IRENA
International Renewable Energy Agency

NURTURING OFFSHORE WIND MARKETS

GOOD PRACTICES FOR INTERNATIONAL STANDARDISATION

Summary for

POLICY MAKERS

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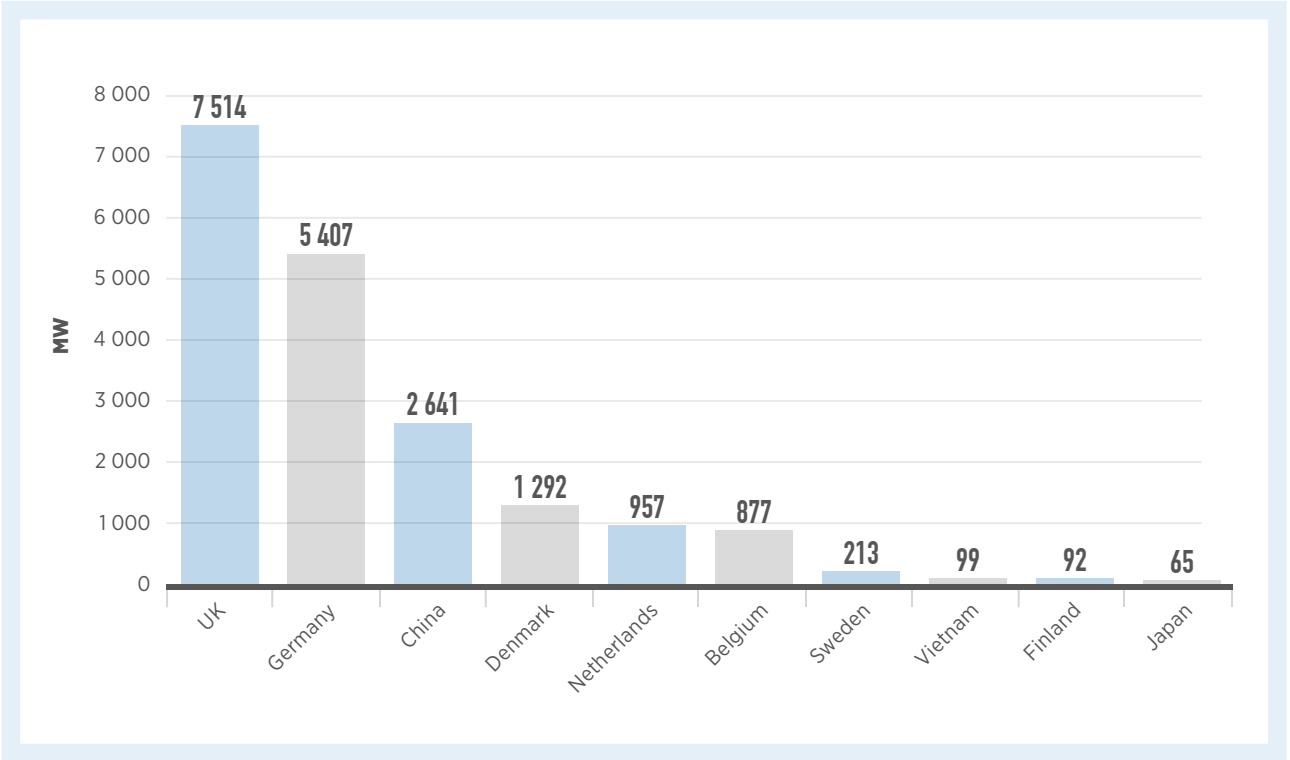
The fast pace of offshore wind development has resulted in remarkable growth, from less than 1 gigawatt of total installed capacity in 2006 to more than 19 gigawatts (GW) in 2017, and the pace is expected to accelerate.

Over the past 25 years offshore wind technology has developed rapidly, with the first commercial plant beginning operation in Denmark in the early 2000s. By 2017 the United Kingdom (UK), Germany, China, Denmark and the Netherlands had the largest offshore wind markets, both in the number of wind farms and in total installed capacity (see Figure 1) (IRENA, 2018a). As such, these European countries, and recently China, have the most relevant experience to share with emerging offshore wind markets. Other non-European offshore wind markets – such as Japan and the United States (US) – are also growing but at a slower pace. According to projections from the International Renewable Energy Agency (IRENA), growth in offshore wind energy will accelerate in the coming years, with installed capacity rising from 19.2 GW in 2017 to 521 GW in 2050 (IRENA, 2018b).

