LEVERANSEMODELLER FOR HAVVIND

Overview of offshore wind standards and certification requirements in selected countries

Norsk Industri AS

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Objective:
Provide an overview of government requirements, standards, guidelines and CE marking and other certification requirements within offshore wind for Norway and internationally, covering both bottom-fixed and floating wind.

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1 INTRODUCTION

1.1 Scope of work

DNV GL has been asked by Norsk Industri to perform the following:

- Create an overview that shows the connection between government requirements, standards, guidelines, CE marking and other certification requirements within offshore wind for Norway and internationally.
    - The assessment will focus on France, Germany, Norway, South Korea, Taiwan, UK and the US.
- Establish an overview of rules, standards, guidelines and certification requirements that are currently used or that are known during development for floating offshore wind valid both above and below water for Norway and internationally, including turbine, transformer station / structure and submarine cable.
    - The assessment will focus on floating wind specific standards developed and not country specific requirements, as this is linked to the regimes described for the different countries in the above task.

This report is responding to the above scope by the following outline:

- Section 2 provides a summary of the the status of offshore wind market and aim to allow the reader to see the regulatory requirements in the context of the market
- Section 3 provides an overview of the standarisation bodies (3.1) and the relevant standards for bottom-fixed (3.2) and floating (3.3) wind
- Section 4 describes the most commonly applied certification schemes
- Section 5 defines important terms in relation to regulatory requirements
- Section 6 describes the main findings regarding project certification requirements found in the assessed countries: France, Germany, Norway, South Korea, Taiwan, UK and the US
- Section 7 provides the references where more information can be found
- The Appendixes provides an overview of the detailed regularatory requriements in the assessed countries.

2 OFFSHORE WIND STATUS

Accoring to DNV GL's Energy Transition Outlook 2020 /1/, in 2018, wind power provided 4.7% of the world's electricity output. In some regions, like Europe and North America, the share was as high as 11.4% and 6.3%, respectively. In 2019, 47% of Denmark's electricity was generated from wind power, and the country is planning further expansion in the next few years. This uptake has been driven by financially supportive policies and a growing awareness of the impact of conventional energy sources on the environment and climate. In the future, DNV GL foresee support for onshore wind slowing in some developed countries, where the industry has reached a high maturity level, and where conflicts on wind turbine location are on the increase. For offshore wind, DNV GL expect strengthened support in countries with limited land areas, bypassing community opposition, and a fast uptake of offshore wind in new regions where this technology is yet unexploited.

For offshore wind to be successful, the development of large wind turbines with a rating of 10+ MW is seen as key for cost reduction of offshore wind applications. Today, 9.5 MW turbines are in operation and a 12 MW turbine has been tested and begins commercial operation this year. In 2030, turbines as large as 20 MW may be seen.

Wind turbine technology will further develop using new materials and advanced monitoring and control, making it fully competitive with conventional electricity generation. Cost reductions in floating offshore will enable new geographic areas to be developed where previously limited land availability or lack of shallow water hindered wind energy development.

According to IEA /2/, Europe is a leader in offshore wind technology and policy support has helped the European Union reach nearly 20 GW of offshore wind capacity by the end of 2018. Worldwide, the installed capacity of offshore wind (bottom-fixed) is of approximately 30GW by mid-year 2020.

Alongside Europe, China has taken strides forward on offshore wind and now stands among the market leaders. In 2018, China added 1.6 GW of offshore wind capacity, the most of any country. In the US, state-level targets set the course for rapid growth over the next decade. India, Korea and Taiwan also have ambitious targets, while other countries, including Japan and Canada, are laying the groundwork for future offshore wind development.

An illustration of the offshore bottom-fixed wind installed capacity per 2020 from the "Global Offshore Wind Report" /48/, can be seen in Figure 2-1.

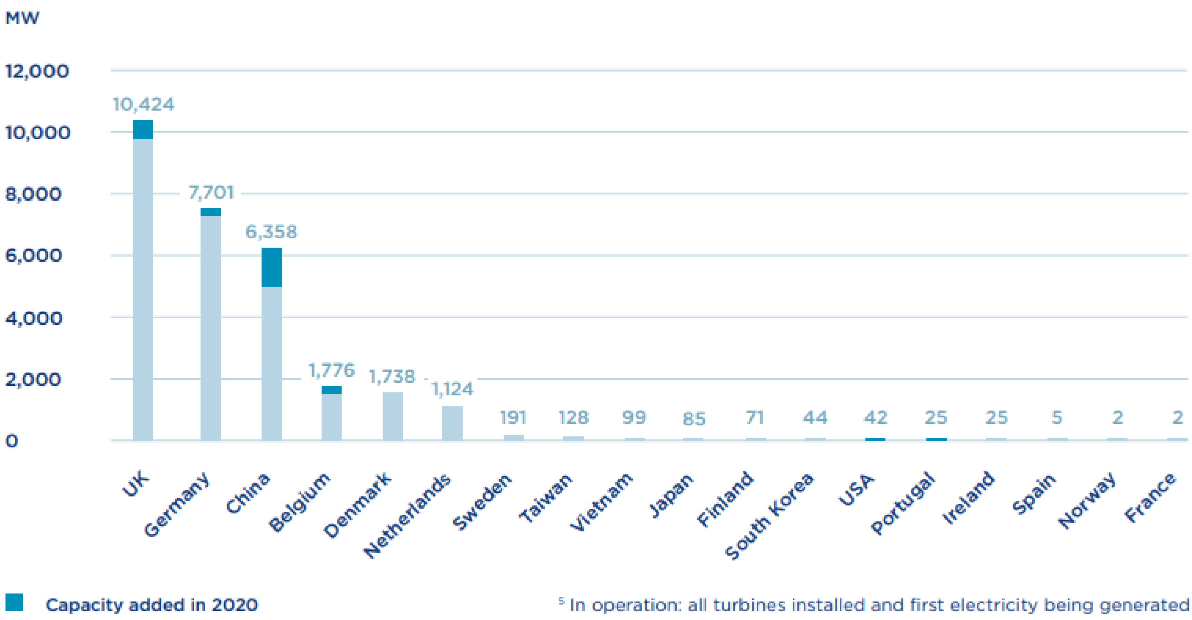

Figure 2-1 Offshore wind (bottom fixed) status /48/

An illustration of the floating wind status per 2020 made by DNV GL, can be seen in Figure 2-2.

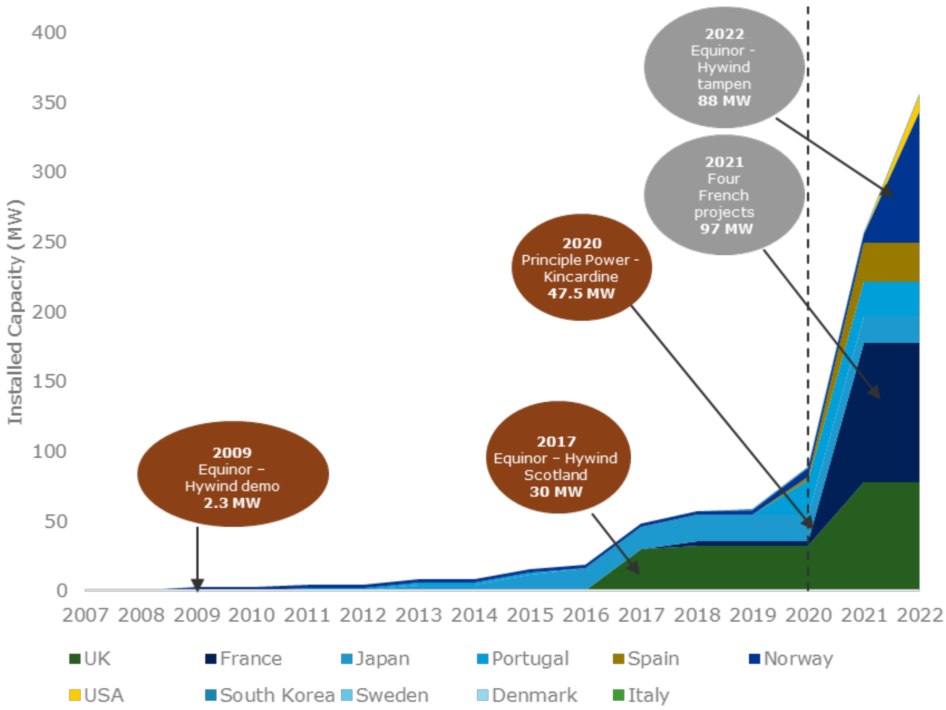

Figure 2-2 Floating wind status per 2020 (DNV GL)

3 APPLICABLE STANDARDS FOR OFFSHORE WIND

3.1 Standardization bodies

In this document a standardization body is defined as an organization that in some way produces technical standards that are intended to address the needs of the industry.

An international standards organization produces international standards and examples are the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO). A special group of standards organizations consist of classification societies, which are non-governmental organizations that establish and maintain technical standards for ships and offshore structures. In addition, there exist various different industry-based standards organizations such as the Institute of Electrical and Electronics Engineers (IEEE).

There are also regional standardization organizations such as European Committee for Standardization (CEN) and European Committee for Electrotechnical Standardization (CENELEC), both recognized by the EU to provide European Standards (EN), and national standardization organizations such as the British Standards Institute (BSI) in the UK, Deutsches Institut für Normung (DIN) in Germany, Danish Standards (DS) in Denmark, Standard Norge and Norsk Elektroteknisk Komite (NEK) in Norway, etc.

These organizations are responsible to develop, maintain and publish the respective standards. Typically, the standards are developed and maintained by subject related committees. The committees are composed of a group of experts often across countries and companies.

In addition, also local authorities can publish regulations, requirements and/or standards such as Bundesamt für Seeschiffahrt und Hydrographie (BSH) in Germany and Petroleum Safety Authority (PSA) in Norway.

Table 3-1 below includes examples of the most known standardization bodies, their mission and indication whether they provide specific offshore wind standards. The table may not be exhaustive.

Table 3-1 Standardization bodies

Type	Organization	Providing specific standards developed for the offshore wind industry
International standard organizations	International Organization for Standardization (ISO)	ISO is an independent, non-governmental international organization with a membership of 165 national standards bodies /52/. Provides more than 23 000 international standards covering almost all aspects of technology and manufacturing, however, no standard specific for wind turbines. Standard Norge is the Norwegian member of ISO.
	International Electrotechnical Commission (IEC)	IEC is an organization for preparation and publication of international standards for all electrical, electronic and related technologies /53/. Technical committee TC88 of IEC is responsible for development of wind related standards. The national standardization organizations have the opportunity to participate in TC88 by nominated individuals. The IEC 61400-series includes a set of standards wind turbines. NEK is the Norwegian member of IEC.
Regional standard organizations	EU: European Committee for Standardization (CEN)	CEN is an association bringing together the National Standardization Bodies of EU /58/. European Standards (EN) used for wind turbine structures are e.g. EN 1993-1-series Standard Norge is the Norwegian member of CEN.
	EU: European committee for Electrotechnical Standardization (CENELEC)	CENELEC is responsible for standardization in the area of electrotechnical engineering /59/. European Standards (EN) used for wind turbines are e.g. EN 61400-series. NEK is the Norwegian member of CENELEC.

Type	Organization	Providing specific standards developed for the offshore wind industry
National standardization organizations	UK: British Standards Institute (BSI)	BSI is the national standards body of the UK and develops technical standards such as the BS EN 61400-series /60/.
	US: American Petroleum Institute (API)	API provides standards for the petroleum industry (originally developed for US conditions). API standards were among the first to be developed for this industry and have been the basis for other standards developed later e.g. the NORSOK standards. API has no offshore wind specific standards /54/.
	Norway: Standard Norge	Standard Norge has the responsibility for standardization in all areas except for electrical and postal- and telecommunications standardization. Standard Norge has exclusive rights to decode on and publish "Norsk Standard" (NS) /51/. There are no wind specific standards within the NS series. The NORSOK ("the Norwegian shelf's competitive position") standards are developed by the Norwegian petroleum industry. Standard Norge are managing the NORSOK standards. There are no wind specific NORSOK standards.
	Norway: Norsk Elektroteknisk Komite (NEK)	NEK deliver and are responsible for the completion of international standards from IEC and CENELEC /50/. In addition, NEK translate international standards and create national standard collections. NEK is also responsible for a number of manuals and technical specifications and sell regulations from "Direktoratet for samfunnssikkerhet og beredskap" (DSB) based on national regulations. NEK is a Norwegian supplier of regulations and standards for the electrotechnical area.
National authority	Germany: Bundesamt für Seeschiffahrt und Hydrographie (BSH)	The BSH is a higher federal authority within the portfolio of the Federal Ministry of Transport and Digital Infrastructure (BMVI). It is the public institution for maritime tasks. This concerns tasks such as averting dangers at sea, issuing official nautical

Type	Organization	Providing specific standards developed for the offshore wind industry
		charts and surveying tasks in the North Sea and Baltic Sea, as well as forecasting tides, water levels and storm surges. In addition, the BSH is responsible for the surveying of ships, flag law, the testing and approval of navigation and radio equipment and the issue of certificates for seafarers. With regard to construction projects in the North and Baltic Seas, the BSH is responsible for spatial planning and for the testing and approval of power generation systems (offshore wind turbines), cables and other systems within the scope of federal responsibility /57/. See Appendix B for more details.
	Norway: Petroleum Safety Authority (PSA)	Responsibility for the safety of renewable energy generation on the Norwegian Continental Shelf (NCS) has been added to the PSA's supervisory responsibilities (since 17 August 2020) /3/. A dedicated regulatory regime covering HSE in the offshore wind sector will be developed. The starting point will be the HSE regulations for petroleum operations, with performance-based requirements and a risk-based approach. See Appendix C for more details.
Classification societies/Certification bodies	ABS (American Bureau of Shipping) Delivers classification services, technology leadership and technical advice for marine and offshore industries.	Three offshore wind specific documents /49/: ABS Guide for Building and Classing Bottom-Founded Offshore Wind Turbine Installations ABS Guide for Building and Classing Floating Offshore Wind Turbine Installations Guidance Notes on Global Performance Analysis for Floating Offshore Wind Turbine Installations (technical guidance in addition to applicable industry standards and regulations) See section 3.3.2 for more detailed information about the floating wind specific documents.

