SME GROWTH PLATFORM REPORT

CATAPULT
Offshore Renewable Energy

An innovator's guide to

THE OFFSHORE WIND MARKET

IMAGE: Burbo Bank

CONTENTS

MARKET OVERVIEW

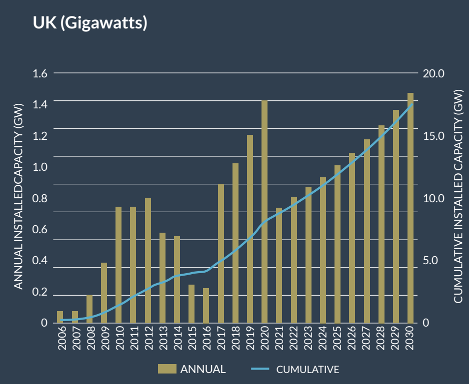
SIZE

29,147MW

Planned offshore wind capacity in the UK
at the end of 2017

6,737MW

Installed offshore wind capacity in the UK
at the end of 2017

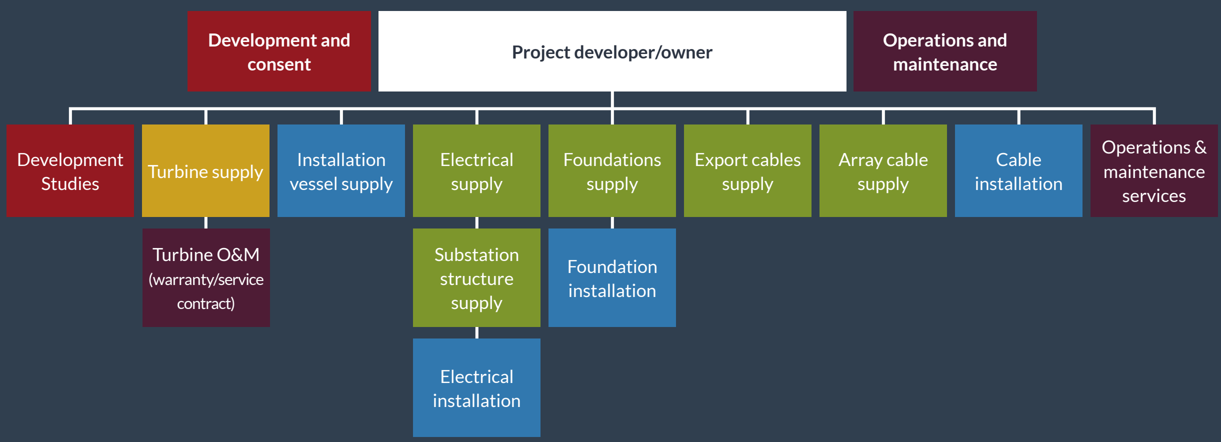


36%

UK's share of the global offshore wind market

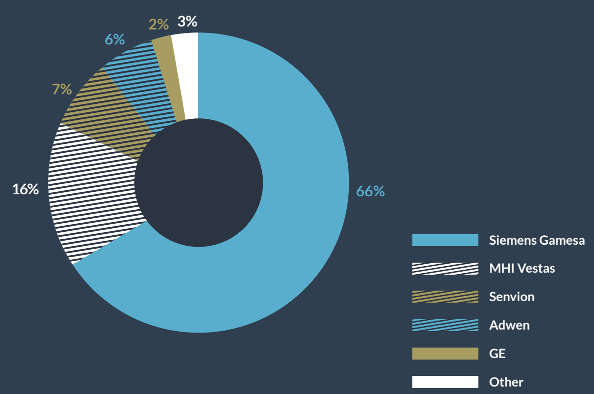
STRUCTURE

Innovators will need to consider the structure and dynamics of their customer's activities and relationships with other stakeholders in order to best target sales



TURBINE MANUFACTURERS

The market for offshore wind turbines is dominated by Siemens Gamesa and MHI Vestas, who have been responsible for most installed capacity to date



INDUSTRY TRENDS

Larger, more efficient turbines, increased power output and less offshore structures

Increased technological capabilities of turbines

Deeper waters, further from shore

Rapid reduction in levelised cost of energy (LCoE) through technology innovation

1 INTRODUCTION

This document is a source of information for innovators looking to develop business in the offshore wind industry. It contains useful market insights to support a business case or to help with writing a technology funding application. The document is designed to be used as a reference guide and is produced from a combination of publically available material and Offshore Renewable Energy (ORE) Catapult internal sources. The document also provides links to recommended resources and detailed information specific to individual topics throughout.