Figure 1: Installed capacity of offshore wind by country in 2017



Standardisation in offshore wind emerged mainly from the offshore oil and gas industry and is happening almost exclusively at the international level.

As offshore wind technology moves from the demonstration stage towards wider commercialisation, there is a need to deploy instruments to foster its global scale-up. An important instrument for the globalisation of offshore wind markets is the development and implementation of internationally harmonised standards, documenting good practices and lessons learned to enable a rapid diffusion of this technology.

A standard is a repeatable, harmonised, agreed and documented way of doing something. Standards contain technical specifications or other precise criteria designed to be used consistently, as a rule, guideline or definition. Standards result from collective work by experts in a field and are an instrument to reduce costs, mitigate technical risks, attract investment, gain public acceptance and set expectations by all stakeholders.

International standardisation is crucial to harmonise requirements and enable global scale-up of offshore wind technology

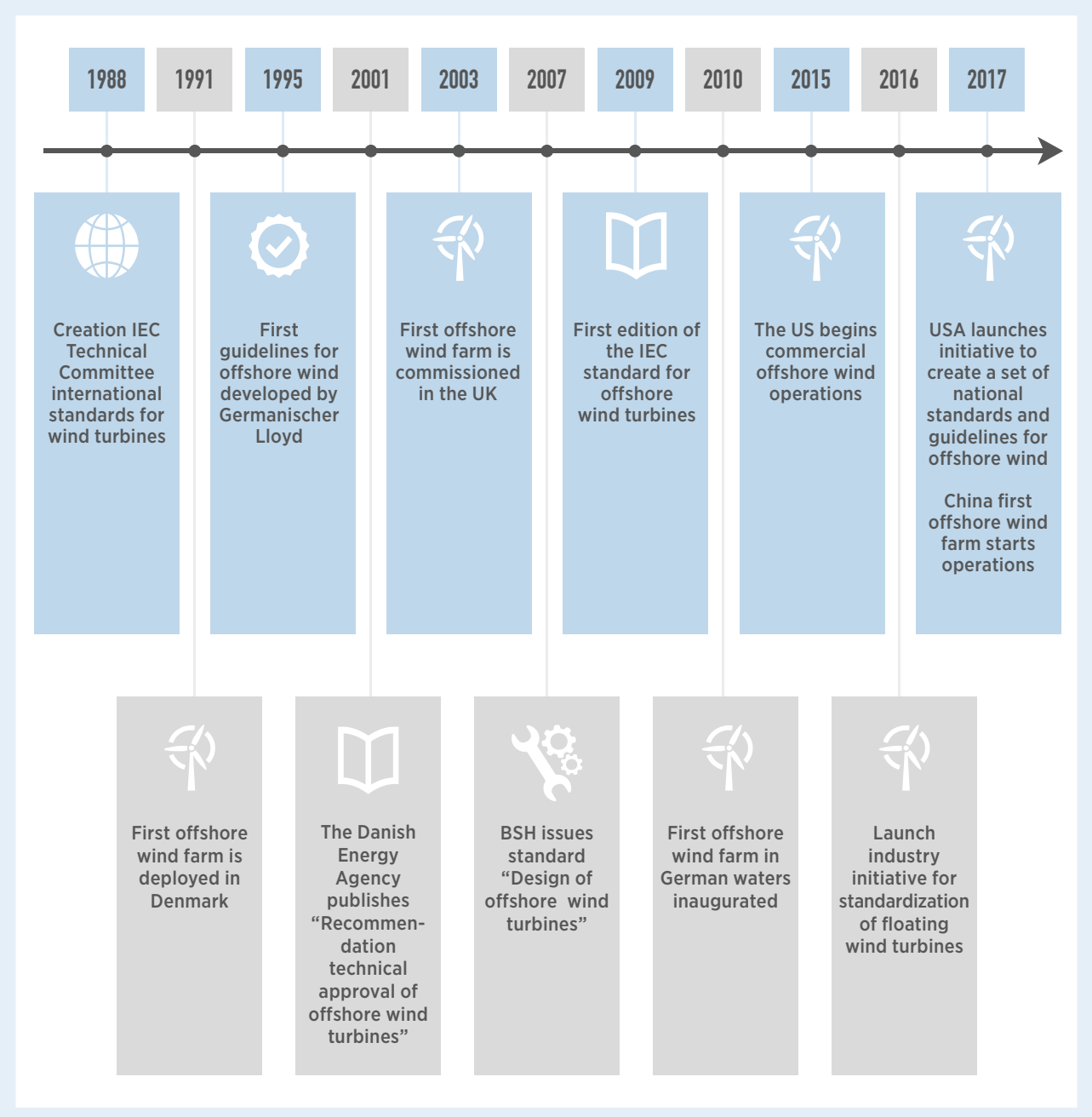
Several countries with existing offshore wind markets have developed their own customised national standards for this technology. However, the industry is currently striving for stronger international co-ordination and thus harmonised standards, as developed under the International Electrotechnical Commission (IEC) and its technical committee IEC TC 88 on wind energy generation systems.

