and foundation approved (ECN, 2000). Based upon request by the industry, a technical expert group of ca. 20 experts was commissioned to develop the first German offshore standard. The group contained a variety of industry actors. BSH has moderated the process and was responsible for the final decision-making. The first unified guidelines for site investigations were published in 2004/05, and the first offshore standard for constructive design was published in 2007. In its current version, the 117-page document provides legal and planning security for the development, design, implementation, operation, and decommissioning of offshore structures. The document lays out standard directives and justifications for each point. It mentions and clarifies which standards are applicable where, and points to regulations and procedures. There is a continuous review process & commenting of the draft by industry associations and transmission system operators. In the preparation of its first update (2015), already more than 75 technical experts were involved.

4.2.4 Site investigations

In Belgium, Denmark, the Netherlands, and the United Kingdom, detailed regulative requirements for site investigations are intentionally not issued by the authorities (Fischer *et al.*, 2020). Site investigation requirements are widely based on part 8 of the ISO 19901 standard and further recommendations taken from supplementary guidance for offshore wind energy such as e.g., the DNV GL standards (DNVGL 2018) and specific guidance on geophysical investigations like, for example, IHO 2008. It is commonly accepted that the sole use of this ISO standard, which originates from the petroleum industry, does not provide a sufficient basis for site investigations for offshore wind farms. Hence, it is the practical project requirements rather than regulative requirements that drive OWF site investigations. In the worst case, an inadequate site investigation could cause issues in the project certification process at a later stage of the project (Fischer *et al.*, 2020).

In Germany, a different approach is followed. Here, minimum requirements for geophysical and geotechnical investigations are detailed in BSH 7004 'Standard Ground Investigations', which specifies the priority use of Eurocode 7, its national annexes and DIN standards[33], and, in future the bundled requirements through part 4 of the DIN standard 18088 (DIN 2019). The 'Standard Ground Investigations' was defined by a working group of experts and stakeholders (Fischer *et al.*, 2020), in a similar process as for BSH 7005 described above.

There are no mandatory techniques for site investigation. Only in Germany, there is some restriction due to the specification of minimum technical requirements on the towing speed, the frequency, and the resolution of geophysical devices – however, the decision about the most appropriate device and the detailed execution of the site investigation remains with the owner (Fischer *et al.*, 2020).

According to BSH 7004, the geological survey for turbine locations requires order 1b surveys for multi beam echo sounder and in accordance with the IHO standards for hydrographic surveys (IHO 2008). According to part D of BSH 7004, IHO special order surveys are required for the inner-array cable routes and the export cable routes.

In practice, the approaches in the European countries are similar. E.g., for the currently developed Thor OWF in Denmark, the scope for geotechnical investigations for a 440 km^2 area comprises 15-20 borehole locations with soil sampling, 60-80 CPT (cone penetration testing) locations and a number of laboratory tests. According to the Danish authorities, the geophysical survey does not deviate from the technical requirements laid out in the German BSH standard, except for organisational matters (Fischer *et al.*, 2020). This is in particular in reference to the "10% criterion" laid out in the BSH Standard, according to which the total number of borehole locations and CPT locations of the preliminary site investigation shall correspond to 10% of the planned number of wind turbine locations[34].

According to IEC 61400-3-1, an assessment of earthquake conditions shall be performed if relevant, following IEC 61400-1:2018. However, some countries such as France require such an analysis for every project, even if seismic risks are very low, according to the bill of specifications (n° 2011/S 126-208873) for new offshore wind projects. More accurately, every company willing to develop an offshore wind farm must provide a geological structure assessment, made by high resolution seismic reflection with a vertical resolution of 1m. This technique, among others, is described in the "Geotechnical and geophysical investigations for offshore and nearshore developments" manual, issued by the Technical Committee TC1 of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). This manual also includes recommendations on how to plan offshore campaigns of geophysical and geotechnical investigations.

[33] Eurocode 7 "Geotechnical Design",
- DIN 1054:2005 "Ground – Verification of Safety of Earthworks and Foundations"
- DIN 4020:2003 "Geotechnical Investigations for Civil Engineering Purposes"
- DIN 4017 "Calculation of the Design Bearing Capacity of Soil beneath Shallow Foundations",
- DIN 4084 "Soil – Calculation of Embankment Failure and overall Stability of Retaining Structures"
- DIN 4085 "Soil — Calculation of Earth Pressure"

[34] generally assuming that one turbine will be installed per 0.5 km^2 of the wind farm area

The entities undertaking site investigations differ between countries. In Denmark, the responsible body for preliminary site investigation is Energinet. In Germany, for wind farms that start operation before end of 2025, the owner of the OWF is responsible for all parts of the preliminary and main site investigation campaigns. For OWF commissioned after 2025, the BSH will take over the responsibility for the following scope (all activities before the tender takes place): desk study, geophysical survey, preliminary geotechnical investigation, geological report. The associated factual reports and raw data are forwarded to each relevant applicant (Fischer *et al.*, 2020). The works related to the geotechnical investigations are to be carried out by an independent and suitably qualified third-party geotechnical expert. Regarding geophysical investigations, no such requirement exists.

4.2.5 Site-specific assessment of loads and load cases

According to DNV (DNV-SE-0073 and DNV-SE-0190) and Bureau Veritas (Marine & Offshore technology report), an independent load analysis must be carried out in order to verify that specific loads are derived in conformity with the approved design basis. Such an independent analysis will be carried out based on a full dynamic load modelling of the integrated systems consisting of wind turbines and support structures, including soil modelling of offshore sites and using an aero-hydro-elastic computer program. The integrated load analysis is preferably performed by a single computer program. It should consider the simultaneous dynamic impacts of all relevant environmental forces such as wind, waves, current, etc. on the complete system. The model on the complete system shall comprise rotor-nacelle assembly, support structure, foundation, and soil properties. This enables an analysis of the dynamic system response taking the correlation of all acting environmental impacts into account.

The following figure, extracted from DNV-SE-0190, gives an overview of the link between the various kinds of information required to perform the analysis.

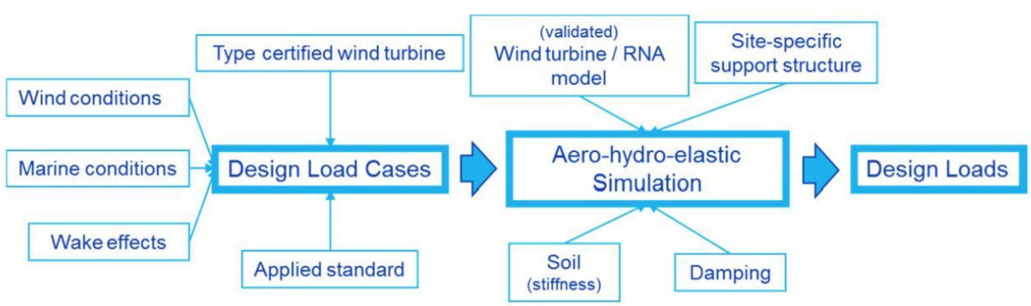


Figure 12 Information required for the load analysis

Source: DNV

In general, the loads must fulfil the requirements of IEC 61400-3-1 and IEC 61400-3-2 for fixed offshore wind turbines and floating offshore wind turbines respectively. These documents specify that the structural analysis is based on ISO 2394.

Loads include the following:

- Gravitational and inertial loads: static and dynamic loads resulting from gravity, vibration, rotation and seismic activity
- Aerodynamic loads: static and dynamic loads derived from the airflow and its interaction with stationary and moving parts of wind turbines (tower, nacelle, rotor, floating substructure for floating turbines)
- Actuation loads: they result from the operation and control of wind turbines
- Hydrodynamic loads: dynamic loads derived by the water flow and its interaction with the support structure of wind turbines, including mooring system for floating wind farms
- Ice loads: static and dynamic loads induced by icing. ISO 19906 applied for floating wind turbines
- Other loads: wake loads, vessel-impact loads, earthquake loads…

According to IEC 61400-3-1, earthquake loads shall be considered according to IEC 61400-1:2018 (where a detailed assessment of earthquake loading is presented in Annex D), if relevant. A time-domain simulation is required for the load calculation of the support structures of offshore wind turbines. Appropriate modelling methods shall be used for specific support structure types, e.g., an interaction model is needed for a monopile support structure while a sway-rocking model can be used for a gravity base structure (more details provided in ISO 3010:2017). In addition, hydrodynamic loads from waves resulting from sub-sea earthquakes (tsunamis) may need to be considered.

The following table gathers examples of design load cases related to power production from IEC 61400-3-1. More details concerning each of the load cases are given in the report. The integrated load analysis has to focus on a selected sub-set of load cases for fatigue and extreme loads in the scope of project certification.