Type	Organization	Providing specific standards developed for the offshore wind industry
Classification societies/Certification bodies	BV (Bureau Veritas) Delivering testing, inspection and certification services.	One floating offshore wind specific document /55/: NI572 Classification and certification of floating offshore wind turbines See section 3.3.2 for more detailed information about the floating wind specific documents.
	ClassNK (Nippon Kaiji Kyokai) Delivering classification of ships, certification and technical advisory services.	One floating offshore wind specific document /29/: Guideline for Offshore Floating Wind Turbine Structures See section 3.3.2 for more detailed information about the floating wind specific documents.
	DNV GL Delivering classification, certification and advisory services for the maritime, petroleum and renewables industry.	Complete set of standards and recommended practices for wind power plants including turbines, bottom-fixed and floating support structures, cables and offshore substation /56/. Certification scheme for both type and project certification. See section 3.2 and 3.3 for more detailed information.

3.2 Applicable standards for bottom-fixed wind power plants

Complete sets of offshore wind specific standards are available. The most extensive sets are provided by IEC and DNV GL (see also section 3.1). Common practice in the wind industry is to apply these standards but in special cases apply standards developed for other industries like the petroleum or maritime industries. It should be noted that recently there are also standards developed that are intended for offshore structures in general (wind turbines, petroleum platforms, fish farms etc.) e.g. DNVGL-ST-N001 Marine operations and marine warranty.

The main IEC relevant standards which cover wind energy generation systems are the IEC 61400-series. The IEC 61400-1 Design requirements (/33/) is the main standard used for wind turbine design (Rotor Nacelle Assembly) by turbine manufacturers. The standards in the 61400-series are maintained by IEC Technical Committee (TC) 88. Other IEC standards are also applied in the wind energy sector. The standards are focusing on the electrical components but are also including requirements for the support structure.

The DNV GL relevant standards and recommended practices covers all assets in a wind power plant. The DNV GL documents make use of international available standards and provide additional support, where subjects are not addressed in existing standards. Examples are the industry acknowledged standards DNVGL-ST-0145 for offshore substations, DNVGL-ST-0126 for support structures for wind turbines, and DNVGL-ST-0359 for subsea power cables for wind power plants. Their purpose is to provide a basis for design, manufacturing, installation and operation. The site-specific conditions, wind turbines and wind power plants systems such as electrical, mechanical, structural, control, protection and grid compatibility are addressed.

The relevant standards and other guidance documents provided by ISO, IEC, DNV GL and other standardization organizations, clustered per asset of a wind power plant, are listed in the following tables. As earlier mentioned, many of these are not offshore wind specific, but contain requirements that may be used. The tables may not be exhaustive.

Table 3-2 Wind turbine relevant standards and other guidance documents

Document code	Title
DNVGL-OS-C401	Fabrication and testing of offshore structures
DNVGL-RP-0043	Safety, operation and performance of grid-connected energy storage systems
DNVGL-RP-0286	Coupled analysis of floating wind turbines
DNVGL-RP-0360	Subsea power cables in shallow water
DNVGL-RP-0416	Corrosion protection for wind turbines
DNVGL-RP-0419	Analysis of grouted connections using the finite element method
DNVGL-RP-0423	Manufacturing and commissioning of offshore substations
DNVGL-RP-0440	Electromagnetic compatibility of wind turbines
DNVGL-RP-A203	Technology qualification
DNVGL-RP-D201	Integrated software dependent systems
DNVGL-ST-0054	Transport and installation of wind power plants
DNVGL-ST-0076	Design of electrical installations for wind turbines
DNVGL-ST-0119	Floating wind turbine structures
DNVGL-ST-0125	Grid code compliance

Document code	Title
DNVGL-ST-0126	Support structures for wind turbines
DNVGL-ST-0145	Offshore substations
DNVGL-ST-0262	Lifetime extension of wind turbines
DNVGL-ST-0358	Certification of offshore gangways for personnel transfer
DNVGL-ST-0359	Subsea power cables
DNVGL-ST-0437	Loads and site conditions wind for turbines
EN 50308	Wind Turbines – Protective Measures – Requirements for Design, Operation and Maintenance
IEC 60076 series	Power transformers
IEC 60227 series	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V
IEC 60335-2-40	Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
IEC 60364 series	Low-voltage electrical installations
IEC 60502 series	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um= 1,2 kV) up to 30 kV (Um= 36 kV)
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC 60870 series	Telecontrol equipment and systems
IEC 60947 series	Low-voltage switchgear and controlgear
IEC 60947-3	Low-voltage switchgear and controlgear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
IEC 61131 series	Programmable controllers
IEC 61400-1	Wind energy generation systems- Part 1: Design requirements
IEC 61400-11	Wind turbines - Part 11: Acoustic noise measurements techniques
IEC 61400-12-1	Wind energy generation systems - Part 12-1: Power performance measurements of electricity producing wind turbines
IEC 61400-12-2	Wind turbines - Part 12-2: Power performance of electricity-producing wind turbines based on nacelle anemometry
IEC 61400-13	Wind turbines - Part 13: Measurement of mechanical loads
IEC 61400-14	Wind turbines - Part 14: Declaration of apparent sound power level and tonality values
IEC 61400-21	Wind turbines - Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines
IEC 61400-21-1	Wind turbines - Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines
IEC 61400-22	Wind turbines - Part 22: Conformity testing and certification of wind turbines
IEC 61400-23	Wind turbines - Part 23: Full-scale structural testing of rotor blades
IEC 61400-24	Wind turbines - Part 24: Lightning protection
IEC 61400-25 series	Wind energy generation systems - Communications for monitoring and control of wind power plants
IEC 61400-26-1	Wind energy generation systems – Part 26-1 IECRE Availability for wind energy generation systems
IEC 61400-27-1	Wind turbines - Part 27-1: Electrical simulation models - Wind turbines
IEC 61400-3-1	Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines
IEC 61400-4	Wind turbines - Part 4: Design requirements for wind turbine gearboxes
IEC 61400-5	Wind energy generation systems - Part 5: Wind turbine blades
IEC 61400-6	Wind energy generation systems - Part 6: Tower and foundation design requirements

Document code	Title
IEC 61508 series	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 61511 series	Functional safety - Safety instrumented systems for the process industry sector
IEC 62040 series	Uninterruptible power systems (UPS)
IEC 62053 series	Electricity metering equipment (a.c.) - Particular requirements
IEC 62271 series	High-voltage switchgear and control gear
IEC 62305 series	Protection against lightning
IEC 62477-1	Safety requirements for power electronic converter systems and equipment - Part 1: General
IEC 62610	Mechanical structures for electronic equipment - Thermal management for cabinets in accordance with IEC 60297 and IEC 60917 series
IEC/IEEE 82079-1	Preparation of information for use (instructions for use) of products - Part 1: Principles and general requirements
IECRE CBC 6A	IEC Clarification sheet: Project certification recognition arrangement
ISO 3834-2	Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements
ISO 5149 series	Refrigerating systems and heat pumps - Safety and environmental requirements
ISO/IEC 13273-1	Energy efficiency and renewable energy sources - Common international terminology - Part 1: Energy efficiency
ISO/IEC 13273-2	Energy efficiency and renewable energy sources - Common international terminology - Part 2: Renewable energy sources

Table 3-3 Offshore substation relevant standards and other guidance documents

Document code	Title
API RP 2X	Recommended Practice for Ultrasonic and Magnetic Examination of Offshore Structural Fabrication and Guidelines for Qualification of Technicians
API RP 75	Safety and Environmental Management System for Offshore Operations and Assets
API Spec 2W	Specification for Steel Plates for Offshore Structures, Produced by Thermo-Mechanical Control Processing (TMCP)
API Spec 2Y	Specification for Steel Plates, Quenched-and-Tempered, for Offshore Structures
ASTM E1529	Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies
CAP 437	Standards for offshore helicopter landing areas
CIGRE Technical Brochure 483	Guidelines for the Design and Construction of AC Offshore Substations for Wind Power Plants
CIGRE Technical Brochure 502	High-Voltage On-Site Testing with Partial Discharge Measurement
CIGRE Technical Brochure 537	Guide for Transformer Fire Safety Practices
DIN 50930-6	Corrosion of metals - Corrosion of metallic materials under corrosion load by water inside of pipes, tanks and apparatus - Part 6: Evaluation process and requirements regarding the hygienic suitability in contact with drinking water
DNVGL-OS-A101	Safety principles and arrangements
DNVGL-OS-A301	Human comfort
DNVGL-OS-B101	Metallic materials
DNVGL-OS-C101	Design of offshore steel structures, general - LRFD method
DNVGL-OS-C301	Stability and watertight integrity
DNVGL-OS-C401	Fabrication and testing of offshore structures
DNVGL-OS-D101	Marine and machinery systems and equipment
DNVGL-OS-D201	Electrical installations
DNVGL-OS-D202	Automation, safety and telecommunication systems
DNVGL-OS-D301	Fire protection

Document code	Title
DNVGL-OS-E401	Helicopter decks
DNVGL-RP-0360	Subsea power cables in shallow water
DNVGL-RP-0416	Corrosion protection for wind turbines
DNVGL-RP-0419	Analysis of grouted connections using the finite element method
DNVGL-RP-0423	Manufacturing and commissioning of offshore substations
DNVGL-RP-0423	Manufacturing and commissioning of offshore substations
DNVGL-RP-A203	Technology qualification
DNVGL-RP-B401	Cathodic protection design
DNVGL-RP-C204	Structural design against accidental loads
DNVGL-RP-C205	Environmental conditions and environmental loads
DNVGL-RP-C210	Probabilistic methods for planning of inspection for fatigue cracks in offshore structures
DNVGL-RP-C212	Offshore soil mechanics and geotechnical engineering
DNVGL-RU-SHIP Pt.4 Ch.6	Piping systems
DNVGL-RU-SHIP Pt.6 Ch.5	Equipment and design features
DNVGL-ST-0054	Transport and installation of wind power plants
DNVGL-ST-0126	Support structures for wind turbines
DNVGL-ST-0145	Offshore substations
DNVGL-ST-0359	Subsea power cables for wind power plants
DNVGL-ST-0377	Shipboard lifting appliances
DNVGL-ST-0378	Offshore and platform lifting appliances
DNVGL-ST-C502	Offshore concrete structures
DNVGL-ST-N001	Marine operations and marine warranty
DNVGL-ST-N002	Site specific assessment of mobile offshore units for marine warranty
DNV-RP-C201	Buckling strength of plated structures
EN 10025-series	Hot rolled products of structural steels
EN 10160	Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method)
EN 10204	Metallic products - Types of inspection documents
EN 10210-series	Hot finished structural hollow sections
EN 10219	Cold formed welded steel structural hollow sections
EN 10225-series	Weldable structural steels for fixed offshore structures
EN 1090-2	Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures
EN 12097	Ventilation for Buildings - Ductwork - Requirements for ductwork components to facilitate maintenance of ductwork systems
EN 12599	Ventilation for buildings - Test procedures and measurement methods to hand over air conditioning and ventilation systems
EN 1363-2	Fire resistance tests - Part 2: Alternative and additional procedures
EN 14986	Design of fans working in potentially explosive atmospheres
EN 1993-1-series	Eurocode 3: Design of steel structures
EN 353-1	Personal fall protection equipment - Guided type fall arresters including an anchor line - Part 1: Guided type fall arresters including a rigid anchor line
EN 353-2	Personal protective equipment against falls from a height - Part 2: Guided type fall arresters including a flexible anchor line
EN 50272-2	Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries
EN 50499	Procedure for the assessment of the exposure of workers to electromagnetic fields

Document code	Title
EN 50522	Earthing of power installations exceeding 1 kV a.c
EN 54-series	Fire detection and fire alarm systems
FSS Code	International Code for Fire Safety Systems
FTP Code	International Code for Application of Fire Test Procedures
IACS UI SC241	Manually operated call points (SOLAS II-2/7.7)
IACS UR D11	Safety features
IACS UR D8	Hazardous areas
IACS UR E15	Electrical services required to be operable under fire conditions and fire resistant cables
IACS UR F29	Non-sparking fans
IACS UR P1	Rules for pipes
IEC 60076-series	Power transformers
IEC 60079-10-1	Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres
IEC 60079-14	Explosive atmospheres - Part 14: Electrical installations design, selection and erection
IEC 60092-series	Electrical installations in ships
IEC 60099-series	Surge arresters - Part 4
IEC 60331-series	Tests for electric cables under fire conditions. Circuit integrity
IEC 60332-3-series	Tests on electric and optical fibre cables under fire conditions
IEC 60364-7-701	Low-voltage electrical installations - Part 7: Requirements for special installations or locations
IEC 60364-series	Low-voltage electrical installations
IEC 60376	Specification of technical grade sulphur hexafluoride (SF6) and complementary gases to be used in its mixtures for use in electrical equipment
IEC 60502-2	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) - Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)
IEC 60598-series	Luminaires
IEC 60700-1	Thyristor valves for high voltage direct current (HVDC) power transmission - Part 1: Electrical testing
IEC 60812	Failure modes and effects analysis (FMEA and FMECA)
IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV) - Test methods and requirements
IEC 60865-1	Short-circuit currents - Calculation of effects - Part 1: Definitions and calculation methods
IEC 60871-series	Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V
IEC 61000-series	Electromagnetic compatibility (EMC)
IEC 61025	Fault tree analysis (FTA)
IEC 61071	Capacitors for power electronics
IEC 61400-3-1	Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines
IEC 61643-11	Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods
IEC 61643-21	Low-voltage surge protective devices- Part 21: Surge protective devices connected to telecommunications and signaling networks - Performance requirements and testing methods
IEC 61869-series	Instrument transformers
IEC 61892-series	Mobile and fixed offshore units - Electrical installations
IEC 61936-1	Power installation exceeding 1 kVa.c. - Part 1: common rules
IEC 62067	Power cables with extruded insulation and their accessories for rated voltages above 150 kV (Um = 170 kV) up to 500 kV (Um = 550 kV) - Test methods and requirements
IEC 62271-series	High-voltage switchgear and control gear