Standardisation for offshore wind technology has been influenced by two main industry sectors: offshore oil and gas, and onshore wind. These two markets have provided the basis for developing offshore wind standards, and international efforts from the offshore wind industry have resulted in a number of standards already available. Despite remarkable progress in offshore wind, however, the sector needs to continue to reduce costs, to ease its integration with onshore electricity grid systems and to expand its reach into new markets, while also addressing environmental, health and safety aspects. The development of international standards and their adoption at the national level is essential in this regard. Efforts must continue and be strengthened to keep up with the state of the art of the technology, to accommodate technological innovation and to ensure the international harmonisation of technical requirements for a globalised scale-up of offshore wind.

Markets in China, Denmark, Germany and the UK have adapted offshore wind standards to meet local needs, customising their legislation, certification requirements and regulatory measures. However, while technical requirements in standards should consider local market conditions, the industry would benefit from having these conditions reflected in international standards, avoiding the need to meet different requirements for each market, enabling economies of scale and reducing transaction costs. This calls for close engagement of both mature and emerging offshore wind markets in an international standardisation process to ensure that these local contexts are well incorporated in international standards.

Most of the historical experience in offshore wind standardisation comes from countries that have more mature markets, such as Denmark, Germany and the UK (see Figure 2 for a summary of milestones). This report provides a deeper analysis of these three markets, based on multiple expert interviews and showcasing both historical developments and current practices. The report also details cross-cutting initiatives led by other countries and regions that are now advancing important activity in offshore wind standardisation.