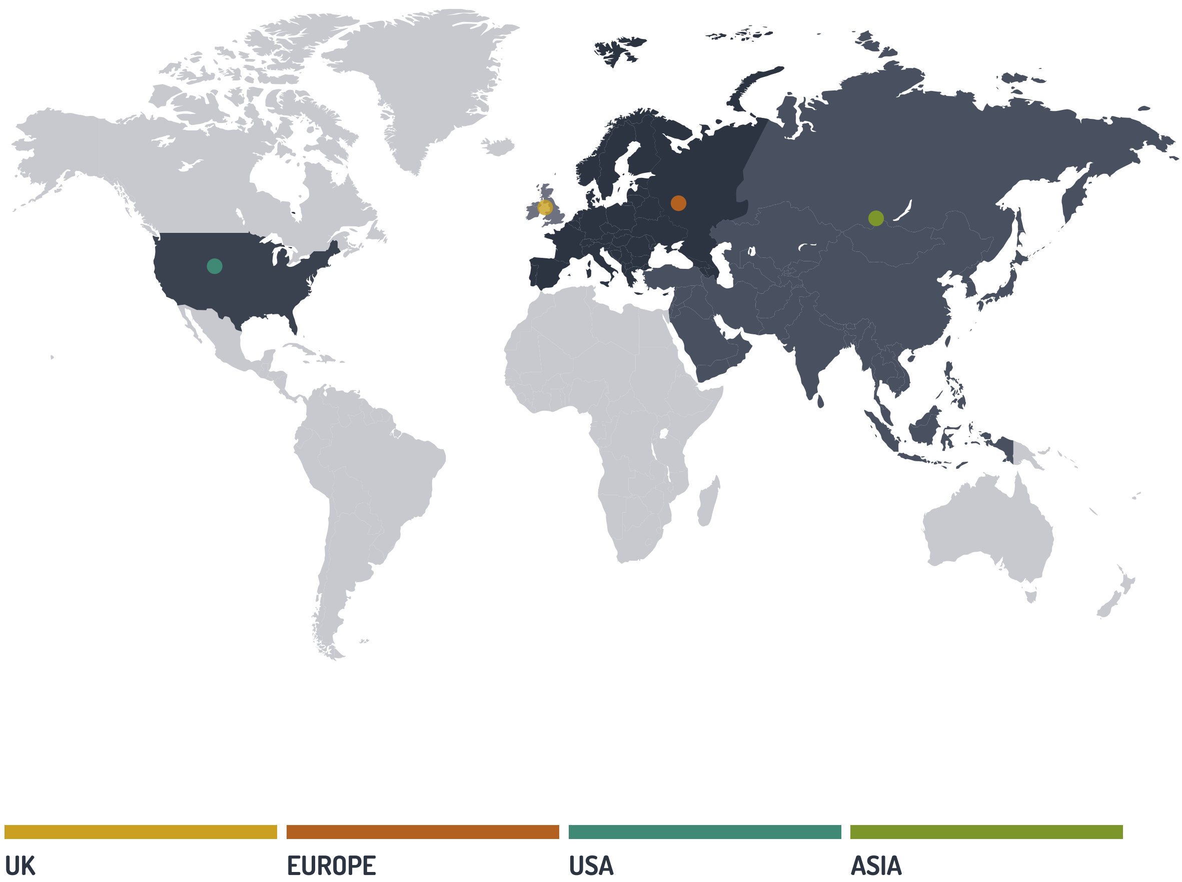
1.1 THE OFFSHORE WIND INDUSTRY

The offshore wind industry was developed in the UK and continental Europe, where early projects utilised marinised versions of onshore wind turbines. Technology has progressed rapidly and the wind farms of today are typified by:

- The use of larger, more efficient turbines to increase the power output and decrease the amount of structures required offshore
- Siting in deeper waters, further from shore to exploit areas with higher wind resources
- A rapid reduction in the through life costs or levelised cost of energy (LCoE) to reach energy prices that are competitive with conventional thermal power generation
- Increased technological capabilities of turbines and their supporting infrastructure.

2 GLOBAL MARKET GROWTH

This section provides an overview of key offshore wind markets and reference sources for market data. This will support innovators with business case development.



2.1 UNITED KINGDOM

2.1.1 OVERVIEW

The UK leads the world in both installed and planned offshore wind capacity, with 6737 MW installed generating capacity and 29,147MW in planning at the end of 2017. It represented 36% of the global market, by installed capacity, at the end of 2017. The expansion is driven by Government policy on economic development, energy security, energy affordability and decarbonisation. The UK is committed to delivering 15% of its total energy consumption from renewable energy by 2020, which translates into approximately 30% of electricity generation. Offshore wind is a cornerstone to achieving this through its scalability and affordability.

2.1.2 MARKET SIZE

Figure 1 presents annual and cumulative offshore wind market forecasts for the UK. The slowdown in development post 2020 is partially due to the structure of the UK development rounds and also due to a lower certainty on construction dates for projects to be constructed in the 2020s. The charts display both the scale of the market in gigawatts (GW) installed and by number of turbines. Innovator's will need to understand whether the market size for a given technology is defined by the number of turbines or by the number of GW installed.

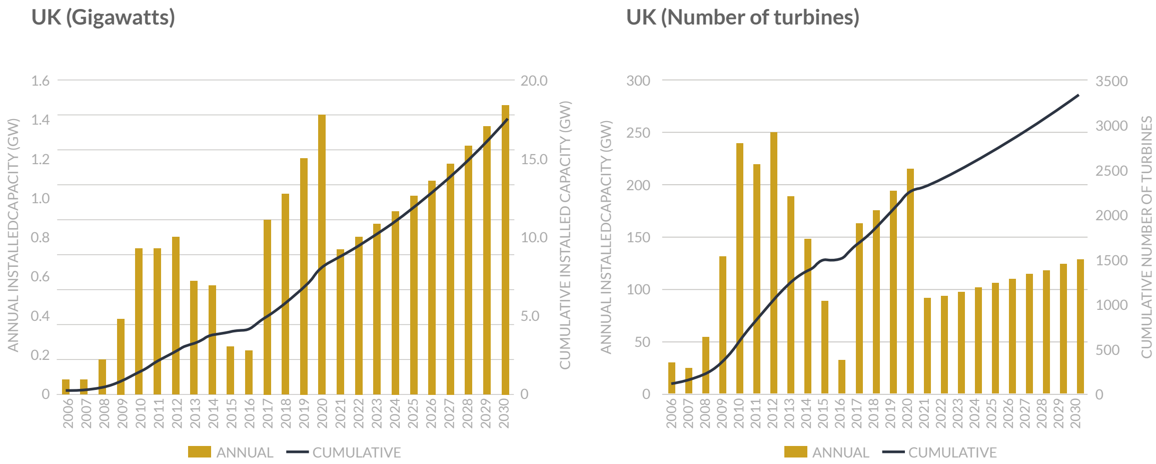


Figure 1: *UK offshore wind market size by MW and by number of turbines* (source: 4C Offshore wind farm database)