Document code	Title
IEC 62305-1	Protection against lightning - Part 1: General principles
IEC 62305-3	Protection against lightning - Part 3: Physical damage to structures and life hazard
IEC 62305-4	Protection against lightning - Part 4: Electrical and electronic systems within structures
IEC 62485-series	Safety requirements for secondary batteries and battery installations
IEC 62501	Voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) power transmission - Electrical testing
IEC TR 62001-series	High-voltage direct current (HVDC) systems - Guidance to the specification and design evaluation of AC filters
ISO 12944 series	Paints and varnishes - Corrosion protection of steel structures by protective paint systems
ISO 14122-series	Safety of machinery - Permanent means of access to machinery
ISO 14224	Petroleum, petrochemical and natural gas industries - Collection and exchange of reliability and maintenance data for equipment
ISO 14520-1	Gaseous fire-extinguishing systems — Physical properties and system design — Part 1: General requirements
ISO 15138	Petroleum and natural gas industries - Offshore production installations. Heating, ventilation and air-conditioning
ISO 1716	Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value)
ISO 17631	Ships and marine technology - Shipboard plans for fire protection, life-saving appliances and means of escape
ISO 19900	Petroleum and natural gas industries - General requirements for offshore structures
ISO 19901-2	Petroleum and natural gas industries - Specific requirements for offshore structures
ISO 19902	Petroleum and natural gas industries - Fixed steel offshore structures
ISO 20902-1	Fire test procedures for divisional elements that are typically used in oil, gas and petrochemical industries — Part 1: General requirements
ISO 7547	Ships and marine technology — Air-conditioning and ventilation of accommodation spaces — Design conditions and basis of calculations
ISO 8861	Shipbuilding - Engine room ventilation in diesel-engined ships - Design requirements and basis of calculations
ISO 8862	Air-conditioning and ventilation of machinery control rooms on board ships - Design conditions and basis of calculations
ISO 9001	Quality management systems - Requirements
ISO 9943	Shipbuilding - Ventilation and air treatment of galleys and pantries with cooking appliances
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
LSA Code	International Life-Saving Appliance (LSA) Code
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 as amended, including Annex V: Prevention of Pollution by Garbage from Ships
MODU Code	Code for the Construction and Equipment of Mobile Offshore Drilling Units
NFPA 11	Standard for Low-, Medium-, and High-Expansion Foam
NFPA 13	Standard for the Installation of Sprinkler Systems
NFPA 15	Standard for Water Spray Fixed Systems for Fire Protection
NFPA 16	Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems

Document code	Title
NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 2001	Standard for Clean Agent Fire Extinguishing Systems
NFPA 750	Standard on Water Mist Fire Protection Systems
NORSOK C-001	Living quater area
NORSOK C-002	Architectural components and equipment
NORSOK H-003	Heating, ventilation and air conditioning (HVAC) and sanitary systems
NORSOK M-501	Surface preparation and protective coating
NORSOK N-004	Design of steel structures
NORSOK S-002	Working environment
SOLAS	International Convention for the Safety of Life at Sea
VDI 6023	Hygiene in drinking-water installations - Requirements for planning, execution, operation and maintenance
Vds 2109	VdS Guidelines for Water Spray Systems - Planning and Installation
Vds 2380	VdS Guidelines for Fire Extinguishing Systems - Fire Extinguishing Systems Using Non-liquefied Inert Gases - Planning and Installation
VDS 2381	VdS Guidelines for fire extinguishing systems - Fire Extinguishing Systems using Halocarbon Gases - Planning and Installation

Table 3-4 Power cables relevant standards and other guidance documents

Document code	Title
API RP 2A	Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design
API RP 2RD	Dynamic Risers for Floating Production Systems
CIGRÉ Electra 189	Recommendations for tests of power transmission DC cables for a rated voltage up to 800 kV
CIGRÉ Technical Brochure 177	Accessories for HV cables with extruded insulation
CIGRÉ Technical Brochure 279	Maintenance for HV cables and accessories
CIGRÉ Technical	Third-party damage to underground and submarine cables
CIGRÉ Technical Brochure 415	Test procedures for HV transition joints for rated voltages 30 kV (Um = 36 kV) up to 500 kV (Um = 550 kV)
CIGRÉ Technical Brochure 476	Cable accessory workmanship on extruded high voltage cables
CIGRÉ Technical Brochure 490	Recommendations for testing of long AC submarine cables with extruded insulation for system voltage above 30 (36) to 500 (550) kV
CIGRÉ Technical Brochure 496	Recommendations for testing DC extruded cable systems for power transmission at a rated voltage up to 500 kV
CIGRÉ Technical	Guideline to maintaining the integrity of XLPE cable accessories
CIGRÉ Technical Brochure 610	Offshore generation cable connections
DNVGL-RP-0360	Subsea power cables in shallow water
DNVGL-RP-F401	Electrical power cables in subsea applications
DNVGL-ST-0359	Subsea power cables for wind power plants
DNVGL-ST-N001	Marine operations and marine warranty
ICPC Recommendation	Standardization of electronic formatting of route position lists

Document code	Title
ICPC Recommendation 3	Criteria to be applied to proposed crossings between submarine telecommunications cables and pipelines/power cables
ICPC Recommendation 9	Minimum technical requirements for a desktop study (also known as cable route study)
IEC 60183	Guide to the selection of high-voltage cables
IEC 60228	Conductors of insulated cables
IEC 60287-1-1	Electric cables - Calculation of the current rating - Part 1-1: Current rating equations (100% load factor) and calculation of losses - General
IEC 60287-2-1	Electric cables - Calculation of the current rating - Part 2-1: Thermal resistance - Calculation of thermal resistance
IEC 60287-3-2	Electric cables - Calculation of the current rating - Part 3-2: Sections on operating conditions - Economic optimization of power cable size
IEC 60300-1	Dependability management - Part 1: Dependability management systems
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV)
IEC 60793	Optical fibres
IEC 60794	Optical fibre cables
IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV) - Test methods and requirements
IEC 61400-3	Wind turbines - Part 3: Design requirements for offshore wind turbines
IEC 62067	Power cables with extruded insulation and their accessories for rated voltages above 150 kV (Um = 170 kV) up to 500 kV (Um = 550 kV) - Test methods and requirements
IMCA M 190	Guidance for Developing and Conducting Annual DP Trials Programmes for DP Vessels
IMO MSC/Circ.645	Guidelines for vessels with dynamic positioning systems
ISO 13628-5	Petroleum and natural gas industries - Design and operation of subsea production systems - Part 5: Subsea umbilicals
ISO 14688-1	Geotechnical investigation and testing - Identification and classification of soil - Part 1: Identification and description
ISO 14688-2	Geotechnical investigation and testing - Identification and classification of soil - Part 2: Principles for a classification
ISO 19901-6	Petroleum and natural gas industries – Specific requirements for offshore structures — Marine Operations
ISO 9001	Quality management systems - Requirements
ITU-T G.976	Test methods applicable to optical fibre submarine cable systems

As an example of a complete set of standards for an offshore wind power plant, Figure 3-1 shows an overview of DNV GL's standards and recommended practices. These are covering all the different assets in an offshore wind power plant; wind turbines and their support structures, offshore substation, power cables etc. It should be notes that these standards are referring to all the standards listed in the above tables (mainly IEC and ISO).

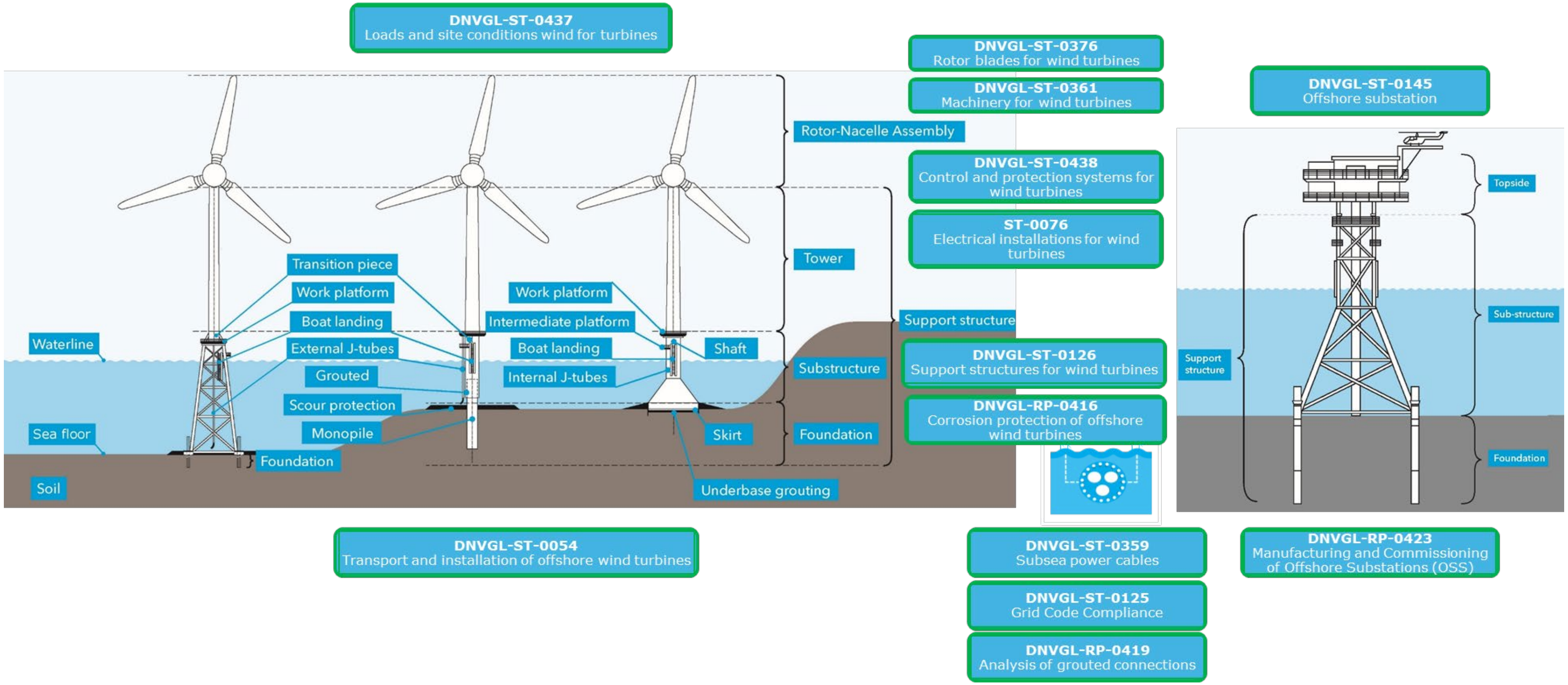

Figure 3-1 Overview of DNV GL standards for the different assets in a wind power plant

3.3 Applicable standards for floating wind power plants

3.3.1 Overview and status

Standards for floating wind structures were initially developed by certification bodies/class societies with the first releases in the period from 2010 to 2013. Later IEC also initiated development of requirements and issued a technical specification in 2019.

Figure 3-2 shows an overview of the standards that has been developed specifically for floating wind turbines and associated asset in a farm.

Section 3.3.2 includes a description of the current standard documents for floating wind turbine structures including their history and main differences. It should be noted that these standards do not apply for the turbine, but for the support structure and the station keeping system. The DNV GL standard (DNVGL-ST-0119) also covers the dynamic power cable (the mechanical part).

The common practice when it comes to the turbine, is to use a type certified turbine. However, at the current stage the turbines are only type certified for bottom-fixed foundations. Therefore, in a floating wind project, a site and floater specific assessment of the turbine (including control system) is performed to ensure that the turbine is suitable for operation on the floating foundation. In many cases, modification to the turbine control system is needed to keep the loads imposed on the turbine from the floater within the limitations given in the type certificate. Also, often the tower will need to be strengthened to fit a floating foundation.