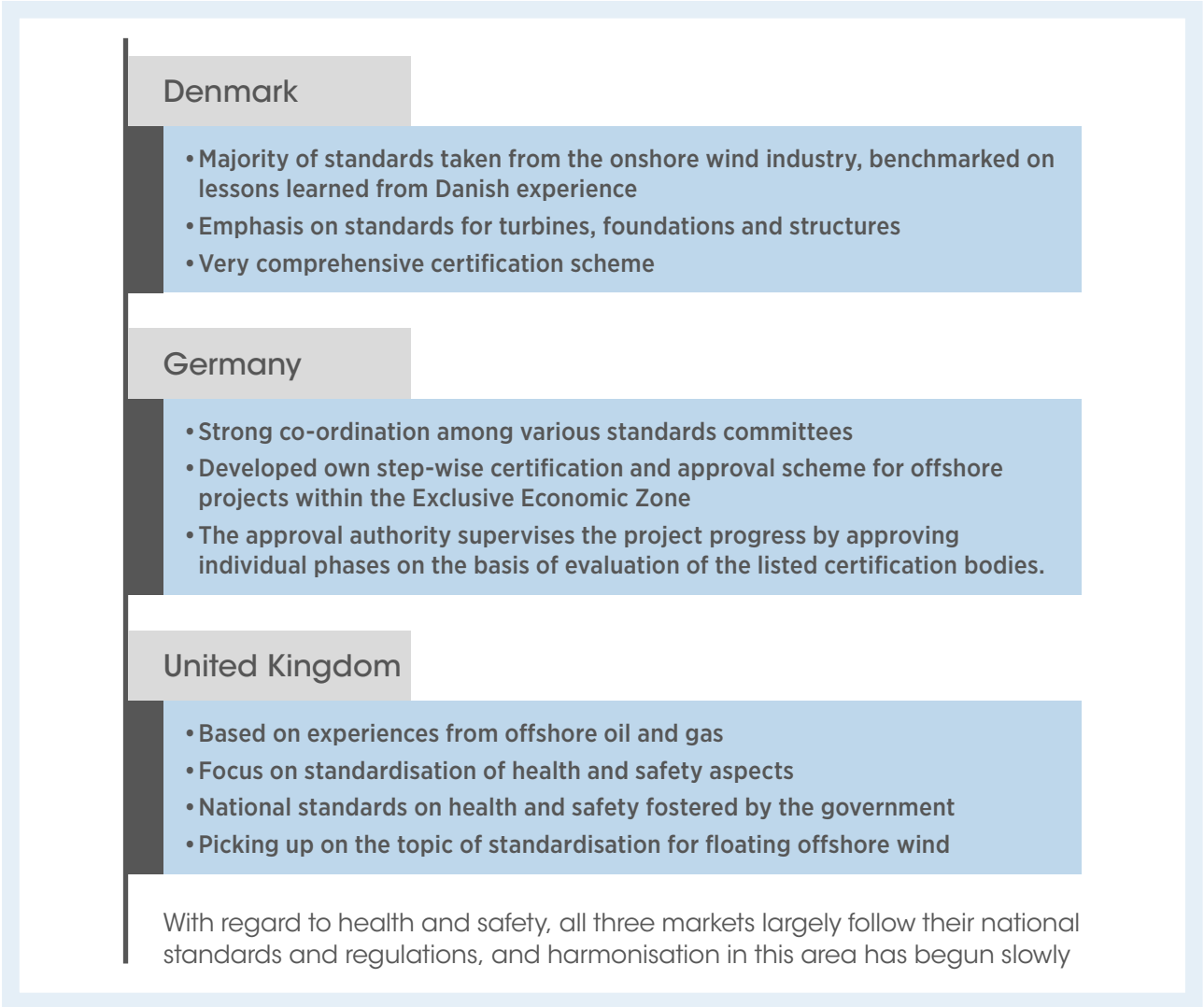
Figure 2: Timeline of standardisation for offshore wind



Nuances exist in national implementation of standards for offshore wind. For example, in Denmark and Germany standards are used in certification requirements for projects to receive approval from the respective government authorities. In the UK certification is not a legal requirement but generally is needed for projects to secure financing, as funding institutions regard certification based on guidelines and standards as a means to mitigate technical risks.

Denmark's offshore wind market was influenced by the country's long-term experience in the onshore wind industry and has focused largely on standards for turbines, foundations and structures. In Germany emphasis has been placed on clear responsibilities and co-ordination of various standards committees relevant to the offshore wind sector. Close co-ordination among the committees dealing with turbines and power-producing components is important for port operations and support vessels; for example: interaction is needed between the respective committees handling the maritime sector and wind turbine foundations. Work on standardisation in the UK has concentrated mainly on health and safety aspects similar to those being addressed in the country's offshore oil and gas industry. Figure 3 shows a summary of the good practices in these three national markets.

Figure 3: Good practices for standardisation in national markets



Standardisation in offshore wind has been shaped predominantly by market conditions in Europe; however, new standards today also must consider the needs of international offshore wind markets.

The expansion of offshore wind markets is moving beyond front runners such as Denmark, Germany and the UK. Because turbine manufacturers and other industry stakeholders operate transnationally, the industry is a major promotor of harmonising and developing international standards that will cover local conditions in new and future markets.