2.2.1 PIPELINE

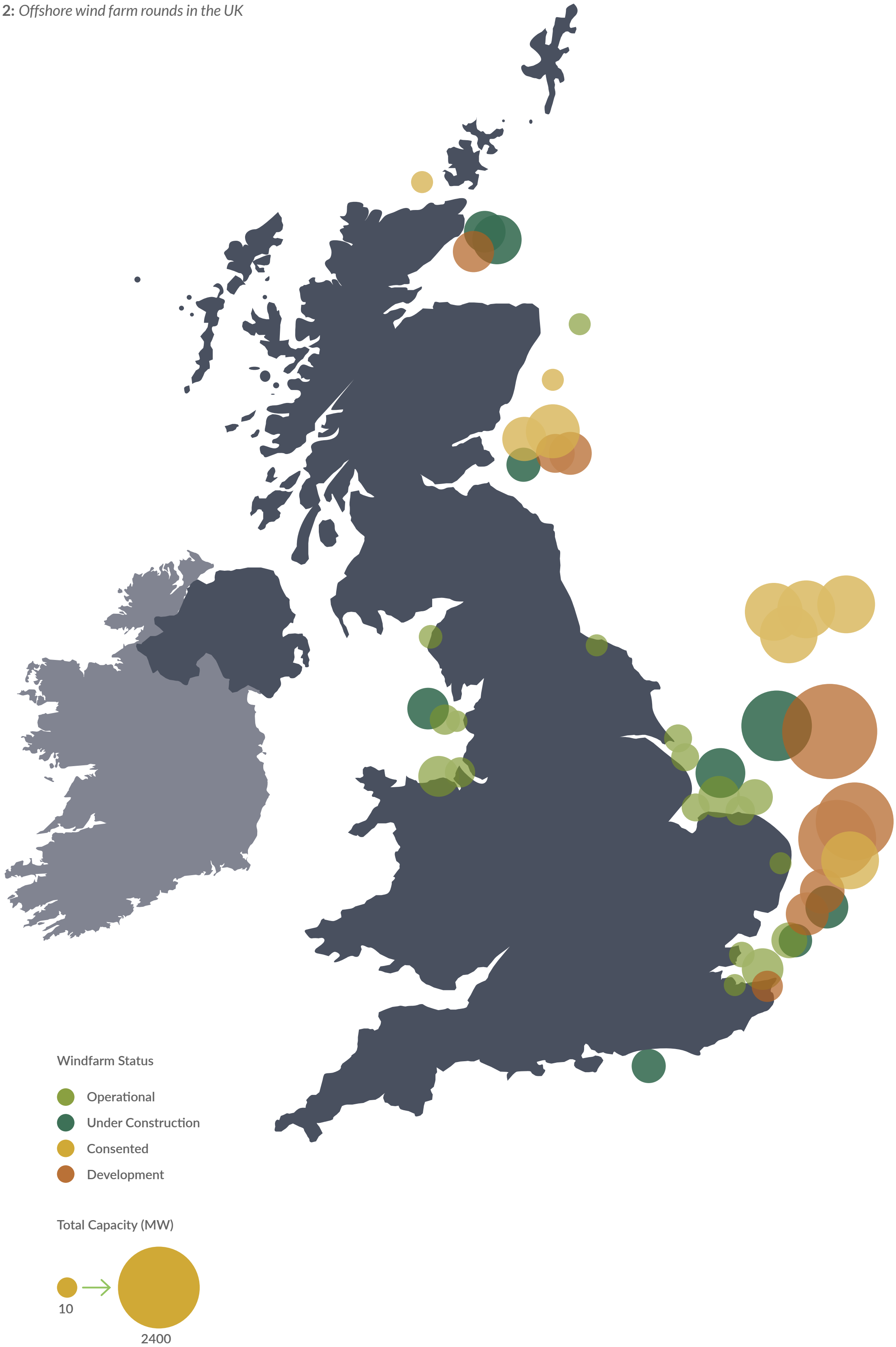
The UK project pipeline was announced in a series of leasing rounds between 2000-2009, enabling project developers to secure sites competitively. Rounds 1-3 (plus extensions) and Scottish Territorial Waters sites are highlighted on the map in **Figure 2**.