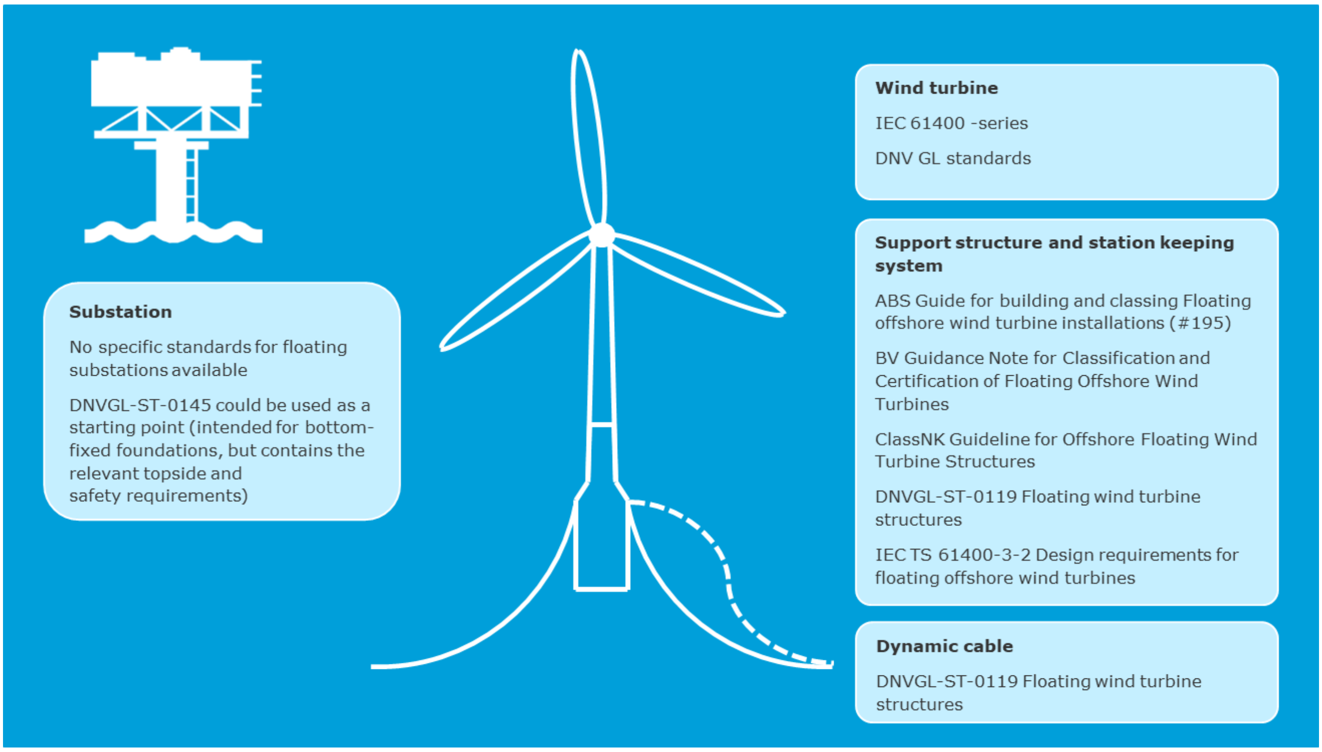

Figure 3-2 Overview of specific floating wind standards

3.3.2 Floating wind standards and guidelines

3.3.2.1 Floating wind support structure

American Burau of shipping (ABS)

The *ABS Guide for building and classing Floating offshore wind turbine installations* (#195) /27/, was first issued in January 2013 and updated in July 2014. Later, the guide was issued in a new version in October 2015, updated in March 2018 and further updated in July 2020.

As the title of the ABS document indicates, ABS195 is not a document with technical requirements only. It is also a document with requirements related to a classification service, for example requirements for surveys and documentation. Approximately 20% of the document relates to ABS' classification service.

The technical requirements cover the floating substructure, the station keeping system and onboard machinery, equipment and systems including applicable marine systems and associated equipment and machinery, safety systems and associated equipment, and lifesaving appliances and machinery. The tower may also be designed according to this Guideline.

New content is added regarding life extension and relocation of a floating wind turbine in the 2020 revision of the ABS Guideline.

ABS has also published a Guidance Notes document regarding analysis of floating wind turbine installations named *Global performance analysis for floating wind offshore wind turbine installations* /28/. This document was first published in February 2014 followed by an updated version in July 2020. The document provides suggested global performance analysis methodologies, modelling strategies and numerical simulation approaches for floating offshore wind turbines. These Guidance Notes do not set additional design requirements and criteria other than those specified in the FOWTI Guide /27/ and should be used as a supporting document to the FOWTI Guide.

Burau Veritas (BV)

BV issued the *Guidance Note for Classification and Certification of Floating Offshore Wind Turbines* in October 2015. This was updated and re-issued in January 2019. Like ABS, BV includes both technical requirements and specific guidance and recommendations for classification and certification. This Guidance Note is intended to cover floating platforms supporting single or multiple horizontal or vertical axis turbines. It does not cover the top structure, i.e. tower, rotor, blades and nacelle design (their influence on floating platform and mooring system is however considered). Guidance on mechanical components is added in the 2019 revision.

ClassNK

The ClassNK Guideline for Offshore Floating Wind Turbine Structures /29/ was issued in July 2012. The Guideline covers requirements for external conditions, loads, materials, structural design and welding, mooring, stability, equipment, machinery installations and electrical installations of the floating structure including the tower. In addition to the requirements listed above, the ClassNK Guideline gives requirements for classification surveys and make reference to Rules for Survey and Construction of Steel Ships. The Guideline is based on the following standards and rules /31/:

- IEC 61400-1 /33/
- IEC 61400-3 (Ed. 1) (currently IEC 61400-3-1) /34/
- Rules for Survey and Construction of Steel Ships /40/
    - Part P (Mobile Offshore Drilling Units, Work-ships and Special Purpose Barges)

- Part PS (Floating Offshore Facilities for Crude Oil/Petroleum Gas Production, Storage and Offloading)

An updated version of the ClassNK Guideline was published in 2020, incorporating some requirements from the updated IEC standards. Unfortunately, this currently exists only in Japanese language and is not considered herein.

DNV GL

DNV issued a Guideline for offshore floating wind turbine structures in December 2009 /27/. This Guideline provided requirements and recommendations for design of floating support structures for offshore wind turbines by mainly referring to exiting DNV standards applied for O&G and bottom-fixed wind turbine structures.

DNV-OS-J103 Design of floating wind turbine structures /18/ was published in June 2013. This standard was developed through a Joint Industry Project (JIP) led by DNV GL ongoing from 2011 to 2013. The following industry partners were involved: Equinor (former Statoil), Navantia, Gamesa (now Siemens Gamesa), Alstom Wind (now part of GE), Iberdrola, Sasebo Heavy Industries, Nippon Steel, STX Offshore & Shipbuilding, Principle Power and Glosten Associates.

A new revision of this standard, DNVGL-ST-0119 Floating wind turbine structures /17/, reflecting the merger between GL and DNV and the gained industry experience since the first issue, was published in July 2018.

DNV GL keeps service-related requirements separate from the technical requirements, so DNVGL-ST-0119 covers technical requirements only, while service-related requirements are covered by DNVGL-SE-0422 Certification of floating wind turbines /13/. Recently, DNV GL has also developed Rules for Classification; DNVGL-RU-OU-0512 Floating offshore wind turbine installations /14/ issued in October 2020. These rules are intended for floating offshore wind turbine installations operating under a maritime regime, where the classification concept is used as part of the certification or license regimes for obtaining compliance with applicable national requirements (e.g. regulations of the shelf state and/or flag state administration, as required).

The standard DNVGL-ST-0119 covers structural design of floating wind turbine structures, i.e. the tower, substructure and station keeping system. Wherever possible the standard makes reference to DNVGL-ST-0126 Support structures for wind turbines /15/ and DNVGL-ST-0437 Loads and site conditions for wind turbines /16/. DNVGL-ST-0119 includes requirements for safety philosophies and design principles, environmental conditions, loads and load effects including floater specific design load cases, load and material factors, material selection, structural design, station keeping, anchor foundations, floating stability, control system, mechanical and electrical systems, corrosion protection, transport and installation, in-service inspection, maintenance and monitoring. The standard also contains a section for power cable design which gives criteria, requirements and guidance for structural design and analysis of power cable systems exposed to dynamic loading for use in the floating wind industry. This is further elaborated in section 3.3.2.3.

DNV GL has also developed, through a JIP, the recommended practice (RP), DNVGL-RP-0286 /20/, which gives guidance for modelling, load analysis and model testing of floating offshore wind turbines. This includes recommendations for the following:

- analysis approach

- environmental conditions, models and parameter selection
- numerical models
- design load cases setup
- controller implementation
- model testing and numerical model validation.

IEC

IEC has developed a ”technical specification” for floating wind turbines, IEC TS 61400-3-2 Design requirements for floating offshore wind turbines. This specification was issued in 2019. This part of IEC 61400, which is a technical specification, specifies additional requirements for assessment of the external conditions at a floating offshore wind turbine (FOWT) site and specifies essential design requirements to ensure the engineering integrity of FOWTs. Its purpose is to provide an appropriate level of protection against damage from all hazards during the planned lifetime. This document is applicable to unmanned floating structures with one single horizontal axis turbine. Additional considerations might be needed for multi-turbine units on a single floating substructure, vertical-axis wind turbines, or combined wind/wave energy systems. This document is to be used together with the appropriate IEC and ISO standards mentioned in Clause 2. In particular, this document is intended to be fully consistent with the requirements of IEC 61400-1 and IEC 61400-3-1. The safety level of the FOWT designed according to this document is to be at or exceed the level inherent in IEC 61400-1 and IEC 61400-3-1.

IEC TC 88 has lately established a maintenance team (MT3-2) to develop a complete standard based on the technical specification. The update will incorporate updates included in other standards in the 61400-series and fill gaps where guidance previously was not available. The team intend to publish a committee draft to the national committees for their approval by mid-2021. The standard is expected to be published by end of 2021.

3.3.2.2 Floating support structure for electrical substation

At the time of the issue of this report, there are no standards or guidelines particular for floating offshore substations (OSS), however, the DNVGL-ST-0145 may be extended to floating installations taking into account additional floating specific requirements.

3.3.2.3 Dynamic power cable

Of the above-mentioned standards, DNVGL-ST-0119 is the only standard including requirements for dynamic power cables (structural design and analysis of power cable systems exposed to dynamic loading). The section for power cable design refers to a number of available design codes of relevance for dynamic power cable design, in addition to provide some provisions. However, currently, a complete standard for dynamic power cables is not available.

An exhibit of available design standards is shown in Table 3-5. Reference is made to table 16-1 in DNVGL-ST-0119 /17/ for additional relevant DNV GL recommended practices and API specifications.

Table 3-5 Relevant standards for design, analysis and testing of dynamic power cables

Standard	Design aspect
DNVGL-ST-0359 /21/	General requirements for subsea power cable installations covering the full life cycle (static cables only)
DNVGL-RP-0360 /22/	Guidance for all phases of the life cycle of subsea power cable projects, with a focus on static service in shallow water renewable energy applications
ISO 13628-5 /25/	Main reference for mechanical design of dynamic umbilicals, providing requirements for global load effect analyses and requirements for local load effect analyses

Standard	Design aspect
IEC 63026 /45/	Specification of test methods and requirements for power cable systems, cables with extruded insulation and their accessories for fixed submarine installations, for rated voltages from 6 kV (Um= 7,2 kV) up to 60 kV (Um= 72,5 kV)
Cigre TB 623 /46/	Recommendations for mechanical testing of submarine cables
Cigre TB 722 /47/	Recommendations for additional testing for submarine cables not covered in the IEC 63026
DNVGL-ST-N001 /24/	General requirements for marine operations, including installation of submarine power cables
DNVGL-ST-F201 /23/	Analysis guidance: – outline of global response model verification – guidance on statistical response processing
API Spec. 17J /38/	Acceptance criteria for tensile armour: – acceptance criteria for polymer layers in flexible pipes
API Spec. 17L1 /39/	Design guidance for ancillary components such as buoyancy modules, bend stiffeners etc.

4 CERTIFICATION SCHEMES FOR OFFSHORE WIND

4.1 Offshore wind certification scheme

In general, the certification schemes describe the process and scope to conduct and achieve e.g. type, component or project certificate, referring to the relevant standards. Reference is made to section 5 for details about certification types and related terminologies.

There are two main recent international project certification schemes for offshore wind power plants. The IECRE OD-502 *Project Certification Scheme* and the DNVGL-SE-0190 *Project certification of wind power plants*.

The common practice related to the extent of the certification scope varies between the countries, see section 6 and the Appendixes. Some countries have clear requirements for certification, but other have more indirect requirements. Regardless of the requirements, most of the offshore wind power plants are subject to a certain extent of certification e.g. type certification of the wind turbine and third-party assessment of design basis and design for the support structure.

The IEC 61400-22, defining rules and procedures for a certification system for wind turbines comprising both type certification and certification of wind turbine installed onshore or offshore, has been withdrawn by IEC in 2018 and replaced by the IECRE system (new IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications). The IECRE system has introduced several new documents; for example the IECRE OD-501 *Type and Component Certification Scheme* and the IECRE OD-502 *Project Certification Scheme*. The IECRE OD-501 is mainly the successor of Sec. 8 of IEC 61400-22 and the IECRE OD-502 is mainly the successor of Sec. 9 of IEC 61400-22. The IECRE system have not yet arrived into the market as expected by the stakeholders. In Europe it is confirmed by CENELEC to keep the EN 61400-22 until 2023-05.

DNV GL provides a complete set of service documents for certification and project development (design, construction, in-service) of offshore wind power plants. 80% of the bottom-fixed wind power plants have been certified based on DNV GL's service documents.

DNV GL provides three different levels of service documents relevant for offshore bottom-fixed wind:

- Service specifications for certification services (see Table 4-1 below)
- Standards providing technical requirements (see section 3.2)
- Recommended practices providing recommendations and guidance relevant for design (see section 3.2)

An exhibit of DNV GL's relevant service specifications for certification of offshore wind turbines and offshore wind power plants is shown in Table 4-1.

Table 4-1 DNV GL service specifications for offshore wind certification

Document code	Title
DNVGL-SE-0190	Project certification of wind power plants
DNVGL-SE-0441	Type and component certification of wind turbines
DNVGL-SE-0076	Certification of navigation and aviation aids of offshore wind farms
DNVGL-SE-0077	Certification of fire protection systems for wind turbines
DNVGL-SE-0124	Certification of grid code compliance
DNVGL-SE-0263	Certification of lifetime extension of wind turbines
DNVGL-SE-0436	Shop approval in renewable energy
DNVGL-SE-0439	Certification of condition monitoring

Document code	Title
DNVGL-SE-0448	Certification of service and maintenance activities in the wind energy industry

In addition to the above service descriptions, DNV GL also have the DNVGL-SE-0073 Project certification of wind farms according to IEC 61400-22 which offers certification in accordance with the IEC 61400-22 scheme (the new IECRE system is considered as well) and the DNVGL-SE-0422 Project Certification of floating wind turbines (see section 4.2).

Table 4-2 shows a comparison of the IEC/IECRE and the DNV GL certification schemes for offshore wind power plants.