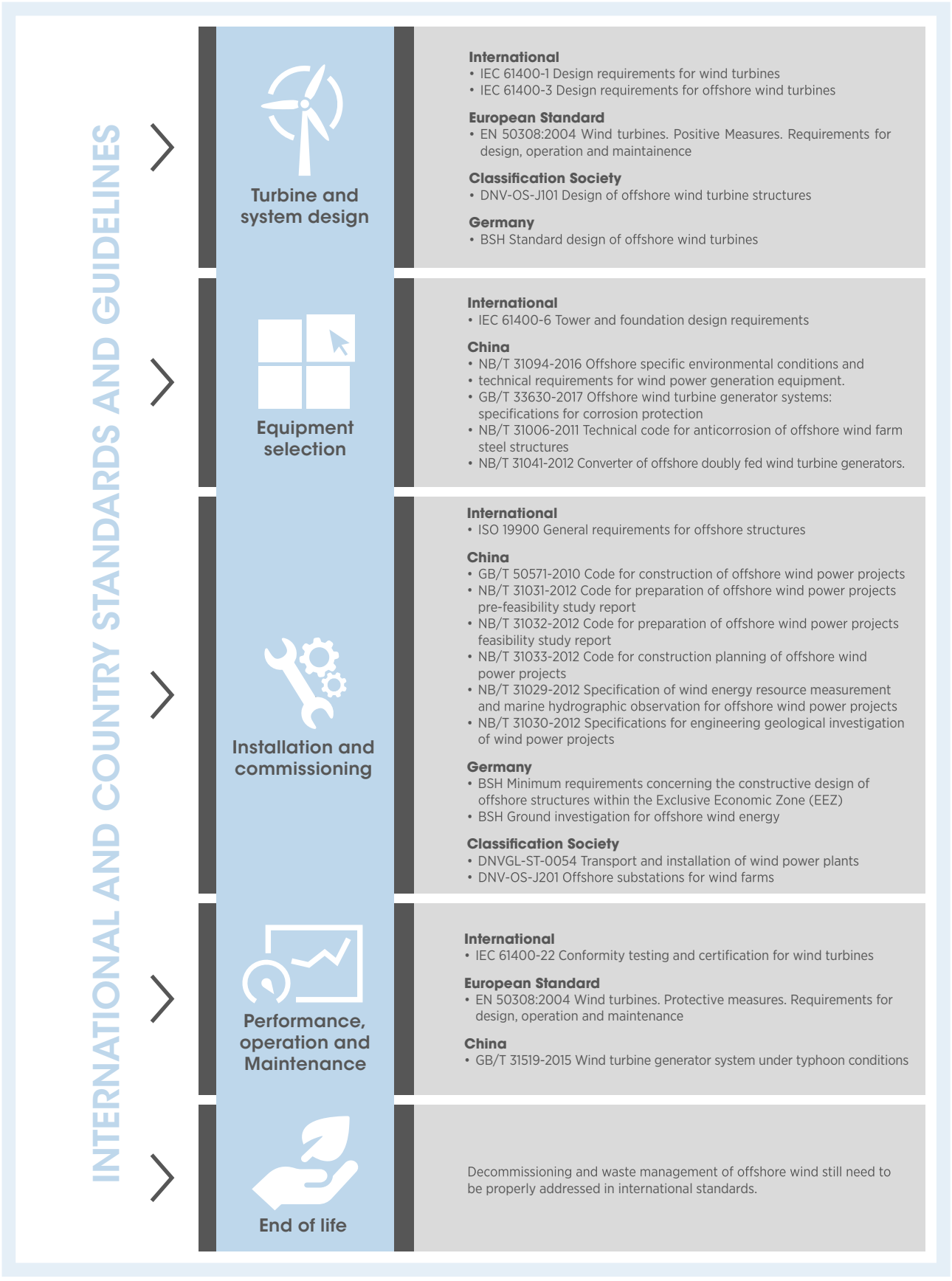
Countries such as Australia, Canada, China, Turkey and the US have ambitious plans to develop their offshore wind markets over the next few years. This market expansion comes with new requirements that must be rapidly incorporated into international standards. For example, because the first offshore wind markets emerged in Europe – a region with relatively shallow waters (particularly in Denmark and Germany) – the focus was on fixed structures, and floating offshore wind turbines have emerged only recently. The standards for floating offshore wind are now being developed for markets with deeper waters (depths greater than 50 metres), such as Japan and the US.