Round one and two sites exploited sites close to shore (0.5-22nm) and in relatively shallow water depths (0.5-38m). Most sites were located off the east coast of the UK, where favourable seabed and logistical conditions prevailed. Round 3 contained much larger sites, further from shore (upwards of 200nm) and were mainly located off the East coast, in the North Sea. Deep (>100m) Atlantic waters prevented early development of sites off the west coast with higher wind speeds. This was due to the requirement for deep-water foundation technology that at the time was in the very early stages of development.

For an overview of specific UK project timelines, please see the periodic **Renewable UK Offshore Wind Project Timelines** publication.

Innovators with a longer time horizon that are looking beyond commercial projects already in development, should consider **The Offshore Valuation (2050)**, published in 2010. The study provides a detailed analysis of the potential for offshore renewables beyond round 3 in the UK, where new technologies for deeper water sites, further from shore, will be required.

Figure 2: *Offshore wind farm rounds in the UK*



2.3 REST OF EUROPE

2.3.1 OVERVIEW

Europe (including the UK) represents 51% of the global offshore wind market, with 9,096 MW installed and 34,733MW of planned generating capacity at the end of 2017. The EU has a collective target of 20% of its final energy consumption from renewable energy by 2020 and 27% by 2030, which is driving member states with coastlines to develop offshore wind technology.

Continental Europe is home to the majority of offshore wind technology Original Equipment Manufacturers (OEMs), having grown out of indigenous onshore wind and offshore engineering industries. High market visibility and strong forecast growth has enabled the continental supply chain to make significant investments in infrastructure, allowing it to lead by reducing costs through increased economies of scale, technical learning and competition. This strength typically makes it more challenging for innovators to enter the market if they don't have a pre-existing relationship with potential customers on the continent.

For country-specific market forecasts and supply chain information, please see the Oil and Gas 'Seize the Opportunity' Guide from Scottish Enterprise.

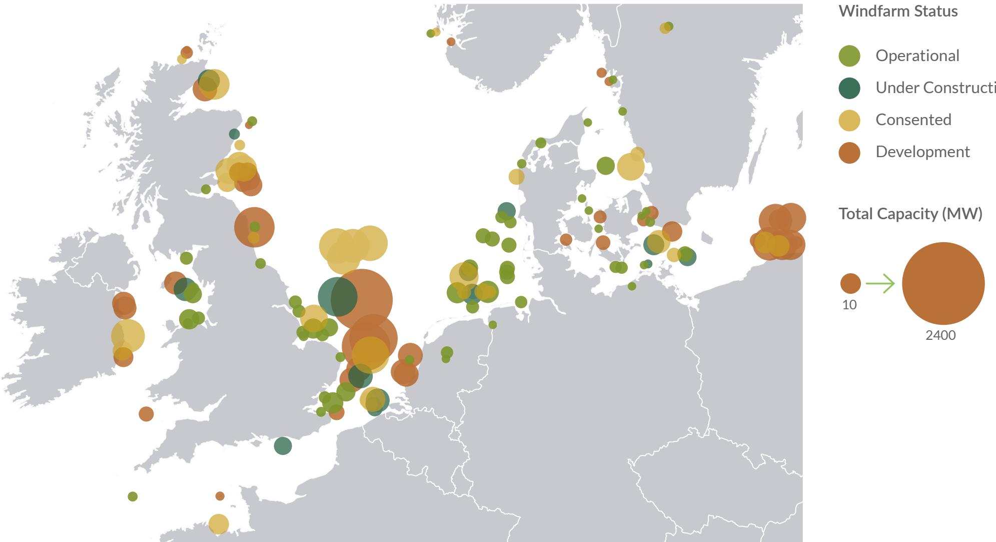


Figure 4: *Offshore wind farms in Europe* (Source: 4C Offshore)