Table 4-2 Comparison of the IEC/IECRE and the DNV GL certification schemes

IEC 61400-22 / IECRE OD-502 scheme	DNVGL-SE-0190 scheme
First published in 2010, latest revisions in 2018	First published in 1986, latest revisions in 2020
Longer revision cycles due to the number of participants representing the country member bodies	Shorter revision cycles, latest project learnings and state-of-the-art faster implemented
Focus on the wind turbine and do not cover relevant wind power plant assets e.g. offshore substation, power cables etc.	All wind power plant assets addressed in the service documents (wind turbine, offshore substation, power cables, machinery structures, support structures etc.)
Project certification only	In addition to Project Certification, phases as concept/innovation, prototype, in-service, lifetime extension, decommissioning etc. are included
Extent of guidance for application is limited	Guidance and descriptions included to facilitate transparency, understanding and application

To further understand why certification is commonly applied in the offshore wind industry, the considered added value of third-party assessment providing conformity to defined requirements, is summarized below:

- mitigation environmental, personnel and damage risks
- increasing confidence in technical integrity and reliability
- supporting quality management
- minimising financial project risks
- securing investments and optimise return of investment
- securing better insurance/policy rates; decrease contingencies
- increasing trust in the project by independent approval in the relevant phases (development, construction to operations)
- reducing costs by early detection of non-conformities
- supporting interface management between assets, stakeholders and project phases
- confirming that requirements from project developers, investors, operators, manufacturers, governmental and non-governmental organizations are fulfilled
- proving that the national and international acknowledged state of the art requirements are met
- utilising statements and certificates to support authorisations by governmental institutions

- providing stepwise documentation of the maturity of the wind power project.

The benefits depend on the specific individual interests and the contracted certification scope for the different assets and phases.

4.2 Floating wind certification schemes

Generally, the schemes applied in the different countries and the overall regulations given by the authorities for bottom-fixed wind also apply for floating wind. However, some countries considering floating wind do not always have an existing offshore wind industry practice from before.

The third-party services offered for floating wind turbines, originate from either a project certification approach used on the offshore wind industry or an offshore classification approach as applied in the maritime industry resulting in class notations. There are many similarities between these two approaches. A classification approach will result in the class notation providing assurance that a set of requirements laid down in defined rules are met during design and construction and maintained during operation. Within a class approach, each unit will obtain a class notation. A complete project certification approach results in issuance of a *Project Certificate*, attesting compliance with the set of requirements laid down in the standards (defined in the applicable service specification) through design, construction and in-service. Project Certification can cover either a single unit or a complete wind power plant including all assets. Project Certification includes a Statement of Compliance after each completed phase (i.e. design basis, design, etc.)

The service specification DNVGL-SE-0422 /13/ is an extension to the DNV GL service specifications for type and project certification for bottom-fixed on- and offshore wind turbines. It should be considered in combination with DNVGL-SE-0441 Type and component certification of wind turbines /9/ and DNVGL-SE-0190 Project certification of wind power plants /12/. The services described herein consider the specific floating wind turbine requirements which are not covered by DNVGL-SE-0441 or DNVGL-SE-0190. The service specification covers certification services for all development phases of a floating wind concept towards implementation in a wind farm i.e. concept, prototype, site type, project (farm) and in-service level certification.

The DNVGL-RU-OU-0512 /15/ rule supplements DNVGL-SE-0422 by providing classification services that may be used as part of the design, construction and operation of a floating offshore wind turbine project. Generally, DNV GL rules for classification contain procedural and technical requirements related to obtaining and retaining a class certificate. The rules represent all requirements adopted by the Classification Society as basis for classification. Classification provides assurance that a set of requirements laid down in rules established by DNV GL are met during design and construction and maintained during operation of a floating offshore wind turbine installation. Generally, the rotor-nacelle assembly (RNA), tower for RNA including slewing ring/yaw bearing, power transmission system for RNA and inter-array and power export cables are not covered by these rules. The notation *✠OI Floating offshore wind turbine installation* will be given to installations intended for long term service at one specific location for a prolonged period with hull, utility and safety systems found to be in compliance with the basic requirements of applicable DNV GL offshore standards referred to in the rules. DNVGL-ST-0119 is main design standard referenced in the rules. It should be noted that DNV GL will not verify compliance with statutory requirements unless authorized by the national authority or flag state administration.

Like DNV GL, ABS provides a class notation ✠ A1 Offshore Wind Turbine (Floating) with additional notations possible about the RNA, the lifetime and lifetime extension etc. (/27/). The Rotor-Nacelle Assembly (RNA) may be included in the classification and is then subject to the ABS Type Approval requirements of the ABS Rules for Conditions of Classification – Offshore Units and Structures (Part 1).

When the RNA is not included in the classification, the RNA installed on the ABS classed Floating Offshore Wind Turbine Installation is required to have a type certificate in accordance with IEC 61400-22/ IECRE or other recognized standards.

BV also offers classification/certification. According to the BV Guidance Note, a classification approach will result in the structural type notation offshore special type unit (FOWT), while a certification approach results in issuance of certificates attesting the compliance of FOWT and/or its components with the applicable rules or standards (ISO standards and other BV documents made for the petroleum industry).

ClassNK has also procedures for wind farm certification described in RE-SP-003 Wind Farm Certification Procedures (May 2019). This procedure applies for wind power plants in Japan with an output of 500 kW or more and that are subject to the Electric Business Act. The type and project certification of turbines and wind farms are performed by use of IEC's wind standards and ISO standards (related to process and quality management). It should be noted that this might not apply for floating wind farms. The ClassNK Guideline gives requirements for classification surveys and make reference to Rules for Survey and Construction of Steel Ships.

Reference is made to section 3.3.2.1 for more details about the combined standard and classification documents from the different providers above.

The IECRE OD-502 or IEC 61400-22 scheme do not mention floating wind.

5 REGULATION ON PRODUCT, CERTIFICATION, ACCREDITATION AND RECOGNITION

5.1 General

Regulation on products such as wind turbines, wind power plants or their components could be stipulated by laws, regulations, executive orders, schemes, standards, guidelines or any other documents, typically publicly available.

The requirements can come from European Union (EU), National, State/Regional, or Local authorities, see also section 3.1.

5.2 Requirements

5.2.1 Standards

Standards provides technical requirements. Reference is made to section 3 for details about standards and the providers.

5.2.2 CE marking

In the European Union (EU) the CE marking has been introduced to ensure that the original equipment manufacturer (OEM) follows relevant standards. Therefore, in general, in EU, all products should have a CE marking. The CE marking is a self-declaration of the OEM. An involvement of a third party is not required.

The CE mark indicates conformity with health, safety and environmental protection standards for products sold within the European Economic Area (EEA). One of the main legislations governing the harmonisation of essential health and safety requirements for machinery at EU level is the Machinery Directive /9/.

In case a CE marked product fails and the root cause analysis reveals that the relevant standards have not been applied, it has more severe legal consequences than without the self-declaration. In this way the end-user rights should be supported.

5.3 Ministry and approving body

The governmental ministry is typically responsible for providing approvals usually before installation and operation. The approval can be delegated to an execution body being linked with the ministry. In this document this is called the approving body. The approving body takes the decision on approvals and permits typically based on their processes and reviews.

5.4 Accreditation body

The Accreditation Body is the authoritative body that performs third-party attestation and issues a statement, based on a decision following review that fulfilment of specified requirements has been demonstrated related to a conformity assessment body.

The requirements for accreditation bodies to assess conformity assessment bodies/certification bodies are defined by ISO 17011. Additionally, the accreditation body shall comply to the Multilateral Agreements set by the International Accreditation Forum (IAF) /26/ and European Accreditation (EA) /61/.

5.5 Certification body

The Certification Body, or according to ISO 17000 so called conformity assessment body, typically performs conformity assessment activities.

A third-party conformity assessment activity is performed by an accredited certification body (ACB). This means the accredited certification body has proven towards the accreditation body, that the ACB is independent of the person or organization that provides the object (e.g. wind turbine or wind farm) and of user interests in that object. The accredited certification body shall comply with the requirements given in ISO 17065. Additionally, it is relevant to check for which relevant standards the ACB is accredited for. This can be seen from the appendix of the accreditation certificate issued by the Accreditation Body.

In general, an accreditation facilitates the acceptance as certification body by the national and local authorities.

5.6 Certification

5.6.1 General

A typical reason for asking for certification is to assure by an independent and qualified third-party, that the wind power plant including its assets (e.g. wind turbines incl. support structure, substation and power cables) is safe and reliable.

Certification is to attest that a wind power plant is fulfilling the defined requirements (applicable standards and state of the art knowledge) for the defined phases. Typically, the phases from development to construction and operations, are included. A successful certification shall document compliance with the defined requirements.

The following definitions are taken from the ISO 17000:

- Certification
  Third-party attestation related to products, processes, systems or persons
- Attestation
  Issue of a statement, based on a decision following the review, that fulfilment of specified requirements has been demonstrated
- Review
  Verification of the suitability, adequacy and effectiveness of selection and determination activities, and the results of these activities, with regard to fulfilment of specified requirements by an object of conformity assessment.

Certification means in short confirmation, by a third-party, of compliance of a product (e.g. wind turbine/wind power plant) towards defined requirements (e.g. a standard), see Figure 5-1.

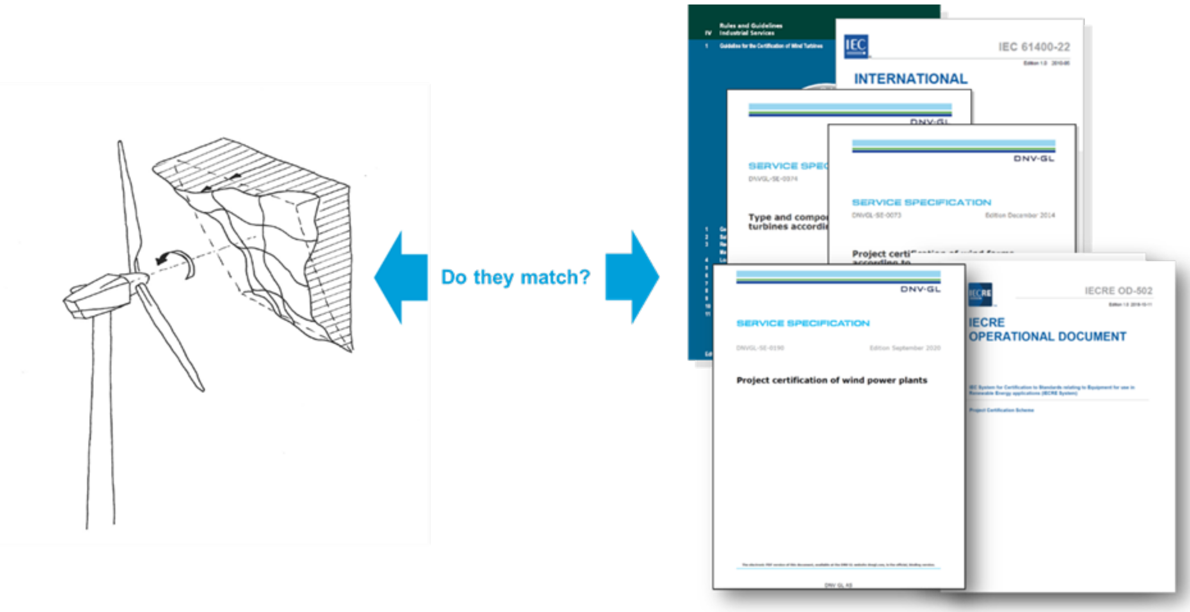

Figure 5-1 Certification to show compliance with defined requirements

5.6.2 Type Certification

Within the wind industry, type certification means certification of the wind turbine rotor-nacelle assembly (RNA) and its components. The type certificate can also cover the RNA and tower. Especially for offshore wind the tower is always site-specific designed, thus typically not part of the type certificate. Also other site-specific components such as foundations and assets such as offshore substation and power cables are not type certified. The type certification is in general a certification of a type of turbine considering generic wind conditions (wind turbine class).

The type certification scheme according to IEC 61400-22, DNVGL-SE-0073 or IECRE OD-501 consists of five mandatory modules and three optional modules. The five mandatory modules refer to five major tasks during the design, manufacturing and testing of the wind turbine. The three optional modules refer to design and manufacturing of the foundation for the wind turbine and to type characteristics measurements, see Figure 5-2.

The certification modules design basis evaluation and design evaluation cover the steps necessary to achieve final design verification of the wind turbine. This verification includes an evaluation of the design basis and an evaluation of the design itself. The two modules are mandatory, however, although not recommended, the design basis module may be integrated in the design evaluation module. The design evaluation module does not cover the foundation and may therefore be supplemented by an optional module "foundation design evaluation", see Figure 5-2.

The certification module manufacturing evaluation is mandatory. The manufacturing evaluation module does not cover the foundation and may therefore be supplemented by an optional module foundation manufacturing evaluation, see Figure 5-2.

The certification module type testing is mandatory. The type testing module may be supplemented by an optional module for type characteristics measurements, see Figure 5-2. The certification module final evaluation is mandatory.