Table 5 Examples of design load cases related to power production from IEC 61400-3-1

Design load case (DLC)	Wind condition	Wave condition	Wind/wave directionality	Sea current	Water level
DLC 1.1	Normal turbulence model for all wind speeds	Normal sea state	Same direction	Normal current model	Mean sea level
DLC 1.5	Extreme wind shear	Normal sea state	Same direction	Normal current model	Mean sea level
DLC 1.6	Normal turbulence model for all wind speeds	Severe sea state	Same direction	Normal current model	Normal water level range

IEC standards for wind turbines focus on design conditions and load cases using a Load and Resistance Factor Design (LRFD) approach, which accounts for design load uncertainties and consequences of failure through a summation of partial safety factors (NREL 2014). Generally, IEC adheres to a 50-year return period for extreme design conditions.

Besides, IEC 61400-3-2 reports some specific load cases for floating wind turbines. As an example, they include other conditions such as redundancy check of the mooring system.

As an example, TÜV carries out load calculations thanks to finite-element computation. This includes linear and non-linear analysis of stresses, deformations, and stability, the evaluation of local plastification under extreme loads and fatigue analysis. Some failure scenarios are also investigated throughout this process.

4.2.6 Steel standards in Europe

Two relevant sets of steel standards are EN10027 and EN 10025. EN 10025 (Hot rolled products of structural steels) refers to a set of European standards which specify the technical delivery conditions for hot rolled products of structural steels. The standards consist of the following parts:

- EN 10025-1: Part 1: General technical delivery conditions
- EN 10025-2: Part 2: Technical delivery conditions for non-alloy structural steels
- EN 10025-3: Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
- EN 10025-4: Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels
- EN 10025-5: Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
- EN 10025-6: Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition
- Related to EN 1993 Eurocode 3: Design of steel structures

CE marking for all construction products that are covered by a harmonised European standard or conforming to a European Technical Assessments is imposed by the EU Construction Products Regulation, which became mandatory in 2013. For fabricated structural steelwork, CE marking became mandatory in the EU in July 2014 (EN 1090). CE Marking of structural steelwork is a declaration by the manufacturer. It states the steel product meets certain public safety requirements. This represented a major development for engineers, contractors, and steelwork specialists and demanded careful attention to the new obligations.

In Europe early in the development of offshore wind energy, it was thought that specific ‘offshore steel’ would need to be used. But now, there are no such restrictions on the type of steel used, albeit adequate corrosion protection applies. The experience was made that restricting the type of steel that can be used will delay the process and increase prices of offshore wind energy.

5 Comparison between Japanese and European standards and regulations

5.1 Differences between Japanese and European practices

In the following, we give an overview of the similarities and differences in Japanese and European practices. As described in the respective chapters above, international standards ISO and IEC are applied in Europe as well as in Japan, and those frequently used in Japan are published as JIS standards after translation work into Japanese. Small adjustments in comparison to the international standards seen so far seem justified (e.g., lightning protection), according to industry representatives we talked to. Indeed, internationally, the translation into local language as well as small changes to account for local conditions is common in the adoption of standards. However, we see a difference in the speed and adoption process of the international standards, where in Europe an almost automatic procedure ensures rapid implementation, and a broad participation of different stakeholders ensures support.

Table 6 Overview of similarities and difference identified in the technical regulation and use of standards in Japan and Europe:

	Europe	Japan
Adoption of standards	▪ >80% of IEC standards directly integrated into EN standards ▪ Public procurement based on EN Standards and Eurocodes ▪ **Most countries do not have specific offshore wind standards** ▪ Germany: detailed ”offshore wind standard” (BSH Nr. 7004 & 7005)	▪ National JIS standards based on IEC standards ▪ Detailed offshore wind standard “Official Explanation of Technical Standards for Offshore Wind Power Facilities"
Development of standards and regulation	▪ Development through direct participation in ISO/IEC and IECRE ▪ Germany: technical expert group for further development of ”offshore wind standard”	▪ Participation in IEC and IECRE ▪ Specific regulation for national context under development ▪ Dedicated expert committees of METI and MLIT
Project certification & permitting	▪ Conformity assessment based on IEC 61400 series & IECRE OD 501 & 502 ▪ Full project certification typically undertaken ▪ Typically, no government entity directly involved in undertaking conformity assessment ▪ Today, no project-specific involvement of expert committees	▪ Conformity assessment based on IEC 61400 series ▪ “Wind farm certification” for design phase typical ▪ Conformity assessment now jointly between the third-party certification body and registered body by MLIT, and also undertaken by METI

	▪ Permitting based on certificates issued by accredited third-party bodies ▪ Broad field of conformity assessment bodies active, mutually recognised	▪ Expert committee can be involved in specific projects and issue requests and opinion ▪ Two conformity assessment bodies active
Site investigations	▪ Detailed regulative requirements for site investigations intentionally not issued ▪ Exemption Germany: offshore standard ▪ No mandatory techniques Surveys typically based on Cone Penetration Test (CPT), one soil boring in the vicinity	▪ Complex and diversified seabed conditions ▪ ‘Official explanation’ details requirements ▪ Surveys based on Standard Penetration Test (SPT), desirably multiple soil borings
Loads	▪ Integrated load analysis based on selected sub-set of load cases for fatigue and extreme loads ▪ Load Resistance Factor Design (LRFD) approach ▪ Risk-based assessment for extreme design conditions based on IEC 61400-3-1	▪ Combined analysis of load effects by time-domain methods and of annual averages ▪ Different methods and calculations tried ▪ More research needed to develop generic approach for earthquake and typhoon conditions assessment
Materials	▪ Based on Eurocodes in case of buildings and other civil engineering works ▪ Based on EU Machinery Directive ▪ Steel: approx. 40 key EN steel standards ▪ Steel in offshore wind: Increased flexibility through few requirements (cost decreasing effect)	▪ Steel: JIS certification or METI approval requirement (price increasing effect) ▪ Necessary to undergo separate performance evaluation if specific design not listed (>100mm; =>M72) ▪ Specific guidelines and lists to be developed for materials, incl. concrete, synthetic fibre ropes

5.1.1 Project Certification ("Wind Farm Certification") and Permitting

In Japan, type certification of wind turbines based on the IEC61400 (JIS C61400) series is utilized. Currently, as there are no wind turbine manufacturers in Japan (after Hitachi has ceased its production), there are no new wind turbines to obtain type certification. For wind turbines used in Japan, international mutual certification is utilized for products certified by certification bodies in various countries. As the loads related to the earthquake are not considered in the type certification, they are assessed in the “Wind farm certification” procedure as part of the site-specific assessment.

Project certification is also basically based on the IEC61400 series. Currently, third-party certification is focused on the site conformity assessment (so-called, “Wind farm certification”), which is equivalent to the Site suitability evaluation stipulated in IECRE OD502, 6.3, since safety in the planning phase is the main target of the assessment to obtain the permit by METI. The full project certification is rarely used in Japan and mainly two reasons pointer out are as follows; the periodical inspection during the operation and maintenance phase is regulated in detail by relevant laws and the risk assessment and control of the construction phase are considered to be covered by the Marine Warranty Survey and insurance contracts.

The procedures take into account the meteorological, geological, and seismic conditions peculiar to Japan. In particular, the safety of type-certified wind turbines under seismic conditions is confirmed since the effects of earthquakes are not taken into account at the time of type certification.

In Japan, "Wind farm certification" is at the aim of confirming conformity to technical regulations stipulated by law, and third-party certification bodies review with reference to both IEC standards and regulations. Therefore, if there is any difference between the IEC standards and the technical regulations, a project could be certified only when the latter is cleared.

IEC61400-1 and IEC61400-3 indicate that, the evaluation for earthquakes is based on the seismic motions provided by standards of each country. In this regard, the existence of Japanese technical standards that are not found in Europe is not necessarily a deviation from the international standards.

The technical regulations themselves are clear but general and abstract. As a complement to these standards, the IEC and other concepts and calculation methods conventionally used in Japan for buildings and support structures are used (e.g., guidelines published by the Japan Society of Civil Engineers, JSCE). According to interviews with relevant parties, the differences from international standards are mainly related to the differences in meteorological and geological conditions in Japan compared to Europe: earthquakes, seabed, wind (typhoons), and waves, and specifically with regard to calculation methods and requirement levels (more conservative). Some calculation methods are already established in Japan, but when various calculation methods (e.g., JSCE standards, DNV, IEC) are assumed, it may be possible to be required to use all of them and compliance with the most conservative results may be required. This conservatism may come from the implicit pressure to experts being involved to the conformity assessment which might lead them not to take risks as decision makers, or the fact that risk-based assessment principles are not so common in practice. In addition, since there is little accumulation of experiences for OSW in Japan, the business operator applying for certification is required to prove the validity of methods and calculation results for which there is little track record of certification, and academic papers are currently being used for this purpose. Conversely, during the course of a review, the applicant may be asked to use a new approach or method that incorporates the latest findings, which is considered in some cases as a deviation from the published standards on the third-party certification guidelines or the Official Explanation.