Around 85% of the world's installed capacity for offshore wind is currently in Europe

Moreover, the climatic and natural conditions in Europe do not reflect the extreme conditions found in other parts of the world, leading to the need to adjust standards to address, for example, typhoons, cyclones, earthquakes and icing. In the case of China, the offshore wind industry started by applying components and equipment used in other industries. As such, the industrial supply chain for offshore wind power is focusing on technology development of specialised installation equipment (e.g., vessels) and methods tailored for national conditions.

The international standardisation bodies – the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO) – are key actors for the offshore wind industry. These organisations need to be supported to be able to respond at the speed needed by the rapidly growing offshore wind market. Private actors as well as classification societies are active in setting organisations' standards and guidelines, which serve the industry as international standardisation work evolves. Private actors also provide input to international standardisation bodies through the technical committees of these bodies. Figure 4 presents a, non-exhaustive, summary of the commonly used standards and technical guidelines in the offshore wind industry.

Figure 4: Standards and technical guidelines applicable to the offshore wind value chain



Note: This list comprises the standards discussed in this report; it is not exhaustive. For more details, refer to the standard-making body of a specific country or to the international standardisation bodies.

Standardisation in offshore wind will be crucial to spur widespread deployment of this technology in the future.

Key messages in this study arise from the work developed by the front runners in offshore wind markets. The points below provide a summary of the state of international good practices in standardisation and outline the opportunities for the future trajectory of standardisation in offshore wind.

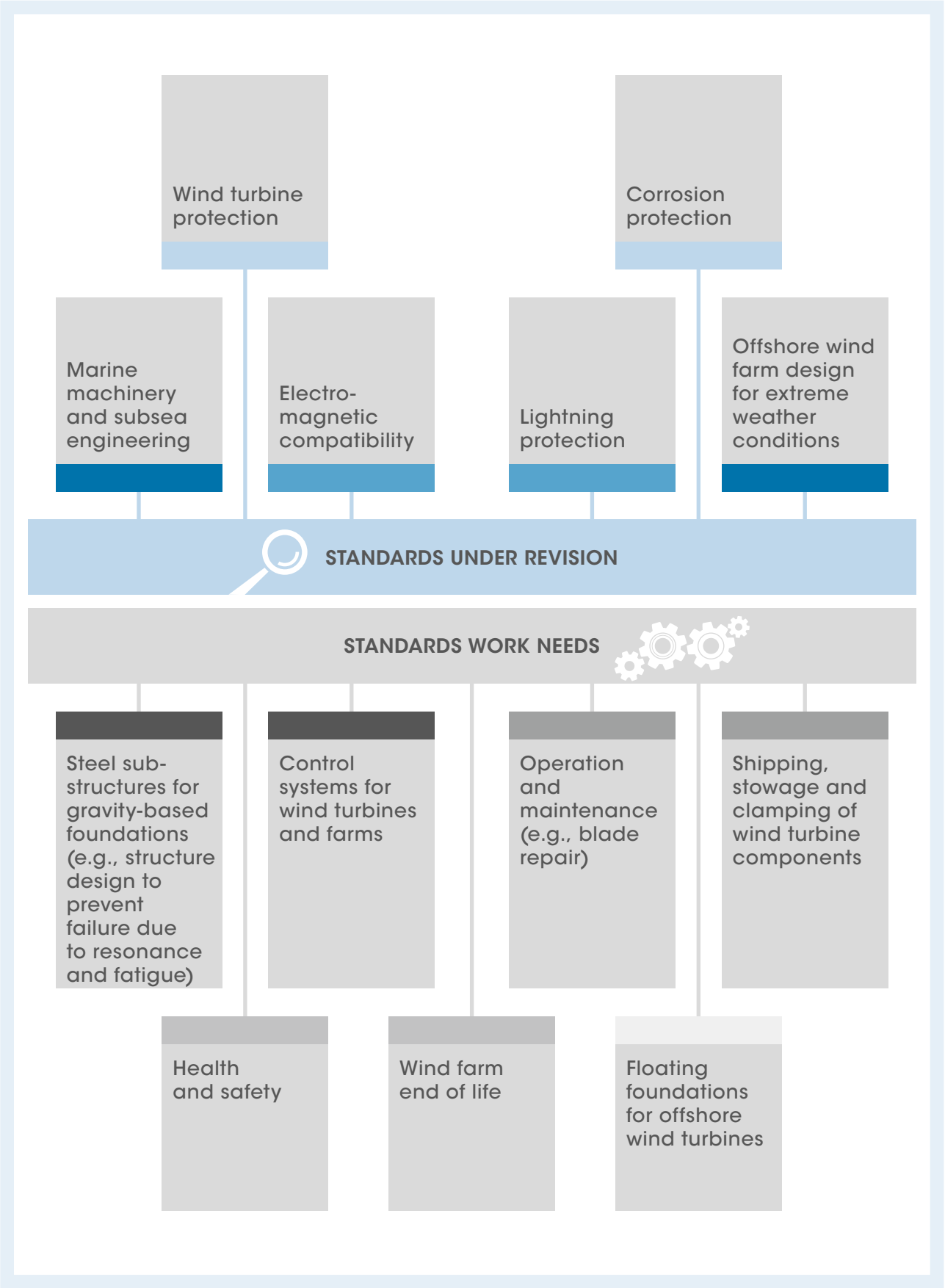
- **Standards developed through an engaging and consensus-based approach can facilitate innovation in the sector.** New offshore wind technologies can better compete in globalised markets if requirements are harmonised and if safety and performance are quality assured. Furthermore, some standards developers and certification bodies have developed concepts of certifying innovative components by using risk-based certification of innovative designs.