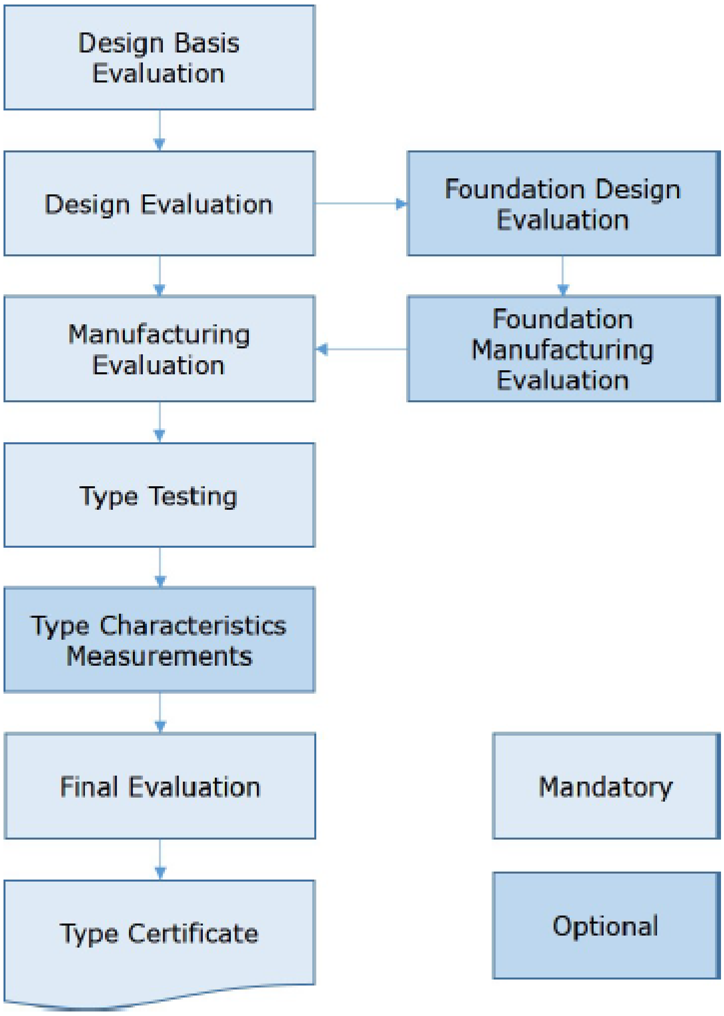

Figure 5-2: Type Certification modules

The design basis shall identify all requirements, assumptions and methodologies which are essential for the design and for the documentation of the design.

The purpose of the design evaluation is to verify that the wind turbine or component design complies with the approved design basis.

The purpose of the manufacturing evaluation is to verify that the requirements identified and specified during the design evaluation with regard to critical manufacturing processes are observed and implemented in production and assembly.

The purpose of the type testing is to prove the wind turbine performance with respect to power production and to verify the load calculations as well as the blade design and manufacturing.

The purpose of the final evaluation is to provide documentation of the findings from the evaluation of all the elements of the type certification.

5.6.3 Component Certification

Component certificates may be issued for specific components, such as 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. The component certification scheme is similar to the type certification scheme and following IEC 61400-22, DNVGL-SE-0073 or IECRE OD-501, see 5.6.2. Component certification covers relevant modules of type certification with the extent depending on the component in question, see Figure 5-3. For component certification, it is required that the interface including the design load envelope is clearly defined.

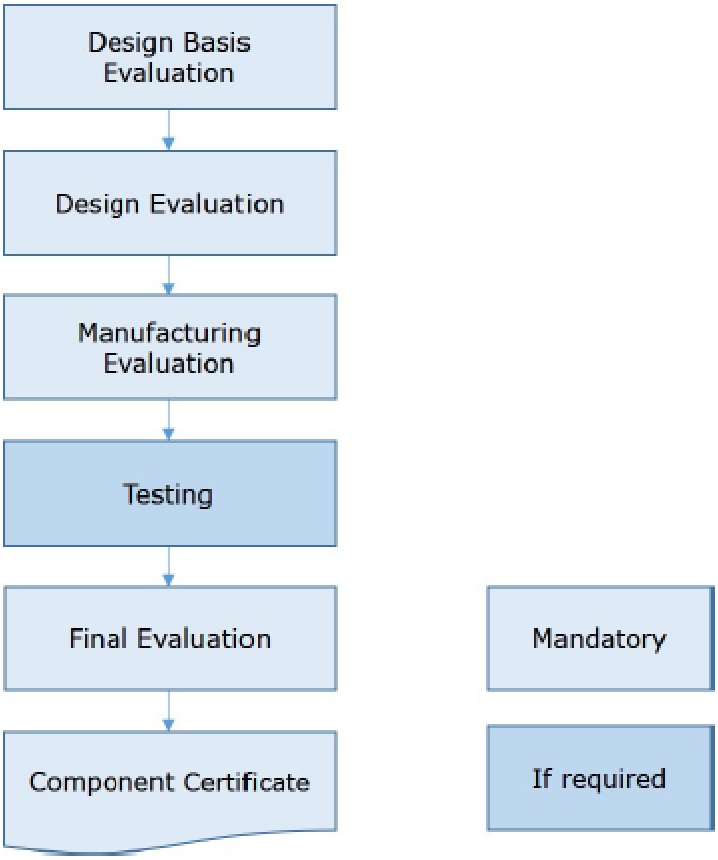

Figure 5-3: Component Certification modules

For floating support structures, component certification will typically be relevant for e.g. mooring components.

5.6.4 Project Certification

Project certification has been developed and is applicable for all phases in the lifecycle of onshore and offshore wind power plants. It constitutes a robust means to provide, through independent certification, evidence to stakeholders that a set of requirements laid down in standards are met during the development and construction and is maintained during operation of the wind power plant.

The five certification phases within the project certification extend from design basis to commissioning, operation and maintenance, see Figure 5-4 (darker blue arrows). Further optional certification phases such as concept and decommissioning are usually on an optional basis, see Figure 2-2 (brighter arrows).

Each phase will be completed by a statement of compliance and associated certification report. The project certificate and associated final certification will only be issued if the mandatory phases have been successfully conducted (dark blue arrows of Figure 5-4).

In some countries the in-service/periodic monitoring certification is demanded on a mandatory basis from the authorities, see Appendix B.

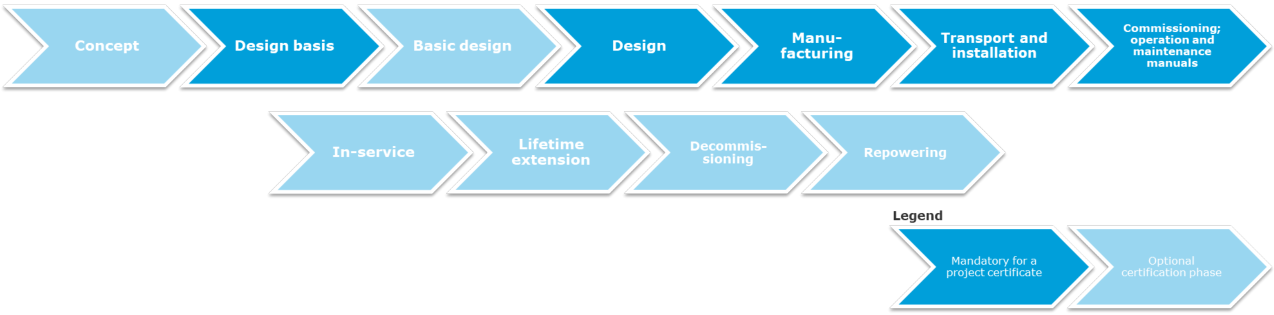

Figure 5-4: Certification phases for wind power plants, modified from source DNVGL-SE-0190

The following certification phases are shown in Figure 5-4:

- Concept: covers the concept development at the beginning of the wind power project.
- Design basis: covers the site conditions and the basis for design.
- 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.
- 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: involves all follow-up evaluation and on-site inspections during the implementation of the project. The concepts and manuals for operation and maintenance to be approved.
- In-service: involves follow-up evaluation and periodic on-site inspections after start of operation and during the subsequent in-service period.

- Lifetime extension: determines the remaining lifetime beyond the design lifetime of the plant or their assets.
- Decommissioning: contains the planning and execution of a wind power plant decommissioning and removal.
- Repowering: the renewal and reinstallation of a wind power plant at a former power plant site.

The wind turbine related design certification phase is also known site-specific design assessment (SSDA). In brief, the site-specific design assessment evaluated, if the type certified wind turbine considering a generic wind turbine class is suitable to be applied at a specific site, considering local site conditions.

5.7 Recognition arrangement

To support international trading, it's important that certificates are accepted by their stakeholders. To support the acceptance recognition, arrangements are defined by the IAF and EA related to the Accreditation Bodies. The arrangements enable the recognition of conformity assessment results and thus acceptance of Accredited Certification Bodies' work in countries those being members.

The international arrangements are managed by International Laboratory Accreditation Cooperation (ILAC) in the fields of calibration, testing, medical testing and inspection accreditation and IAF in the fields of management systems, products, services, personnel and other similar programmes of conformity assessment. Both organizations, ILAC and IAF, work together and coordinate their efforts to enhance the accreditation and the conformity assessment worldwide.

The Figure 5-5 shows the relation from the product to the recognition of certificates worldwide. Reading from right to left, the product (wind turbine or project) of a manufacturer/developer can be certified by a certification body such as DNV GL. DNV GL, Renewables Certification (RC) is accredited by the leading accreditation body DAkkS according to ISO/IEC 17065 and relevant standards. Thus DNV GL, Renewables Certification is an Accredited Certification Body (ACB). The Accreditation Body is among others following the requirements ISO 17011 and Multilateral Agreements such as International Accreditation Forum (IAF) and European co-operation for Accreditation (EA).

Due to this set up the certificates issued are worldwide recognised by accreditation bodies of other countries, being member e.g. of the IAF.

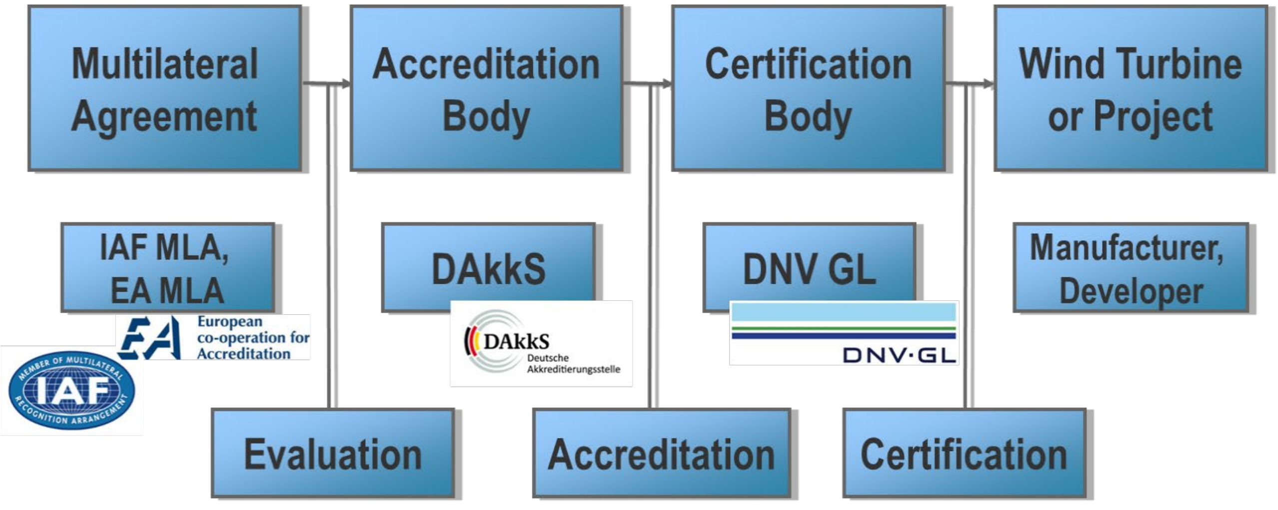

Figure 5-5: Overview on Product, Certification, Accreditation and Recognition

6 COUNTRY SPECIFIC REQUIREMENTS

The appendices to this report comprise the country specific details which include reference to applicable regulations, certification requirements and standards.

APPENDIX	Revision	Subject
A	0	France
B	0	Germany
C	0	Norway
D	0	South Korea
E	0	Taiwan
F	0	United Kingdom
G	0	United States of America

Table 6-1 provides an overview of the country specific requirements for offshore wind power plant certification.

Table 6-1 Overview of the project certification requirements for the selected countries

Country		Project certification	Main stakeholder and extent
France		✓ (orange)	Not required by authorities, but by investors Requirement: full project certification of the wind turbines
Germany		✓ (green)	Responsible authority: BSH Requirement: full project certification of the wind turbines and offshore substation, plus in-service certification of operating wind power plants
Norway			Responsible authority: PSA Requirement: not yet in place (for petroleum installations the operator are responsible for sufficient third party involvement)
South Korea			Responsible authority: KEA Requirement: not yet in place
Taiwan		✓ (green)	Responsible authority: BSMI Requirement: full project certification of the wind turbines, offshore substation and power cables
United Kingdom		✓ (orange)	Not directly required by authorities, but common practice for design basis and design phase Requirement: Health and Safety Legislation requires a company to prove that reasonable measures to ensure the safety of the structures are taken, in practice, certification of design basis and design phase are applied
United States of America		✓ (green)	Responsible authority: BOEM Requirement: full project certification of the wind turbines, offshore substation and power cables

Legend:

✓ (green)	requirement by laws/acts/orders
✓ (orange)	indirect requirement e.g. by investors, insurance;
	no requirement yet

7 REFERENCES

Nr.	Title
/1/	DNV GL Energy Transition Outlook 2020: https://intranet.dnvgl.com/communicationandbrand/Pages/DNV-GL-Energy-Transition-Outlook-2020.aspx
/2/	IEA.org: https://www.iea.org/reports/offshore-wind-outlook-2019
/3/	Petroleumtilsynet, https://www.ptil.no/
/4/	Equinor: https://www.equinor.com/no.html
/5/	Ot.prp.nr. 107 (2008-2009), Om lov om fornybar energiproduksjon til havs (havenergilova), Det Kongelege Olje- og Energidepatement (LOV-2010-06-04-21)
/6/	https://lovdata.no/dokument/LTI/forskrift/2020-06-12-1192
/7/	https://lovdata.no/dokument/SF/forskrift/2016-09-15-1066
/8/	Ministry of Petroleum and Energy: http://www.regjeringen.no/en/dep/oed.html?id=750
/9/	CE marking | Internal Market, Industry, Entrepreneurship and SMEs (europa.eu)
/10/	DNV GL rules and standards: https://rules.dnvgl.com/ServiceDocuments/dnvgl/#!/home
/11/	DNVGL-SE-0441 *Type and component certification of wind turbines* (2016)
/12/	DNVGL-SE-0190 *Project certification of wind power plants* (2020)
/13/	DNVGL-SE-0422 *Certification of floating wind turbines* (2018)
/14/	DNVGL-RU-OU-0512 Floating offshore wind turbine installations (2020)
/15/	DNVGL-ST-0126 *Support structures for wind turbines* (2018)
/16/	DNVGL-ST-0437 *Loads and site conditions for wind turbines* (2016)
/17/	DNVGL-ST-0119 *Floating wind turbine structures* (2018)
/18/	DNV-OS-J103 *Design of Floating Wind Turbine Structures* (2013)
/19/	DNV *Guideline for offshore floating wind turbine structures* (2009)
/20/	DNVGL-RP-0286 *Coupled analysis of floating wind turbines* (2019)
/21/	DNVGL-ST-0359 Subsea power cables for wind power plants (2016)
/22/	DNVGL-RP-0360 Subsea power cables in shallow water (2016)
/23/	DNVGL-ST-F201 Riser systems (2020)
/24/	DNVGL-ST-N001 Marine operations and marine warranty (2018)
/25/	ISO 13628-5 Petroleum and natural gas industries – Design and operation of subsea production systems – Part 5: Subsea umbilicals (2009)