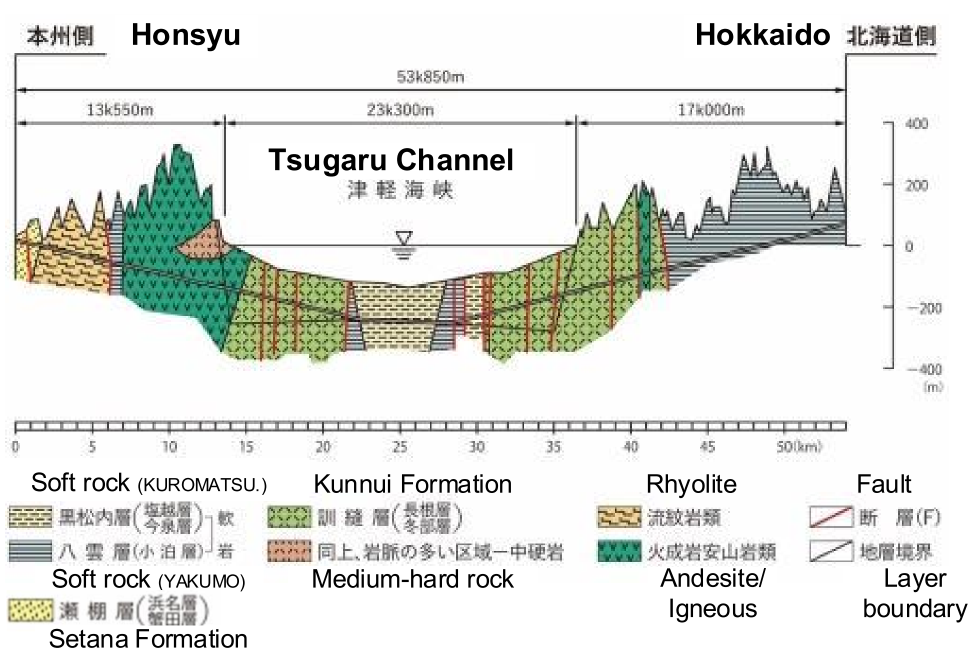
In Europe, Germany is the only country with an approach comparable to the Japanese Official Explanation. Germany has its own unified 'offshore wind standard' (BSH 7004 and BSH 7005). With this, Germany embarked on a special path as compared to other countries, as they refer more directly to the ISO/IEC ICRE standards and leave much room to manoeuvre to the industry itself. Germany's specific offshore standard collects and describes in detail all the standards and regulations that apply specifically for the offshore area. The standard gives much direction and transparency, but it also delayed the offshore wind industry and took several years to develop.

As is the case in Japan now, Germany started with an expert committee that examined projects separately, a.o. due to perceived specificity of sites and load concerns. After a certain period, the committee then developed the overall standard and is since not directly involved with specific projects anymore, only with updating the offshore standard on a regular basis.

While Japan did recently reform its permitting process to avoid double-work in regards to conformity assessment, we find it relevant to point out these important elements of governance practices: 1) In Europe, there is typically no government entity that is directly involved in undertaking conformity assessment, and all work is undertaken by fully independent third-party certification bodies that are independently accredited by a single national accreditation body; 2) activities should be as centralized as possible, so that the same competencies do not have to be built up in several different regional offices. In Europe, there is typically only one national authority office responsible for all offshore wind permitting, and at best, permitting processes are merged so that there is only one point of entry for project developers towards authorities.

5.1.2 Site investigations

The seabed in Japan is more complex than that of European North Sea (where until now most of offshore wind development took place), with a mixture of sand and rock, and soft ground is common in harbours and inner bays.



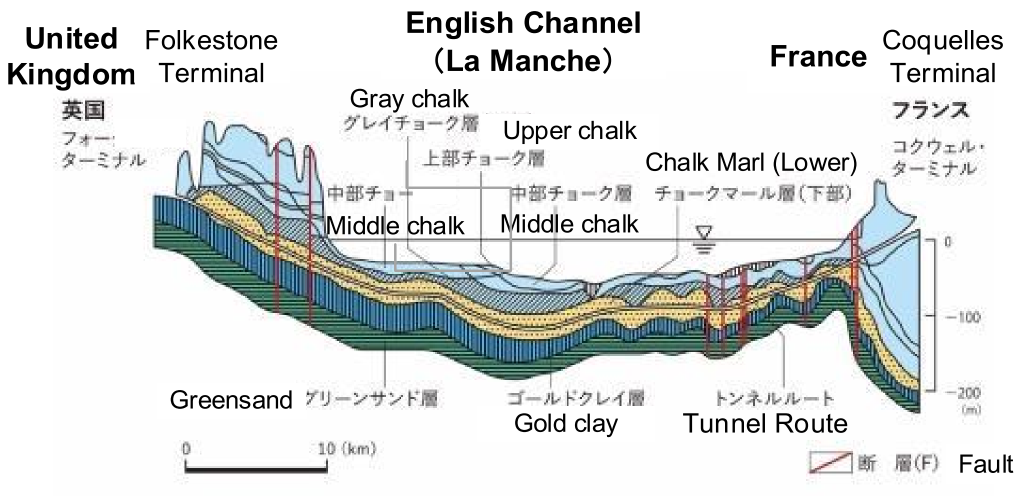


Figure 13 Examples of seabed condition (upper: Tsugaru Strait, lower: English channel)

Source: MLIT, Ports and Harbours Bureau, "Study Group on Base Ports and Harbors for Achieving Carbon Neutrality by 2050 (1st meeting)," (LITMay 18, 2021)[35] *Translation added by REI*

Since the seabed often changes with a slight difference in distance, it is evaluated by grouping when the ground structure and soil properties are judged to be similar based on the results of the preliminary survey and geophysical exploration.

In Japan, the survey is based on the Standard Penetration Test (SPT). When the Cone Penetration Test (CPT), which is popular in Europe, is used, it is necessary to contrast the former and latter methods, compare and study the data, and prove maintainability (safety). The number of data required for calibration of SPT and CPT may be larger than expected in IEC61400-3-1. That is, IEC61400-3-1 requires soil borings at one location in the vicinity of the CPT site, whereas the Official Explanation states that "it is desirable to compare data at multiple locations" due to the complex and diversified seabed conditions as mentioned above.

The IEC61400-50 series on LiDARs has not yet been issued[36], and the implementation of related standards in Europe are not broadly decided yet. In Japan, there is no description on the use of scanning LiDAR and floating LiDAR in the Official Explanation and no applicable standards and criteria have been established. Therefore, the wind conditions are individually verified at each construction site using a ground-based meteorological observation mast, a vertical LiDAR, and multiple scanning LiDARs. Currently, New Energy and Industrial Technology Development Organization, NEDO, is conducting research to accumulate relevant data. A report on data accumulation and utilization as well as recommended standards based on the report are expected to be published within a few years.

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[35] https://www.mlit.go.jp/common/001404624.pdf

[36] They will be expectedly published between July 2022 and May 2023.

5.1.3 Seismic Load evaluation

In IEC61400 series, the evaluation of seismic loads can be done by either response spectrum methods or time-domain methods. In Japan, the Official Explanation states that seismic loads shall be evaluated by combined analysis of the load effects evaluated by time-domain methods and those of the annual average wave and wind. The European regulations typically do not regulate the investigation methods in great detail and general integrated load analyses based on selected sub-set of load cases for fatigue and extreme loads are conducted.

5.1.4 Materials

As mentioned earlier, materials that can be used in the construction of wind power generation facilities are required to conform to JIS standards in principle[37] and the authority incorporates the list of materials in the regulations. Therefore, non JIS materials are basically not eligible. Those include, as an example, steel with a thickness of more than 100mm and bolts with M72 or larger, which are commonly used in Europe. Also, even JIS materials cannot be used if they are not in the list. In such cases, it is necessary to obtain approval by a third-party certification body as having safety equivalent to or better than JIS standards, or to undergo a performance evaluation to confirm compliance with the technical regulations under the Electricity Business Act and the Port and Harbour Act. In that evaluation, the necessary data must be available, such as chemical composition, mechanical properties, and quality control systems in the manufacturing process. With regard to floating OSW, for concrete materials used for the foundations of floating offshore wind power generation facilities and synthetic fibres used for mooring cables, it is necessary to consult the Maritime Bureau of MLIT in addition to complying with domestic standards (concrete materials) and international standards (mooring cables). MLIT is currently formulating guidelines for synthetic fibre ropes.

In Europe, those parts of wind parks that are subject to the Machinery Directive, must be CE-marked. We have not been made aware that there have been any issues with special approval processes required for certain materials to be used in offshore wind farms.

Hence, in contrast to Europe, in Japan the conformity assessment of site suitability cannot be done fully by a third-party and a government entity must make a separate investigation, which increases time and uncertainty. As the testing of this thick steel is specified as using the same methodology and thresholds (295 N/M2) as with thinner steel, it could be considered to change this practice through regulatory reform, so that additional approval processes can be avoided in this respect.

[37] Materials that have been approved for use under certain conditions may be used. The examples include materials approved by the MLIT in accordance with Article 37, Paragraph 1, Item 2 of the Building Standard Act before 2014.