- **Quality infrastructure has to be in place to operationalise standards.** In order to implement and verify that requirements in standards are met, there is a need for quality infrastructure (QI). QI includes metrology, testing, certification and accreditation services that support industry, regulations and end-users.

- **Lessons learned from the offshore oil and gas sectors offer opportunities, but they cannot be applied one-to-one to develop offshore wind standards.**

- **To keep up with the market pace and with technology developments,** a number of standards are already being updated. Also, further work is needed for offshore wind standards focused on components and equipment tailored to industry needs. Figure 5 depicts the standards under update and areas where additional work is needed for the offshore wind industry.

Figure 5: Standards work



- **Health and safety standards and regulations are expected to accelerate standardisation and innovation in other areas as well.** Health and safety requirements lead to the development of new installation vessels, infrastructure in quays and automated production processes. Some national markets adopted health and safety standards from other offshore sectors, such as oil and natural gas, early on, but it became obvious that there was a need for advanced health and safety regulations beyond what had been developed. These efforts have been fruitful, although work is still required to create harmonised international health and safety standards for offshore wind.

- **International offshore wind standards need to incorporate weather and natural conditions of new markets.** Aspects such as earthquakes, severe storms and icing on lakes need to be taken into account in international standards. This is understandable, as the majority of existing standards were initially developed for European conditions, which can differ from those elsewhere.

Standardisation efforts must be supported and strengthened to keep up with state-of-the-art technology