/26/	International Accreditation Forum - IAF. Find IAF Members, addresses & contact details
/27/	ABS Guide for building and classing Floating offshore wind turbine installations (#195) (2020)
/28/	ABS Guidance note on Global performance analysis for floating offshore wind turbine installations (#206) (2014)
/29/	ClassNK Guideline for Offshore Floating Wind Turbine Structures (2012)
/30/	Class NK: Rules for Survey and Construction of Steel Ships (2013)
/31/	https://www.yumpu.com/en/document/read/16344598/2-design-guideline-for-floating-offshore-wind-turbine
/32/	European Commission, Machinery, Machinery Directive 2006/42/EC
/33/	IEC 61400-1:2019 Wind energy generation systems - Part 1: Design requirements
/34/	IEC 61400-3-1:2019 Wind energy generation systems – Part 3-1: Design requirements for fixed offshore wind turbines (standard)
/35/	IEC 61400-3-2:2019 Wind energy generation systems – Part 3-2: Design requirements for floating offshore wind turbines (technical specification)
/36/	IEC 61400-22:2010 Wind Turbines - Part 22: Conformity Testing And Certification (withdrawn 2018-08-31)
/37/	IEC 63026:2019 Submarine power cables with extruded insulation and their accessories for rated voltages from 6 kV (Um = 7,2 kV) up to 60 kV (Um = 72,5 kV) - Test methods and requirements
/38/	API Spec. 17J Specification for Unbonded Flexible Pipe
/39/	API Spec. 17L1 Specification of Flexible Pipe Ancillary Equipment
/40/	NORSOK: http://www.standard.no/en/
/41/	The Norwegian Petroleum Act: https://www.npd.no/en/regulations/acts/act-29-november-1996-no2.-72-relating-to-petroleum-activities/
/42/	The Norwegian Directorate of Health: https://helsedirektoratet.no/English
/43/	Working Environment Act: https://www.arbeidstilsynet.no/en/laws-and-regulations/laws/the-working-environment-act/
/44/	The Pollution and Waste Act: https://www.regjeringen.no/en/dokumenter/pollution-control-act/id171893/
/45/	The Fire and Explosion Prevention Act: https://lovdata.no/dokument/NL/lov/2002-06-14-20?q=Brann%20og%20eksplosjonsvernloven
/46/	Cigre TB 623 Recommendations for additional testing for submarine cables from 6 KV (UM=7.2 KV) up to 60 KV (UM = 72.5 KV) (2015)
/47/	Cigre TB 722 Recommendations for mechanical testing of submarine cables (2018)

/48/	WFO_Global-Offshore-Wind-Report-HY1-2020.pdf (wfo-global.org)
/49/	https://ww2.eagle.org/en/Products-and-Services/offshore-energy/offshore-wind.html
/50/	https://www.nek.no/
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/60/	https://www.bsigroup.com/
/61/	https://www.iecre.org/faq/
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APPENDIX A
France

Requirements

The Ministère de la Transition écologique is responsible for implementation of the Renewable Energy Directive 2009/28/EC to support the renewable energy transition in France.

There is no legal framework or requirement for certification of offshore wind projects. However, French offshore wind projects are applying project certification. Primarily for the reason to reduce the liability risk in connection to the asset installed. Origin is the “Loi Spinetta” law from 1978, in which the liability in case of damage needs to be determined. To mitigate the liability for the designer, developer constructor the “Contrôle Technique de la construction‟ was implemented. In 2005 the wind turbines higher than 12m hub high not distinguishing on- and offshore have been amended to fall under this regulation. The certification as a risk mitigation is therefore an obvious possibility to address the offshore wind aspects.

Standards

Applied certification schemes for French offshore wind power plants were in the past IEC 61400-22 (withdrawn in 2018), DNVGL-SE-0073 *Project certification of wind farms according to IEC 61400-22* and nowadays DNVGL-SE-0190 *Project certification of wind power plants* and IECRE OD-502 *Project Certification Scheme*. These certification schemes refer to applicable standards such as EN, IEC, ISO and DNV GL.

Component certification

The component certificates can facilitate to prove independently compliance of components with defined requirements and therefore it eases the application into the project as well as integration into the type or project certification.

Type certification

The type certificate of the wind turbine facilitates the application into the project as well as integration into the project certification.

Project certification

Project certification by an accredited certification body for offshore wind farms including the wind turbines is common practice.

Ministry and approving body

Offshore wind farm projects can in principle be built and operated with an authorisation awarded by the Minister for Energy. To simplify the authorisation process, a sole authorisation in relation to the Water Act has been introduced (*préfet*).

Accreditation body

The Accreditation Body is the Comite Francais d'Accreditation (COFRAC).

COFRAC is the national accreditation body for France. Pursuant to Regulation (EC) No. 765/2008, it acts in the public interest and as the sole provider of accreditations in France.

Certification body

The certification body shall be accredited according to ISO/IEC 17065 and related standards.

Recognition arrangement

France is a member of the International Accreditation Forum (IAF). The Comite Francais d'Accreditation (COFRAC) is signatory of the IAF MLA.

APPENDIX B
Germany

Requirements

For offshore wind power plants the "Gesetz zur Entwicklung und Förderung der Windenergie auf See (Windenergie-auf-See-Gesetz - WindSeeG), § 47 Planfeststellungsverfahren, Sec, 1, item 5." applies. The Offshore Wind Energy Act (Gesetz zur Entwicklung und Förderung der Windenergie auf See) is published by the Federal Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie). The Offshore Wind Energy Act specifies in §47 the Planning approval process, item 5 the authorisation of the Planning Approval Body (here BSH) to ask for reports by acknowledged bodies (here certification body). BSH has detailed their requirements with the publication of the BSH7005.

Following main documents are governing.

Document No.	Date	Title
BSH7005	2015-12-01	Standard Design Minimum requirements concerning the constructive design of offshore structures within the Exclusive Economic Zone (EEZ)
BSH7004	2014-02-05	Minimum requirements for geotechnical surveys and investigations into offshore wind energy structures, offshore stations and power cables

Local authorities maybe ask for additional requirements.

Standards

The "Standard Design Minimum requirements concerning the constructive design of offshore structures within the Exclusive Economic Zone (EEZ), BSH7005" is a project certification scheme, which contains requirements and refers to applicable standards.

Among others reference is made in BS7005 to standards such as DIN EN, DNV, DNV GL, GL, ISO and NORSOK.

A new edition of BSH7005 is expected to be published end of 2020, considering also latest DNV GL service documents.

Component certification

Component certification requirements are not mentioned in the BSH7005. Anyway, component certificates can facilitate to prove independently compliance of components with defined requirements and therefore it eases the application into the project as well as integration into the type or project certification.

Type certification

The offshore type certificate is a kind of prerequisite for wind turbines being installed in offshore wind farms as stated in the BSH7005.

Project certification

Project certification for wind turbines and substation including support structures according BSH7005 is mandatory for offshore wind farms.

Ministry and approving body

For offshore the Ministry Bundesministerium für Verkehr und digitale Infrastruktur is responsible. The approving body is the Federal Maritime and Hydrographic Agency, Bundesamt für Seeschifffahrt und Hydrographie (BSH).

Accreditation body

The German Accreditation Body is the Deutsche Akkreditierungsstelle (DAkkS).

DAkkS is the national accreditation body for the Federal Republic of Germany. Pursuant to Regulation (EC) No. 765/2008 and the Accreditation Body Act (AkkStelleG), it acts in the public interest and as the sole provider of accreditations in Germany.

Certification body

The certification body should be accredited according to ISO/IEC 17065 and related standards.

Recognition arrangement

Germany is a member of the International Accreditation Forum (IAF). The German Accreditation Body DAkkS is signatory of the IAF MLA.

APPENDIX C
Norway

Requirements

Until August 2020, the responsible authority for the safatey of offshore wind in Norway was not decided. The 17th of August 2020, it was announced that the Petroleum Safety Authority (PSA) has been given the responsibility for safety of renewable energy generation on the Norwegian Continental Shelf (NCS) /3/. A dedicated regulatory regime covering HSE in the offshore wind sector will be developed by PSA.

The Norwegian Coastal Administration has been awarded the responsibility for safety zones and marking and this is regulated by "Forskrift om merking av og etablering av sikkerhetssoner tilknyttet innretning for fornybar energiproduksjon" /7/.

The starting point for the offshore wind regulations will be the HSE regulations for petroleum operations, with performance-based requirements and a risk-based approach. It is assumed that the common practices in the offshore wind industry (especially Europe) will be aknowledged and that the inherent different risk picture pertaining to unmanned structures not carrying hydrocarbons will be taken into account.

DNV GL finds it likely that PSA will rely on recognized standards developed specifically for offshore wind, especially when it comes to structural safety. This is in line with the observations from Equinor's Hywind Tampen project and based on previous communication with PSA and Equinor (elaborated in more detail below).

The current PSA regulations developed for the petroleum industry is explained by the following:

- PSA's key regulations relating to health, safety and the environment (HSE) in the offshore petroleum industry are found in the HSE regulations:
  - Framework Regulations; requirements for basic safety for organization and execution of petroleum activities
  - Management Regulations; requirements for management and duty of disclosure in petroleum activities
  - Facilities Regulations; requirements for design and outfitting of facilities in petroleum activities
  - Activities Regulations; requirements for conducting petroleum activities
- Specific guidelines to the regulations describe how the regulations can be fulfilled. The regulations and the guidelines shall be used together to ensure that the requirements given in the regulations are fulfilled.

To further understand how petroleum activities in Norway are regulated, it is also relevant to consider the applicable acts:

- Most important:
  - The Norwegian Petroleum Act /41/
  - The Working Environment Act /43/
- Other:
  - The Pollution and Waste Act /44/

- The Fire and Explosion Prevention Act /45/
- A number of health-related Acts e.g. /42/

The hierarchy demonstrating the relations between Acts, PSA Regulations, Guidelines to PSA Regulations and Standards/Norms will typically be as shown in Figure 4-1 below. The Guidelines to the PSA regulations provide recommended solutions for fulfilling the specific requirements. These recommendations usually take the form of recognised norms or industry standards.

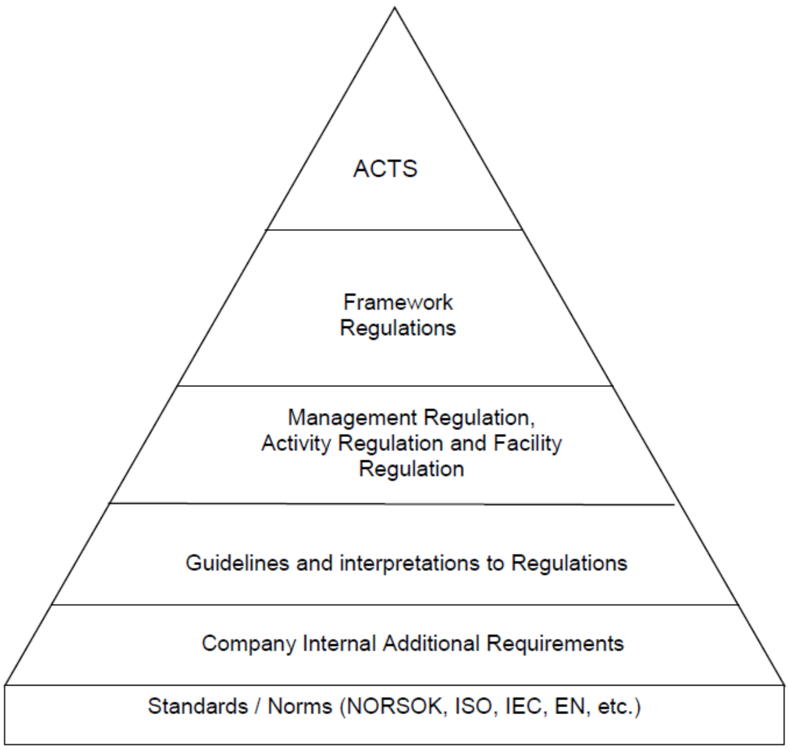

Figure 7-1 Hierarchy, Acts, PSA Regulations and Guidelines to Regulations and Standards/Norms

When a recommended standard is applied, the requirement can be considered to be met. If another standard is used, the operator must demonstrate that the selected standard is as good as, or better than, the standard referred to in the regulations and in compliance with such regulations. This is outlined in §24 in the Framework Regulations.

Regarding offshore renewables, the "Havenergilova" /5/, or the "Offshore Energy Act", became operational in 2010 with the aim to facilitate the utilization of the offshore renewable resources on the NCS. The Regulation ("Forskrift til havenergilova (havenergilovforskrifta)") to the "Offshore Energy Act" /6/ will come into force from 1st of January 2021. From this date, application for licences for renewable projects will also be possible. The Ministry of Petroleum and Energy (MPE) is awarded the responsibility for the regulations under the Act. Further, the purpose of the Act is to ensure that utilization of resources and deployment of technology offshore is made in accordance to societal needs and ambitions, accounting for environmental aspects, energy distribution needs and competing business interests in the larger scheme of the framework.