5.2 Best practices identified that may be relevant for Japan

1) EFFECTIVE GOVERNANCE

There is a value in transparency and consistency, when all standards and documents are fully available and all actors meet the same requirements and are well qualified against the backdrop of the same requirements and activities and use common operational documents. The IECRE conformity assessment standards and procedures generally provide this transparency, consistency, and basis for trust. A major benefit of this is that it enables mutual recognition between certification bodies and test labs. This benefits not only wind farm owners, but also financial and insurance entities, as well as government and regulatory authorities. This may mean that, in some cases, national practices have to be retracted and subside to the internationally agreed ones. This has now been done many times in Europe.

In terms of standard development, it is most effective to work in the international context. That is, we currently still see need for development regarding earthquake and typhoons (load case definitions and specifications), for which the best option would be to update IEC 61400-1 (general design) and specific cases where necessary, e.g., in 61400-3-1. In parallel, some ‘amendments’ can be adopted in the national context to the current version to ensure that new insights are taken into account in a timely manner.

Regarding national technical regulation, it is worthwhile putting effort in identifying essential requirements for a certain application, with focus on functions and interfaces, and less on ‘products’, and use this as basis for the development of technical regulation. Here, the already established technical expert group could play an important role in the identification of issues and the development of offshore-specific insights for standards and technical regulation. It may be of benefit for the technical expert group to facilitate the further inclusion of international offshore wind experience, through experts and knowledge exchanges.

Concretely for Japan, this would mean to:

- Engage in development of IEC standards and IECRE guidelines to ensure that these embrace all Japanese conditions, incl. design load cases for earthquake, typhoon. And then, trust in them and enable direct adoption in Japan. This could also include collaboration with certification bodies that issue their own guidelines as these can be implemented and amended faster.
- Limit the scope of core certification to essential requirements
- The same standards, regulations, processes, and calculation methodologies should apply for all projects
- Provide national leadership to build consensus, take in critical information from wind experts and industries to regulators and state agencies. Here, Japan can become a role model for the whole region.
- Refocus the role of technical expert group to focus on the topical content of the design basis, on standard development and general questions e.g., on load cases and methodology, instead of being involved in specific project-level decisions.

2) TRANSPARENT REQUIREMENTS WITH FREQUENT UPDATES

Most European countries rely on the accountability of the sector. Wind farm developers, finance providers and insurers all have in their interest to build safe and reliable wind farms, and have in the past proven to subject themselves to rigorous conformity assessment even if not mandated by law. Public procurement for offshore wind (through tenders) energy typically mandates project certification, although most countries do not have detailed technical regulation that detail the specific requirements.

However, the path that seems most applicable to Japan, and on which the country has already embarked on, is to follow a different approach and to develop a dedicated “offshore wind standard”, similar to the BSH standard in Germany. Continuing along that path would mean to further develop the “unified explanation” for all standards and regulations applicable for offshore wind. In this endeavour, we see it as crucial that a main goal in the further development is streamlining, ensuring fast adoption of new elements, and creating predictability.

Concretely for Japan, this would mean to:

- Continue to develop a comprehensive unified offshore standard that becomes the single reference document for all offshore wind related regulation and that is equally applied across all projects. This may delay the process and may not been acknowledged a necessary by all actors, but it seems to be the way forward taking into account Japanese culture and traditions.
- Piece-wise updating of standards, quick publication of additions / clarifications. To avoid extensive delays, the document can be built up and adopted step-wise.
- Exploit the options of a dedicated offshore wind standard. It could e.g., contain exemptions from other national standards or from ‘positive lists’ for materials, if a deviation is deemed safe for offshore wind applications.
- Establish a system that ensures fast adoption processes of new international standards and updates to regulation from new national knowledge. This could e.g. include parallel voting to adopt new ISO/IEC standards.
- Establish a system for early piloting in low-risk applications (e.g., LiDAR) and options to feed experiences back into the national offshore standard development. This could e.g. be measurement of wind speed and turbulence intensity by floating LiDAR

3) LIMIT ‘SPECIAL’ REQUIREMENTS

International collaboration on international standards has proven to lead to efficiency gains in the industry and to be less costly for all parties in the long run. Governments do not have to develop their own guidance ‘in-house’, but can choose from suitable available standards. These can be ISO/IEC or others, e.g. also guidelines from accredited certification bodies.

The need for separate approval processes for specific design elements is rendering the overall process rather ineffective and can prolong the development phase and make the offshore wind energy more costly in the long run. E.g., the lack of JIS standards for very thick steels means that a government entity must make a separate investigation, which increases time and uncertainty. As the testing of this thick steel is specified as using the same methodology and thresholds (295 N/M2) as with thinner steel, it seems that this process could be streamlined.

Concretely for Japan, this would mean to:

- Reconsider the practice of using ‘positive lists’ for materials that can be used for offshore wind
- Allow for the use of thicker steel and bolts without specific and separate process for government assessment, through inclusion in standard or unified explanations
- Reconsider the requirement to use JIS certified steel for offshore wind, potentially allow trusted certifications from other countries to enlarge market and increase flexibility.

4) FLEXIBILITY IN COMPLIANCE

An increased flexibility in requirements for compliance demonstration could be adopted with increased experience in the sector. It could be worthwhile reconsidering several areas once experience has been gained with the aim to increase flexibility in compliance options, e.g., by using different methodologies in the demonstration, or by substituting certain requirements in sub-parts if overall compliance can be demonstrated. The following areas could be included in a monitoring for flexibility increase potential:

- Risk-based assessment principles, to balance accountability and cost drivers
- Case-by-case modifications to certification, for potential substitutions if overall compliance can be demonstrated

Part II Accreditation system and certification procedures

6 Accreditation procedures and certification system for conformity assessment bodies in Japan

6.1 Procedures for accreditation of conformity assessment bodies

In Japan, a third-party certification body is accredited by the Japan Accreditation Board (JAB) based on ISO/IEC17065 (JIS Q 17065). JAB is a member of the International Laboratory Accreditation Cooperation (ILAC), an international organization of accreditation bodies for testing and inspection laboratories and has agreed to the ILAC Arrangement.

JAB has established "Sectoral Guidelines on 'Criteria for Accreditation' - Wind Power Generation Systems: Wind Farms, Projects"[38] as guidelines applicable to product certification bodies accredited under JIS Q 17065:2012 (ISO/IEC 17065IDT) for the certification of wind power generation systems. According to this guideline, the evaluation method is based on JIS C 1400-22:2014, which is equivalent to IEC 61400-22 Ed. 1.0, and the method specified by the "Site Conformity Assessment Methodology for Wind Power Generation" of the Japan Electrical Manufacturers' Association, JEMA. In addition to JIS and international standards, laws and ministerial ordinances, their interpretations, and the JSCE guidelines are listed as criteria for assessing conformity.

Currently, Nippon Kaiji Kyokai (Class NK) and Bureau Veritas Japan K.K. are accredited as third-party certification bodies.

The JAB guideline does not mandate the establishment of an expert panel in the certification process, but it is recommended in practice. Both organizations have incorporated the review by the expert panel into their procedures.

The part of the JAB guideline referring to the resource requirement is as follows:

6. resource requirements

6.1 Personnel of the certification body

In addition to JIS Q 17065 clause 6.1, the following shall apply. Assessment personnel shall have the knowledge and experience to conduct the assessment specified in clause 7.4, and the skills to conduct

[38] Japan Accreditation Board for Conformity Assessment, JAB PD366:2017
https://www.jab.or.jp/files/items/common/File/PD3662017V2.pdf

the assessment. In the assessment, such knowledge and experience may be fulfilled by the assessment team. The reviewer of the evaluation results should have knowledge of the evaluation items, pass/fail criteria, and evaluation methods in order to verify the appropriateness, sufficiency, and effectiveness of the results of the evaluation activities. Certification decision makers should have knowledge of certification criteria, certification schemes, and conformity assessment systems in order to judge the appropriateness of review results and make certification decisions. The reviewer of the evaluation results and the certification decision maker may serve concurrently.

6.2 Outline and activities of the accredited body in Japan

Among two conformity assessment bodies in Japan, ClassNK's activities are worth being introduced due to their track record in Japan compared to Bureau Veritas Japan which is recently accredited in November 2021.

ClassNK is one of the eleven classification societies of the International Association of Classification Societies (IACS), headquartered in Japan, with the same background as other classification societies such as DNV and BV, which act as wind power certification bodies. It has the same background as other classification societies that act as wind power certification bodies, such as DNV and BV.

Its activities are diverse and include classification services, management system certification (ISO related), and technical and training services.

In the area of renewable energy, they offer the following services[39]

- Type certification of wind turbines
- Wind farm certification
- Classification of floating offshore wind turbines
- Technical assessment of wind turbine support structures (including material certification)
- Wind turbine support structure manufacturing assessments
- Third-party verification of wind turbine-related technologies
- Periodic safety management audit
- Marine Warranty Survey
- GWO Training Certification
- Publication of guidelines

The guidelines for wind power published by ClassNK are as follows. Guidelines for bottom-fixed offshore wind have not yet been opened in public other than OSW business operators and will be developed and published pending the accumulation of case studies.