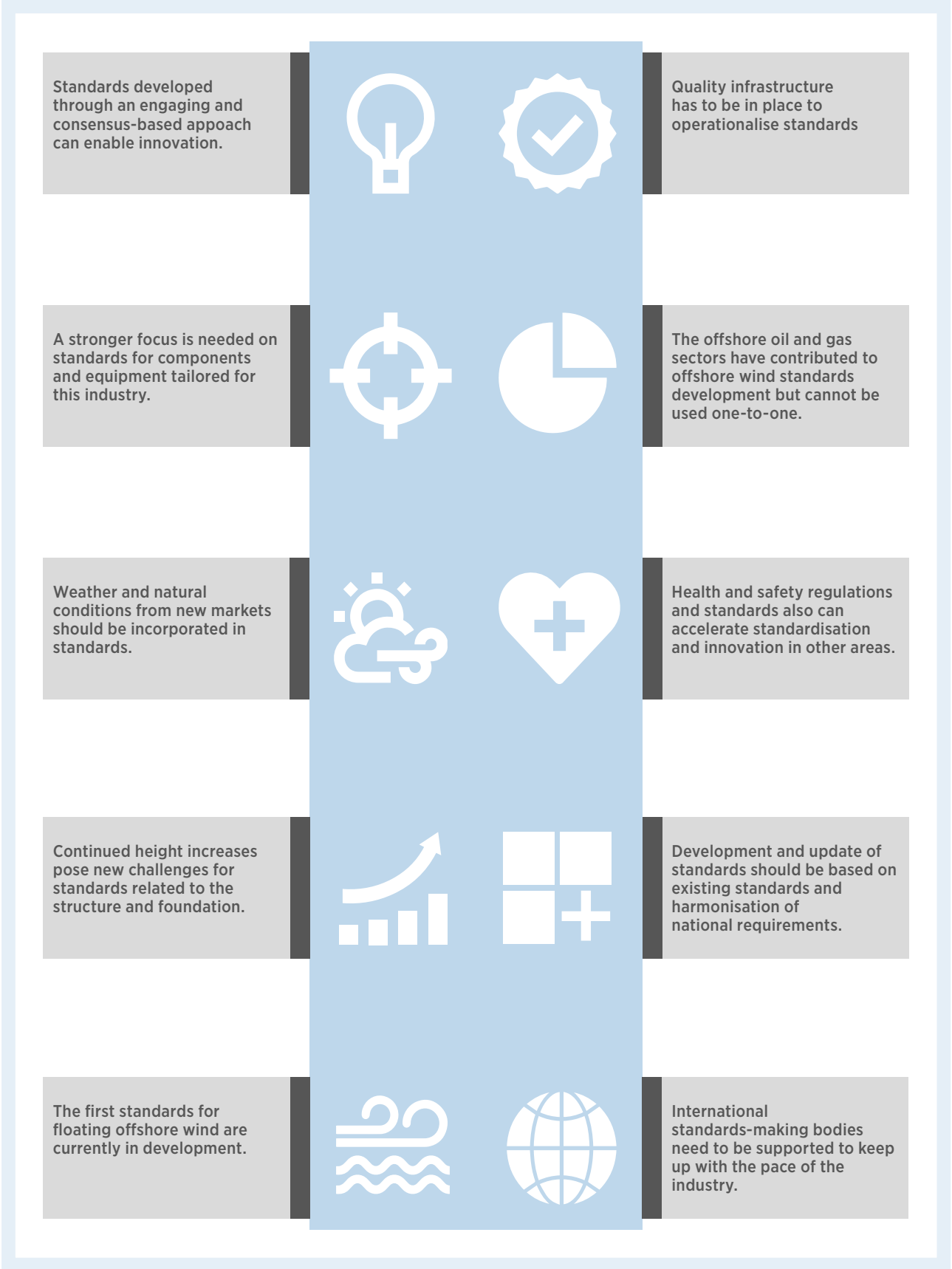
- **New developments in standards should take as their base existing standards and harmonisation of national requirements,** balancing between market needs and not adding specifications that may limit the potential of developers to innovate or optimise their projects. Harmonising requirements and reflecting this in international standards and certifications is key. An example provided by interviewed experts is to harmonise the national requirements for turbine certification, easing the deployment of cross-border projects.

- **As the height of structures such as monopiles continues to increase, this poses new challenges for structure- and foundation-related standardisation.** Standards-making bodies and classification societies are starting to develop new standards to provide solutions in the context of tilt tolerances and stability. Floating foundations can be an alternative solution, as they rely on mooring adjustments.

- **Standards for floating offshore wind** are needed for markets with deep waters and are currently in development. In the IEC, the sub-committee TC 88/PT 61400-3-2 is working on standards for the 'Design requirements for floating offshore wind turbines'. The aim of the work is to minimise the technical risks for this technology, facilitating its scale-up. The sub-committee is at present led by the USA and Korea. It includes experts from European countries, like Germany, Denmark, Netherlands, United Kingdom, Spain, France and Norway, as well as from other countries with a potential market for this technology, such as Japan, China, Korea and South Africa.

- **International standards-making bodies need to be supported to keep up with the pace of the industry.** International standards are developed under a transparent and inclusive process. These bodies require support from countries, for example by sending experts to technical committees and by ensuring that their local conditions are reflected in international standards.

Figure 6: Nurturing offshore wind markets



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