Standards

Due to i) the fact that the regulations for offshore wind not yet have been announced, and ii) DNV GL assume that the new regulations will follow the same principles as exist for the petroleum activities, a description of the current different execution models possible with PSA's petroleum regulations are included in Table 7-1 below. It should be noted that this is based on the current set-up applicable for the petroleum industry, but alternative 3 shows how e.g. the Hywind Tampen project have been able to fit within current PSA regulations and at the same time applied certain acknowledge standards from the offshore wind industry.

Table 7-1 Execution models for compliance with the PSA regulations

Execution model for compliance with the PSA regulations	
Alternative 1	Design according to the standards referred in the PSA regulations. This imply compliance with NORSOK standards for offshore structures.
Alternative 2	Design according to maritime regulations by utilizing § 3 in the Framework regulations. This imply registration in a national ships' register and compliance to the Norwegian Maritime Directorate's regulations for mobile facilities (the Red Book) and with supplementary classification rules provided DNV GL (typically DNV GL Offshore Standards (OS) for floating structures and position mooring). It should be noted that the maritime regulations are intended for mobile units.
Alternative 3	Design according to alternative standards than those in alternative 1 and 2 above by utilizing § 24 in the Framework regulations. It shall be documented that the alternative standards obtain the same level of safety as alternative 1. Combinations of parts of standards shall be avoided, unless it can be documented that an equivalent level for health, safety and the environment can be achieved.

Specific requirements for wind turbines and their support structures are not handled by the NORSOK standards nor in the maritime regulations. Based on the information given by both PSA, Equinor and DNV GL's dialogue with PSA, alternative 3 and utilisation of the Framework regulations § 24, is considered as a suitable approach before the specific regulations for offshore wind are in place. Under alternative 3, it is emphasised that it will be important to select standards that are based on recognised industry standards to ensure the appropriate safety level of the installation.

Component certification

Component certification requirements are not mentioned specifically by PSA. However, this may come into force through the referenced standards. It is noted that component certificates can facilitate to prove independently compliance of components with defined requirements and therefore it eases the application into the project as well as integration into the type or project certification.

A general remark about verification is given in PSA's Framework Regulations §19; "it is the Operator that shall determine the need for and scope of verifications, as well as the verification method and its degree of independence, to document compliance with requirements in the health, safety and environment legislation".

Type certification

Currently, no offshore wind specific requirements are specified by PSA, hence requirements for type certification of wind turbines are not specified. It is expected that PSA will consider this when they develop their offshore wind specific regulations. It is noted that this is common practice in most countries where offshore wind is developed.

Reference is made to PSA's Framework Regulations §19 and the information included above in the "Component certification" part.

Project certification

Currently, no offshore wind specific requirements are specified by PSA, hence requirements for project certification of wind farms are not specified. It is expected that PSA will consider this when they develop their offshore wind specific regulations. It is noted that project certification is mandatory in some countries where offshore wind is developed, but that PSA does not historically require strict requirements for third party involvement, ref. PSA's Framework Regulations §19 outlined in the "Component certification" part above.

Ministry and approving body

The Ministry of Petroleum and Energy (MPE) is awarded the responsibility for the regulations. As no legal framework or requirement for certifying offshore wind projects are currently in place, there is no approving body in Norway from the certification point of view.

Accreditation body

The Accreditation Body in Norway is Norwegian Accreditation (NA).

Certification body

The Certification Body shall be accredited according to ISO/IEC 17065 and related standards.

Recognition arrangement

Norway is a member of the International Accreditation Forum (IAF). The Norwegian Accreditation body is signatory of the IAF MLA.

APPENDIX D
South Korea

Requirements

Renewable Energy Policy RE3020 is aiming for the energy transition to 20% renewable energy generation incl. approx. 12 GW offshore wind by 2030.

Currently no regulations are in place for offshore wind power plants to mitigate risk by involving a third party to perform certifications.

Standards

Wind power relevant standards are the Korea Standards Certificate (KS C), which are mainly translations of the IEC standards. The following main standards apply:

- KS C IEC61400-22:2013-10 *Conformity testing and certification.* This is a translation of the IEC 61400-22.
- KS C 8572:2015-07 *Wind turbines - Part 1: Design requirements for wind turbines*. This is a translation of the IEC 61400-1:2010.
- KS C 8573:2015-07 *Wind turbines - Part 3: Design requirements for offshore wind turbines*. This is a translation of the IEC 61400-3:2009.

Component certification

The component certificates can facilitate to prove independently compliance of components with defined requirements and therefore it eases the application into the project as well as integration into the type or project certification.

Type certification

Type certification is mandatory in South Korea and are currently only accepted by the Korean Energy Agency (KEA) if performed by the Korean company Korean Register of Shipping (KR) in collaboration with Underwriters Laboratories (UL). This kind of monopoly is put in question by the international wind energy stakeholder as it’s limiting the international trading.

Project certification

Project certification is not yet regulated. The KEA has indicated to consider project certification for offshore wind power plants for their upcoming policy.

Ministry and approving body

The Ministry of Trade, Industry and Energy (MOTIE) is responsible for the energy transition in South Korea. The Korean Energy Agency (KEA) is the approving body.

Accreditation body

In South Korea different accreditation bodies exist. The Korea Accreditation Body for product certification is the Korea Accreditation System (KAS).

Certification body

The certification body should be accredited according to ISO/IEC 17065 and related standards.

Recognition arrangement

The Republic of Korea is a member of the International Accreditation Forum (IAF). The Korean Accreditation Body KAS is signatory of the IAF MLA.

APPENDIX E

Taiwan

Requirements

For offshore wind power plants, the regulation “Regulation on the review project certification issued by product CBs in offshore wind farm”, issue 2019-09-23 is set by Bureau of Standards, Metrology and Inspection (BSMI).

Standards

Applicable scheme for is CNS 15176-22, DNVGL-SE-0073 or DNVGL-SE-0190 with the standards CNS 15176-1, CNS 15176-3; including local requirements for Typhoon and seismic conditions. Supplemented by e.g. DNV GL standards for offshore substation DNVGL-ST-0145 and power cables DNVGL-ST-0359.

離岸風力發電案場(含海纜、海上變電站)之開發、設計及施作，應符合CNS 15176-22、IEC 61400-22、DNVGL-SE-0073或DNVGL-SE-0190之要求，並將CNS 15176-1及CNS 15176-3評估外部條件（如極端風速、地震狀況等）之方法納入設計考量。但能源主管機關另有規定者，得從其規定。

因特殊原因以致場址外部條件之量測無法符合前述相關標準之要求者，應經驗證機構之評估後決定其外部條件參數。

Component certification

The component certificates can facilitate to prove independently compliance of components with defined requirements and therefore it eases the application into the project as well as integration into the type or project certification.

Type certification

The type certificate of the wind turbine facilitates the application into the project as well as integration into the project certification.

Project certification

Project certification by an accredited certification body for offshore wind farms including the wind turbines, offshore substation including support structures and power cables is mandatory.

Ministry and approving body

The approving body is the Bureau of Standards, Metrology and Inspection (BSMI).

Accreditation body

The Taiwanese Accreditation Body is Taiwan Accreditation Foundation (TAF).

Certification body

The certification body shall be accredited according to ISO/IEC 17065 and related standards.

Recognition arrangement

Taiwan is a member of the International Accreditation Forum (IAF). The Taiwanese Accreditation Body TAF is signatory of the IAF MLA.

APPENDIX F
United Kingdom

Requirements

There is no legal framework or requirement for certification of offshore wind projects. However, with only a very few exceptions all UK projects have been certified, primarily for the following reasons:

- Traceability during a sale. Certification makes the job of the review undertaken during due diligence simpler and provides an improved level of confidence by the owner and prospective buyer. Often the time frame for review is short and certification from an independent third party simplifies this process.
- Health and Safety Legislation in the UK is strict and requires a company to prove they have taken reasonable measures to ensure the safety of their structures. As the certification process focus on technical safety (for all assets and their components), the third-party review is one way of demonstrating reasonable precautions when it comes to the overall design integrity and safety.
- Projects are increasingly large and there is a drive to refine the design and certification offers a way to ensure rigour in the process.

Standards

Applied certification schemes for UK offshore wind power plants were in the past IEC 61400-22 (withdrawn in 2018), DNVGL-SE-0073 Project certification of wind farms according to IEC 61400-22 and nowadays DNVGL-SE-0190 *Project certification of wind power plants* and IECRE OD-502 *Project Certification Scheme*. These certification schemes refer to applicable standards such as EN, IEC, ISO and DNV GL.

Component certification

The component certificates can facilitate to prove independently compliance of components with defined requirements and therefore it eases the application into the project as well as integration into the type or project certification.

Type certification

The type certificate of the wind turbine facilitates the application into the project as well as integration into the project certification.

Project certification

Typically for UK offshore wind power plants project certification is performed only for the phases design basis and design.

Ministry and approving body

The department that runs the Contracts for Difference (CFD) process is Department for Business Energy & Industrial Strategy (BEIS). As no legal framework or requirement for certifying offshore wind projects are in place, there is no approving body in UK from the certification point of view.

Accreditation body

The Accreditation Body is the United Kingdom Accreditation Service (UKAS).

UKAS is the national accreditation body for the UK. Pursuant to Regulation (EC) No. 765/2008, it acts in the public interest and as the sole provider of accreditations in UK.

Certification body

The certification body should be accredited according to ISO/IEC 17065 and related standards.

Recognition arrangement

UK is a member of the International Accreditation Forum (IAF). The Accreditation Body UKAS is signatory of the IAF MLA.

APPENDIX G
United States of America

Requirements

Offshore wind power plant projects in US federal waters are subject to the US Code of Federal Regulations (CFR), Title 30 – Mineral Resources, Chapter V – Bureau of Ocean Energy Management (BOEM), Department of the Interior, Subchapter B – Offshore, Part 585 – Renewable Energy and Alternative Uses of Existing Facilities on the Outer Continental Shelf.

The regulation is divided into ten parts, Subparts A through J, and covers the full lifecycle of an offshore wind power plant. Subpart G of 30 CFR 585, herein simply referred to as 30 CFR 585, outlines the requirements for the design, fabrication and installation of an offshore wind facility, and requires developers to use a 3rd party to certify each of those phases, ref. 30 CFR § 585.705. This effort shall be performed by a certified verification agent (CVA) and is therefore generally referred to as a CVA's scope of work (SoW) or CVA service. Overall, the role of the CVA aligns well with project certification of an offshore wind facility, as outlined in the SoW of DNVGL-SE-0190 for the Design, Manufacturing and Installation (including transportation) phases.

Following main document is governing.

Document No.	Date	Title
30 CFR 585	2011-10-18	30 – Mineral Resources, Chapter V – Bureau of Ocean Energy Management (BOEM), Department of the Interior, Subchapter B – Offshore, Part 585 – Renewable Energy and Alternative Uses of Existing Facilities on the Outer Continental Shelf

Local authorities may ask for additional requirements.

Standards

The 30 CFR 585 is not a project certification scheme and thus the CVA's SoW needs to be approved by BOEM. The SoW makes typically us of exiting certification schemes such as the DNVGL-SE-0190 *Project certification of wind power plants*. The certification schemes make reference to applicable standards such as DNV GL, IEC and ISO.

Component certification

The component certificates can facilitate to prove independently compliance of components with defined requirements and therefore it eases the application into the project as well as integration into the type or project certification.

Type certification

The type certificate of the wind turbine facilitates the application into the project as well as integration into the project certification.

Project certification

Project certification for design, fabrication and installation of the wind turbines, offshore substation (or alternatively electrical service platform) including support structures and power cables (array and export) is mandatory.

The applicable scheme is a project specific scope, which shall be defined in a “CVA scope of work document” and shall be approved by BOEM. The scope of work as outlined in DNVGL-SE-0190 addresses the requirements for the Design, Manufacturing and Installation (including transportation) phases. This means that DNV GL’s project certification may serve as the basis for certifying offshore wind power plants in the US federal waters, i.e. all projects located in the outer continental shelf (OCS), with some additional items required by 30 CFR 585. Some projects under development in the US have already appointed DNV GL as the CVA.

Anyway, further requirements may be applied as developments and learnings are ongoing.

Ministry and approving body

U.S. Department of Interior (DOI) is the regulatory authority charged with managing the Renewable Energy Program on the Outer Continental Shelf (OCS).

Bureau of Ocean Energy Management (BOEM) regulates Leasing and up to Operation. BOEM is authorized by the Secretary of the Department of Interior to regulate these activities, 30 CFR § 585.100.

The Bureau of Safety and Environmental Enforcement (BSEE) regulates Operation through to Decommissioning. BSEE's Mission is to ensure Safety, Protect the Environment and Conserving Offshore Resources "through vigorous regulatory oversight and enforcement."

Accreditation body

In the USA different accreditation bodies exist. Accreditation bodies are American Association for Laboratory Accreditation (A2LA), ANSI National Accreditation Board (ANAB), International Accreditation Service (IAS) and International Organic and Sustainable Accreditation (IOAS).

Certification body

The certification body is approved on a project specific as Certified Verification Agent (CVA) by BOEM. The accreditation of the certification body according to ISO/IEC 17065 and related standards support the approval to become a CVA.

Recognition arrangement

The accreditation bodies American Association for Laboratory Accreditation (A2LA), ANSI National Accreditation Board (ANAB), International Accreditation Service (IAS) and International Organic and Sustainable Accreditation (IOAS) are signatories of the IAF MLA.

About DNV GL

We are the independent expert in risk management and quality assurance. Driven by our purpose, to safeguard life, property and the environment, we empower our customers and their stakeholders with facts and reliable insights so that critical decisions can be made with confidence. As a trusted voice for many of the world's most successful organisations, we use our knowledge to advance safety and performance, set industry benchmarks, and inspire and invent solutions to tackle global transformations.