- Certification Guideline for Wind Power Generation System (NKRE-GL-WT01, October2021) (published

[39] https://www.classnk.or.jp/hp/ja/authentication/renewableenergy/index.htm

May 2014, revised October 2021)

This guideline "prescribes rules and procedures for a certification system for wind turbines, consisting of type certification and project certification of onshore and offshore wind power plant" and the standards cited are the IEC61400 series and other ISO and IEC standards.

- Wind Farm Certification Onshore Wind Farms Edition (NKRE-GL-WFC01, Edition: July 2021) (published July 2021)

This standard "specifies requirements for onshore wind farms subject to wind farm certification." "In the event of any changes to the requirements for Construction plan review based on the Electricity Business Act, such requirements shall take precedence over the provisions of this guideline". Cited standards include international standards, technical regulations (ministerial ordinances), their commentaries and JSCE guidelines as included in accreditation standards by JAB.

- Guidelines for Floating Offshore Wind turbine - Classification Survey - (NKRE-GL-FOWT01, Edition: December 2021) (issued in December 2021)

This is a new edition of the "Guidelines for Floating Offshore Wind Turbine Generation Facilities" published in July 2012. Cited standards include not only IEC, but also technical regulations and other laws and regulations (e.g., ministerial ordinances of MLIT, those of METI, their interpretations, their commentaries, and Official Explanation).

ClassNK is committed to independence, impartiality, and third-party reliability. . Meanwhile, there is a consulting company, ClassNK Consulting Services Inc. According to its website, the company provides consulting services related to ship construction, operation, and management. According to other public information as of July 2021, the representative director of Japan Wind Energy Consulting, Inc.[40] is concurrently working as the leader of the Wind power group of ClassNK Consulting Services from June in 2020. The services of Wind Energy Consulting include conducting wind condition campaign or other site condition assessments, load analysis, preparing marine documentation for a Wind farm certification, and assisting in the response to the expert panel reviews.[41]

6.3 Conformity assessment practice

6.3.1 The modules of Wind farm certification

Wind farm certification consists of (1) Site conditions assessment, (2) Design basis evaluation, (3) Integrated load analysis, (4) Wind turbine (RNA) design evaluation, and (5) Support structure design evaluation, all of which are conducted in the case of offshore wind farms.

[40] Carbon Trust and ClassNK, "Invitation for OSW Webinar, Offshore wind campaign and the technology of floating LiDAR, held July 21, 2021" (event flyer), https://www.classnk.or.jp/hp/pdf/press/beshi20210706_001.pdf

[41] Japan Wind Energy Consulting Inc. website, https://www.jwinc.co.jp/services/

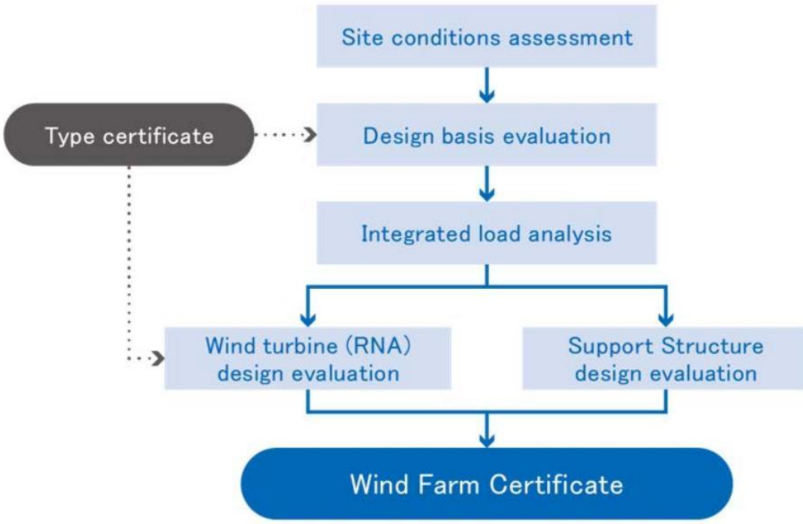
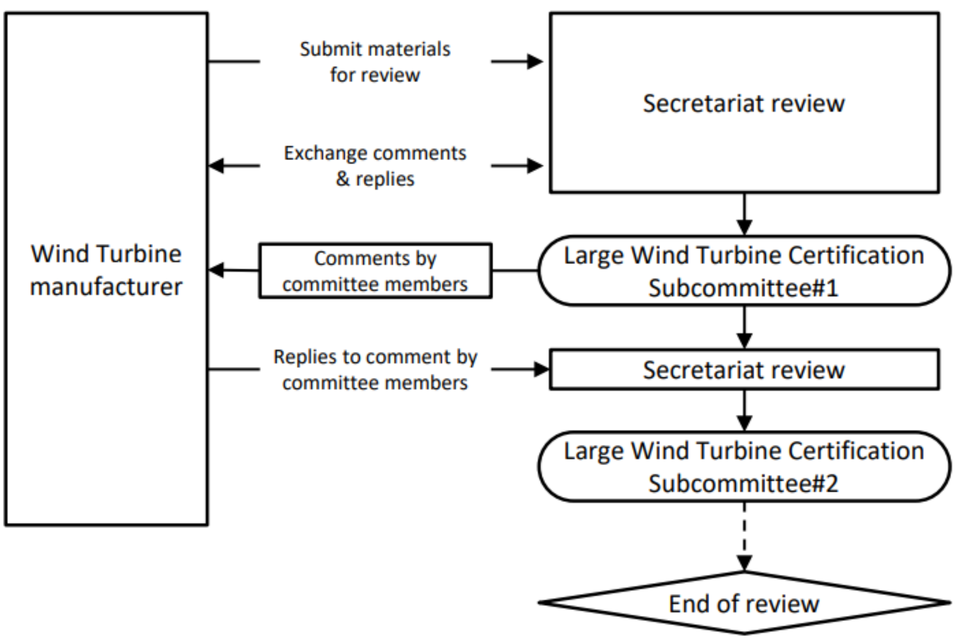


Figure 14 Wind farm certification modules and flow

Source: ClassNK, "ClassNK Wind Turbine Certification and Related Services [Public website version]," August 2021, p.17

Currently, the RNA evaluation is conducted repeatedly by the secretariat and the Large Wind Turbine Certification Subcommittee, which includes experts, until compliance with the technical standards, etc. is confirmed. Regarding the support structure related matter, the business operators (e.g., developer, design company, turbine manufacturer) directly explain the design to the panel members at the meetings of expert panel (Support Structure Certification Subcommittee).



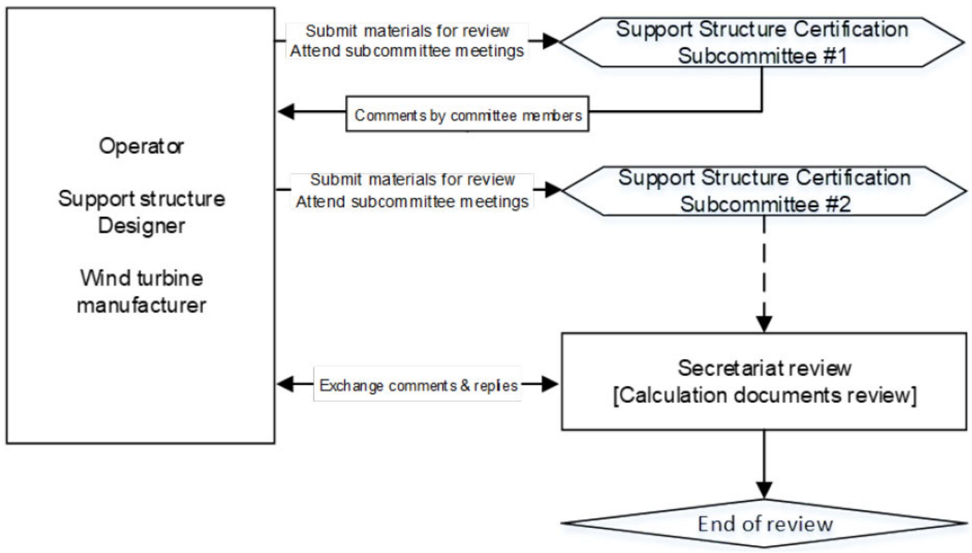


Figure 15 Flow of the review of ClassNK certification related to the RNA (upper) and the support structure (lower)

Source: "ClassNK Wind Turbine Certification and Related Services [Public website version]," August 2021, p.23,24

6.3.2 Issues related to the practice

Several issues have been raised in relation to the expert panel review in the procedures.

One example is that the interval of the panel meetings can be several months, which is pointed out as a reason of the lengthy process to obtain a certification. These issues may be due to the limited experience with offshore wind in Japan, the fact that the certification process itself is still in the process of development, and the limited number of experts who are familiar with offshore wind due to the limited experience.

Since the third-party certification procedure is followed by METI review based on the Electricity Business Act, developers are currently required to undergo two reviews of the Construction plan and to respond to the points raised by the respective expert groups. If the members of the expert panel in the certification procedure are different from those of METI Expert committee, the developer will be at risk of having to deal with different requests from METI expert committee even after obtaining a third-party certification. This might lead developers to select a certification body with similar membership in both panels to avoid the risk.

METI considered a reform by involving the members of their Expert committee in the third-party certification procedure in order to streamline the whole process. Even though the aim of the reform was correct, the intervention of a government in such way may raise doubts about the independence of the third-party certification body.

The latest reform planned by METI to establish a new conformity assessment body could streamline the process by omitting the review by the METI Expert Committee, but it seems uncertain how this new scheme would affect the independent, third-party certification process now existing in Japan.

Meanwhile, there exists a concern raised from European stakeholders related to the monopoly and oligopoly of certification procedure and potential conflicts of interest. In the interviews, no one pointed out any conflict-of-interest issues with respect to ClassNK itself.

7 Accreditation procedures and certification system for conformity assessment bodies in the EU

7.1 System for conformity assessment in the EU

It is European practice (and required in the IEC conformity assessment system) that all conformity assessments are undertaken by an accredited third party, i.e. that the assessment activity is performed by a body that is independent from the manufacturer or the buyer of equipment, and that is recognized by a government authority for this task.

To undertake conformity assessments under the IECRE system, a certification body must be accredited e.g. to ISO/IEC 17065 (product certification). The process of accreditation is set out in the international standard ISO/IEC 17011 Conformity assessment — Requirements for National Accreditation Bodies accrediting Conformity Assessment Bodies. Requirements for accreditation in the EU are set in EU Regulation 765/2008 according to the main principles of:

- Maximum one accreditation body per EU country (it is possible to use another country's accreditation body) and no competition between bodies
- Accreditation as a public sector activity, not a for-profit activity
- Accreditation as the preferred way of demonstrating technical capability to carry out certification
- Stakeholders are represented

In terms of anchoring in European legislation, Article 42(5) of the Regulation 2016/679/EU of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data provides that certification shall be issued by an accredited certification body or by a competent supervisory authority.

7.1.1 Accreditation bodies and their organisation

Each country's accreditation entities are in charge of accrediting companies for the certification of offshore wind projects, offshore wind turbines and their components, etc. The following table shows the accreditation body for each major country leading offshore wind development in Europe.

Table 7 Accreditation body for each major country leading offshore wind development in Europe

	Belgium	Denmark	France	Germany	Netherlands	Portugal	Sweden	UK
Accreditation body	BELAC	DANAK	COFRAC	DAkkS	RVA	IPAC	SWEDAC	UKAS

Accreditation bodies in Europe are independent entities. The Danish DANAK, for example, is organized as a foundation. It is mostly financed through client payments in connection with undertaken accreditation tasks. DANAK's work in international networks as a representative of the state is financed through the state budget. The German DAkkS is an independent firm (GmbH), whose shareholders are the German state (33.33%), the German Industry Association (33.33%) and three federal states (11.11% each). The French COFRAC is an association with a large number of members, comprising diverse stakeholders.

The national accreditation bodies are organised in a European network called European Accreditation (EA). EA, a not-for-profit association, has been instrumental in harmonising accreditation criteria across Europe. EA developed the 'Accreditation for Nofitication' (AfN) package, published in 2016, which includes guidance documents and good practices on assessment for accreditation. The current version is implemented as of April 2021 (EA-2/17 M:2020)[42]. The notification, as well as the accompanying project document[43] contains detailed explanations and lists of preferred standards for use in many application areas. In 2021, EA also published an informative report "Accreditation – a tool to support regulators"[44].

EA spans broader than only Europe. It has 36 Full Members and 13 Associate Members, also including countries like Ukraine, Algeria, Israel, Azerbaijan, Eqypt and Jordan. The Multilateral Agreement (MLA) between all EA accreditation body members established mutual automatic acceptance of accredited certifications, inspections, calibration certificates and test reports. The reach of the MLA is further broadened to international level by the International Laboratory Accreditation Cooperation (ILAC) and the International Accreditation Forum (IAF). The robustness of the MLA is maintained through a strong peer evaluation process, in which bodies are regularly evaluated every four years. The peer evaluation system has been quite active in the past, e.g. in 2016, peer evaluation teams had reported a total of 135 findings where corrective action was required by national accreditation bodies. In 2014, one Accreditation Body had actually been suspended

42 https://european-accreditation.org/wp-content/uploads/2018/10/ea-2-17-m.pdf
43 https://european-accreditation.org/wp-content/uploads/2020/04/AFN-PROJECT-2021.pdf
44 https://european-accreditation.org/wp-content/uploads/2018/10/accreditation-a-tool-to-support-regulators_1.pdf

for a period (EC 2017). The MLA process is overseen by the European Commission, the EA Advisory Board and the national authorities.

EA receives EU funding to assist in drawing up and updating of contributions to guidelines related to accreditations, carrying out work related to peer evaluations, giving assistance to third countries, and participating in international organisations in the field of accreditation.

7.1.2 The procedure of accreditation in European countries

In order to become accredited and then carry out project certification, a body needs to pass the accreditation procedure. In France, for example, the phases are the following: once the application has been submitted, COFRAC, the accreditation body, proceeds with an operational admissibility review. The purpose is to check if the applicant understood correctly all the requirements in order to be accredited and to determine how the assessment is to be carried out on-site with regard to the accreditation regulations and the body's organization. Then, the on-site assessment is carried out for the applicant to demonstrate its competence and the conformity of its operation to the accreditation requirements. Different techniques are deployed: review of documents and records, interviews with staff, witnessing of activities presented for accreditation, traceability audits of technical operations, etc. Once accreditation is issued by the assessment team, a surveillance programme is set up by COFRAC over the accreditation period, according to the terms laid out in the accreditation regulations. Surveillance is carried out similarly to the initial assessment, but it is adapted according to the results of the previous assessments and the changes made within the body, in terms of resources and organization. There is possibility to extend the accreditation.

The process for accreditation in Denmark by DANAK and in the Netherlands by RVA is very similar to the process in France described above.

Typical accreditation cycles span 2 to 5 years, after which accreditation can be renewed after a complete assessment for a new cycle. National Accreditation Bodies carry out regular surveillance assessments to ensure that accredited bodies continue to live up to the high standards of technical expertise. They can impose sanctions when certification bodies do not fulfil all obligations and requirements. Accreditation scopes can be reduced, suspended or withdrawn.

Member States must inform the European Commission and the other Member States that a body, which fulfils the relevant requirements, has been designated to carry out conformity assessment according to a relevant directive. This act is called ‘Notification’. In the European context, accredited certification bodies are therefore also referred to as ‘Notified Bodies’. Lists of Notified Bodies can be searched on the NANDO (New Approach Notified and Designated Organisations) website[45].

[45] https://ec.europa.eu/growth/tools-databases/nando/index.cfm

7.1.3 Certification bodies in Europe

In most cases, third party certification bodies have testing and certification as their main focus of work and are commercial for-profit companies. Note that conformity assessment undertaken by a third party is typically more expensive than a first party (in house) conformity assessment.

The certification bodies vary from a country to another in Europe as shown below*.

Table 8 Certification bodies in Europe

Certification body	Denmark	France	Germany	Netherlands	Portugal	Sweden	UK
DNV	x			x			
Bureau Veritas	x	x		x	x	x	
TÜV	x		x	x			
UL	x		x				
Lloyds	x			x			x
WindGuard certification			x				
Hanseatic Power Cert			x				

* For Belgium, no relevant information has been found.

Certification bodies engage in three main areas of conformity assessment[46]:

(1) Calibration and Testing – Certified testing and test reports are provided for various calibration and performance testing for wind energy equipment and project performance.

(2) Equipment – The equipment certification scheme provides procedures for conformity assessment to IEC standards for WTGs and components, including prototypes.

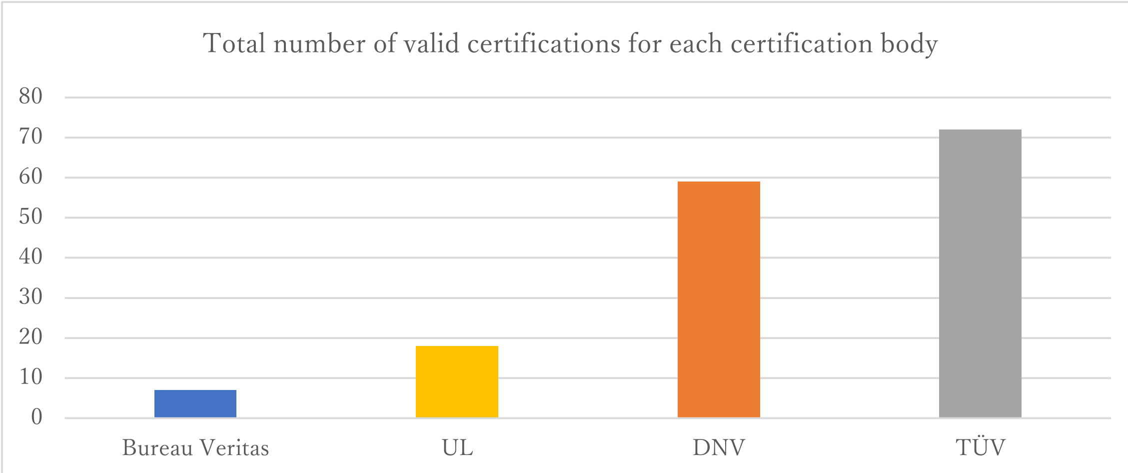
(3) Projects – conformity assessment of a complete wind farm project or individual installation associated with the wind farm

7.1.4 Certification activity for offshore wind in Europe

IECRE provides data concerning certifications given by Bureau Veritas, UL, DNV and TÜV. In total, 156 valid certifications to Europe firms are listed.

[46] https://share.ansi.org/Shared%20Documents/Standards%20Activities/International%20Standardization/IEC/Communications%20Committee/Conformity%20Assessment%20in%20the%20Wind%20Energy%20Industry.pdf

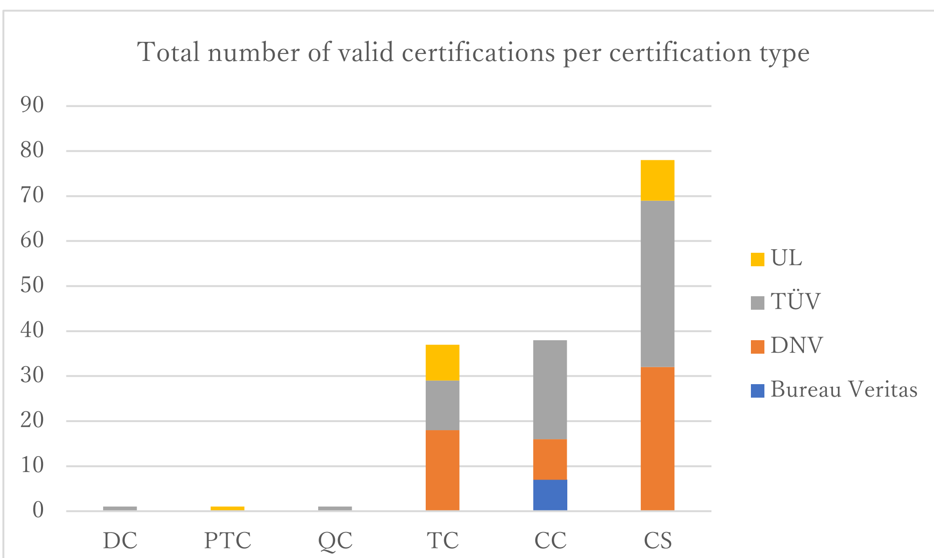
Table 9 Total number of valid certifications for each certification body



Despite its presence in most of the countries at stake, Bureau Veritas delivered only a few certifications according to IECRE data. But since IECRE does not track local offshore wind project certifications, this picture is skewed, as project certification is the area where Bureau Veritas seems to be more involved in. Besides, being accredited in a country does not mean that the company ever gave any certification in this country.

Below, we show the types of certifications listed by IECRE within offshore wind in Europe. In the following figure, the 3 main areas are CS (Design evaluation and conformity statement), CC (component certificate) and TC (type certificate). The allocation among each of the 4 certification bodies is shown.

Table 10 Total number of valid certifications per certification type



Finally, companies seem to have preferences concerning the body in charge of certification of their products.

As examples and according to IECRE data:

- Vestas Wind Systems works only with DNV (34 certificates obtained)
- LM Wind Power works mainly with TÜV (15/21)
- Siemens Gamesa works mainly with TÜV (20/29)

In regard to project certification, we see some more diversity in collaboration, where e.g. Ørsted collaborated with Bureau Veritas on Borkum Riffgrund 2 and Borssele 1&2, with UL on Borkum Riffgrund 3 and Gode Wind 3, with TÜV on Borkum Riffgrund 1, and with DNV on Anholt and Horns Rev 2. Vattenfall collaborated with TÜV on Kriegers Flak and Hollandske Kuist 1-4, and with DNC on Horns Rev 3.

7.1.5 International recognition of conformity assessment bodies

The EU has in the past pursued cooperation agreements, which enable conformity assessment bodies in the EU to test products for export to other world regions and vice versa. This alleviates the need to pay twice for the same test and decreases time to market. These agreements are called Mutual Recognition Agreements (MRAs) and are bilateral between the EU and a third country. MRAs lay down the conditions under which the parties accept conformity assessment results performed by either party's designated conformity assessment bodies (CABs) to show compliance with each other's requirements. MRAs include relevant lists of designated laboratories, inspection bodies and conformity assessment bodies in both the EU and the third country.

Currently, there are MRAs in place between the EU and Australia, Canada, Japan, New Zealand, the USA, Israel and Switzerland (EC, 2022).

The agreement between the EU and Japan is from 2001[47] and operational for the following sectors:

- Electrical Products
- Telecommunications Terminal Equipment and Radio Equipment
- Good Manufacturing Practice for Medical Products
- Good Laboratory Practice for Chemicals

The agreement stipulates that each party shall accept results of conformity assessment procedures, confirmation of facilities conducted by the competent authorities, and data generated by confirmed facilities. This is valid for listed approved conformity assessment bodies in the agreement. No designated conformity assessment bodies are in the area of electrical products.

[47] *Official Journal L 284 , 29/10/2001 P. 0003 - 0032*

7.2 Best practices identified that may be relevant for Japan

1) INDEPENDENCE

National Accreditation Bodies are independent, non-for-profit bodies that operate with government recognition according to internationally recognised standards and are themselves regularly reviewed by international peers. Government representatives are welcome to observe evaluations, but have no formal role in the process. The accreditation authority is typically separate from the regulation or permitting authority.

The internationally implemented process of peer evaluation with rigorous assessments and on-site evaluations of quality systems, processes, and records of accreditation bodies to ensure the continuing conformity with internationally accepted criteria (such as ISO/IEC 17011) is a strong instrument to ensure accountability and quality of accreditation.

Concretely for Japan, this would mean to:

- Ensure separation and independence of conformity assessment regulation and accreditation, following international standards such as ISO/IEC 17011. Accreditation should be undertaken by an independent body that is not directly involved in development of standards, technical regulation or permitting of projects.

2) 'THIRD-PARTY' APPROACH

Only third parties undertake conformity assessments. No government body is directly involved in conformity assessment in wind energy. This requires a number of capable accredited third-party bodies to choose with sufficient experience in the area.

Concretely for Japan, this would mean to:

- Assessments undertaken by independent accredited bodies only – avoiding 'double' certification through authorities. Even if a government body has responsibility for specific assessment tasks, this can be executed by an accredited independent body.
- Enlarge the basis for accredited conformity assessment bodies, to ensure competition, introduce more knowledge into the sector and ensure that there are sufficient capacities available for an accelerated expansion of offshore wind.

3) INTERNATIONAL COOPERATION

The European system includes a strong emphasis on mutual recognition, which extends to flexibility within a project certification process: as certification bodies accept conformity statements by other IECRE accredited certification bodies to different project certification modules, developers can, in principle, engage different certification bodies for different modules.

The strategic development of international cooperation and mutual recognition agreements between accreditation bodies and their associations has proven very valuable. Certification bodies accredited in one EU member state may also operate in others.

This may also a (however weak) mitigation against potentially dominating certification bodies within a country.

Concretely for Japan, this would mean to:

- Pursue multilateral and bilateral recognition and acceptance of standards and conformity assessment

4) TRANSPARENCY AND COMMUNICATION

Transparency in the accreditation can help develop the market. Many European countries are recognizing the potential of accreditation as basis for trust and a well-functioning market. E.g., Ireland has in May 2022 published its first 'Strategy for Accreditation'[48] with the aim to inform and influence national policy, to promote awareness and engagement, to grow uptake and application of accreditation and to develop governance, organisational design and structure of accreditation.

Concretely for Japan, this would mean to:

- Actively engage in communication and information efforts around accreditation and conformity assessment procedures, especially in case of updates and changes

[48] https://www.inab.ie/news-resources/news/strategy-for-accreditation-may-2022.pdf

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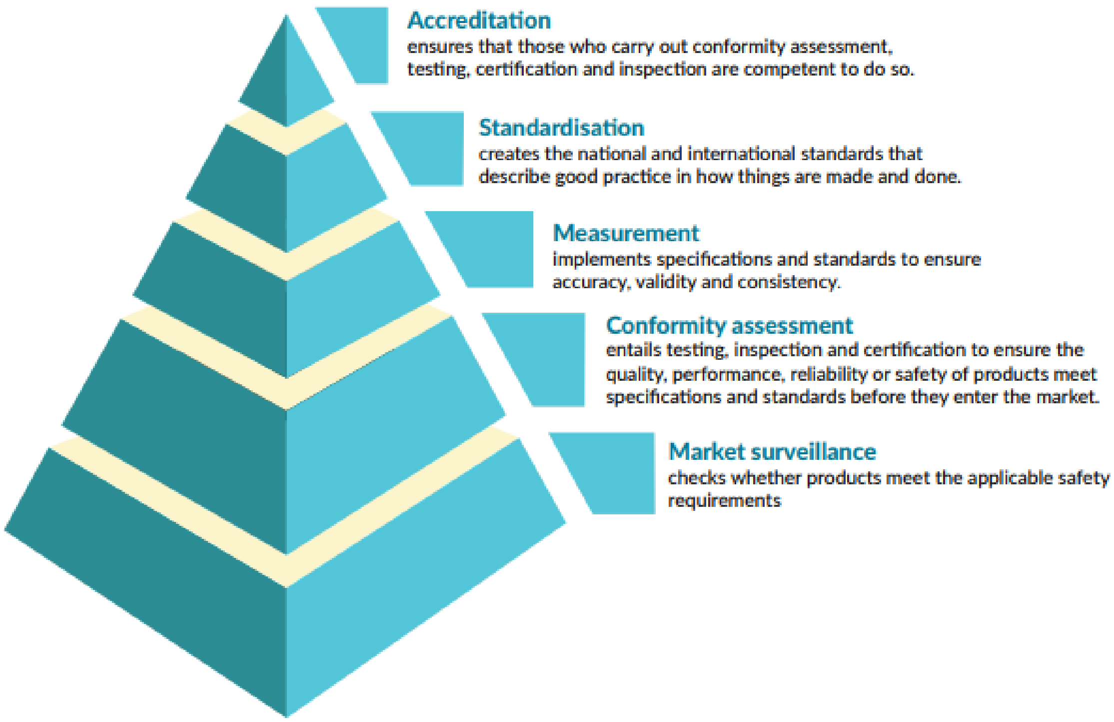
APPENDIX A: Definitions



Key Pillars in a National Quality Infrastructure.

Source: https://www.inab.ie/news-resources/news/strategy-for-accreditation-may-2022.pdf

Accreditation: Independent evaluation of conformity assessment bodies (CABs) against recognised standards to ensure their impartiality and competence to carry out specific activities, such as tests, calibrations, inspections and certifications

Certificate: Document in which an accredited body gives written assurance that a product, process or service conforms to specified requirements, i.e. prove that certification has been completed successfully.

Certification: Procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements. Also known as conformity assessment, i.e. according to IECRE OD-501.

Component certification: Issued for e.g. rotor blades, generators, gearboxes, electrical components, brakes, couplings, nacelle frames, towers, main bearings or systems such as pitch systems, yaw systems, fire protection systems, condition monitoring systems or parts such as bolts and tower internals. For floating support structures, component certification will typically be relevant for e.g. mooring components.

Conformity Assessment: Procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements, based upon a given certification scheme for which the certification body is accredited. In this report, we will focus on third-party conformity assessment only, in which certification is performed by a person or organisation that is independent of the seller or the buyer.

Conformity Assessment Body (CAB): Entities that perform testing, calibration, verification, certification or inspection services

Multilateral Agreement (MLA): A signed agreement between the EA Members whereby the signatories recognise and accept the equivalence of the accreditation systems operated by the signing members, and also the reliability of the conformity assessment results provided by CABs accredited by the signing members.

Regulatory framework: Generally, the published and official laws, standards, guidelines…

Standards: Provide instructions, guidelines, rules or definitions that are then used to design, manufacture, install, test & certify, maintain and repair electrical and electronic devices and systems. Not in principle compulsory, but usually the easiest or in practice the only way to meet the more detailed, law-based requirements.

Technical regulations: Regulations are rules or directives that are made and maintained by a national or regional authority. Generally, compliance with regulations is generally compulsory, such as with laws. Internationally, it is quite common for technical regulations to refer to international standards because standards help avoid that the law becomes too detailed or descriptive. This approach allows laws to stay current because standards are regularly reviewed and updated.[49]

Type certification: Wind turbine types shall be certified according to defined standards by an accredited certification body. Within the wind industry, type certification means certification of the wind turbine rotor-nacelle assembly and its components. The type certification is in general a certification of a type of turbine considering generic wind conditions (wind turbine class). A generic tower type is part of the type certificate. However, especially for offshore wind, a tower is always designed site specific, thus part of the project certification. Also other site-specific components such as foundations and assets such as offshore substation and power cables are not type certified.

Project certification: To evaluate whether a wind farm, including type-certified wind turbines, their support structures and auxiliary installations is designed according to applicable standards, construction codes and other relevant site-specific requirements. The applicant is usually the developer. Project certification may be required by law, by authorities, financial institutions, or by insurers.

Validity of a project certificate: The project certificate is issued for a certain tested design and thus valid only for this specific design and installation. The project certification is restricted and depends on regular surveillance of the O&M activities.

[49] https://www.iec.ch/understanding-standards

APPENDIX B: Extract of the Technical Standards for Floating Offshore Wind Power Generation Facilities related to the issued discussed in the report

"Safety Guidelines of Technical Standards for Floating Offshore Wind Power Generation Facilities" (Maritime Bureau, MLIT, hereinafter, "Safety Guidelines") , the explanative document of the Technical Standards, are also referred to when relevant.

1. Safety regulations

Chapter 1 External Conditions

4-1. Earthquakes

(1) The effects of earthquakes shall be appropriately considered. The largest earthquake that has ever occurred in the vicinity of the installation site shall be taken into account.

(2) The effects of tsunamis shall be considered appropriately. For tsunamis, the largest tsunami that has ever occurred in the vicinity of the installation area shall be considered. However, if the water depth is deep enough, tsunami effects may be considered as tidal fluctuations and ocean currents.

(3) When considering earthquakes and tsunamis, environmental loads such as wind and waves may be assumed to be those under normal conditions.

(4) Liquefaction of the seabed in the event of an earthquake shall be considered.

Chapter 2 Rules for Structure

Section 1 Materials 1. Materials to be used

(1) Materials specified in the Ship Structure Rules (1998 Ministry of Transport Ordinance No. 16) shall be used for the main structural parts of floating offshore wind power generation facilities and for drainage facilities, etc.

(2) If materials other than those specified in (1) above are to be used, an inquiry should be made to the Director, Inspection and Survey Division, Maritime Bureau, MLIT, together with the necessary data.

Chapter 3: Position Retention System

3. mooring analysis

Status	Safety factor	
	Chain and wire rope	Synthetic fibre rope
Non-damaging		
Dynamic analysis	1.67	2.50
Quasi-dynamic analysis	2.00	3.00
Single cable breakage (equilibrium state after breakage)		
Dynamic analysis	1.25	1.88
Quasi-dynamic analysis	1.43	2.15
Transient state at single cable breakage		
Dynamic analysis	1.05	1.58
Quasi-dynamic analysis	1.18	1.77

Table 3-1 *Safety factor of mooring line*

Chapter 4 Regulations Concerning Facilities

2. Equipment related to engines

To be conformed to the Ministerial Ordinance for Ship Engine (Ministry of Transport Ordinance No. 28 of 1984)

3. Facilities related to electricity

To be conformed to the Ministerial Ordinance for Ship Equipment (1934, Ministry of Posts and Telecommunications Ordinance No. 6), Part 6

5. Elevating facilities (if any)

To be conformed to the Ministerial Ordinance for Ship Equipment (1934 Ministry of Posts and Telecommunications Ordinance No. 6), Part 7, Chapter 1.

6. Landing facilities for rotary wing aircraft (if any)

To be conformed to the Guide to Ship Inspection 3-1 Annex [9]

2. Materials

2.1 Concrete materials

Chapter 2

1. materials to be used

(1) Materials specified in the Ministerial Ordinance for Ship Structure (1998 Ministry of Transport Ordinance No. 16) shall be used for the main structural parts and drainage facilities of floating offshore wind power generation facilities.

(2) If materials other than those specified in (1) above are to be used, an inquiry should be made to the Director, Inspection and Survey Division, Maritime Bureau, MLIT, together with the necessary data.

"Safety Guidelines"

When used as a structural strength material of a floating facility, tower, etc., it is necessary to confirm that it has sufficient safety by conducting an appropriate strength evaluation.

For details, refer to References 2-1) and 2-2) and other domestic guidelines related to concrete structures.

Reference 2-1: JSCE Standard Specifications for Concrete [Design Edition], 2012

Reference 2-2: JSCE Standard Specifications for Steel and Rigid Structures, General Provisions, Structural Planning and Design, 2007

2.2 Synthetic fiber cables

Chapter 3, 5 Mooring Equipment

(2) Chains, wires, etc.

(a) Chains, wires or synthetic fibre ropes, intermediate sinkers, intermediate buoys, anchors that serve as mooring points on the seabed, sinkers, piles, etc. used for mooring systems shall be those approved as appropriate by the competent marine authority.

“Safety Guidelines"

(2) Chains. Wires, etc.

Chains, wires or synthetic fibre ropes, intermediate sinkers, intermediate buoys, anchors serving as mooring points on the seabed, sinkers, piles, etc. used for mooring systems shall comply with international standards and shall be approved by the competent marine authority.

Luxembourg: Publications Office of the European Union, 2022

Print ISBN 978-92-76-56956-5 doi: 10.2781/460020 NG-09-22-524-EN-C

PDF ISBN 978-92-76-56957-2 doi: 10.2781/628998 NG-09-22-524-EN-N