2.3.2 PIPELINE

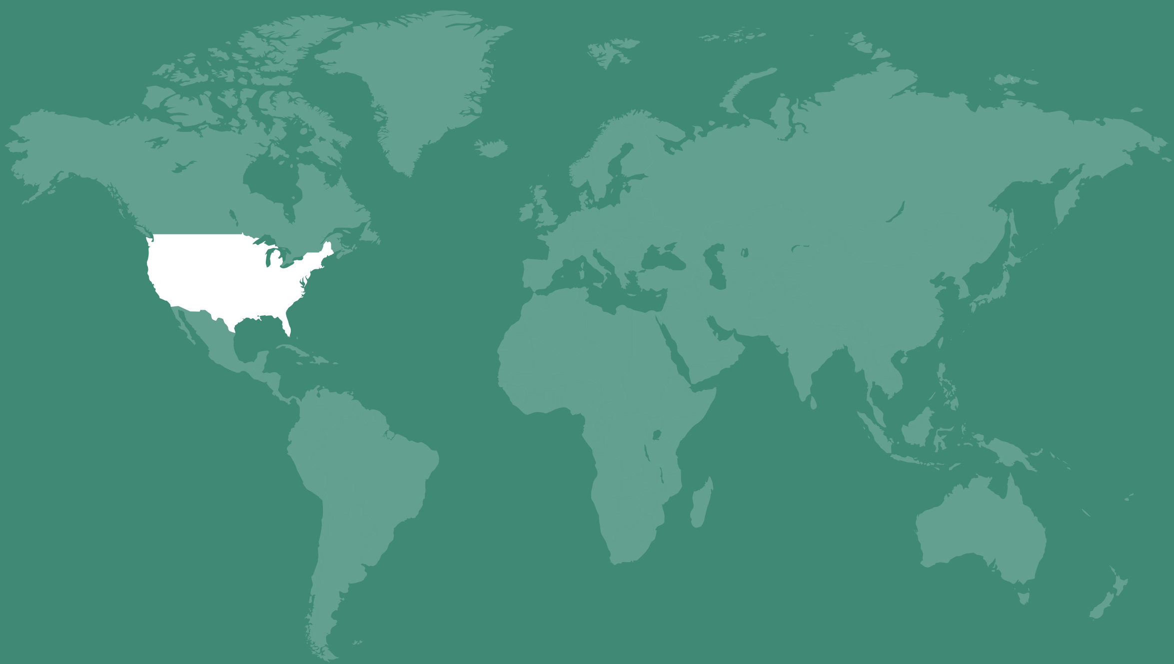
After the UK, Germany leads European installed capacity with projects in the North Sea and Baltic Sea. Denmark is the most mature market and is home to much of the supply chain but future national growth is relatively limited. Denmark has small site allocations to 2030 and a high penetration of intermittent renewable energy already on its grid.

The Baltic Sea is experiencing rapid development in the West from Germany and Poland however the Baltic and Nordic states lag development. Slow uptake is caused by a number of factors including the availability of alternative cheaper sources of renewable energy, lacking political incentives to back a non-indigenous industry and technical challenges related to colder climates.

For detailed European market forecasts, see Appendix 1: Further market data. Please also see the most recent statistics from WindEurope for country-specific pipeline information and frequently updated market data. For anticipated future pipeline scenarios see the WindEurope report Wind energy in Europe: Scenarios for 2030.

For innovators with a longer time horizon that are looking beyond projects already announced, market estimates can be formulated from the WindEurope study Unleashing Europe's Offshore Wind potential.

2.4 UNITED STATES OF AMERICA



2.4.1 OVERVIEW

The United States of America (US) has 30MW of installed generating capacity and 21,700MW in planning at the end of 2017. It represented 0.02% of the global market, by installed capacity, at the end of 2017, but is expected to rapidly pick up pace.

The US has lagged behind Europe in development of offshore wind. This is largely due to a strong supply of cheaper onshore renewable energy alternatives, a lack of incentives for offshore renewables and site characteristics that are technically challenging due to ground conditions and deep waters. The market is now picking up pace, with evidence from Europe that technology costs are falling and strong government support via state-level mandates for offshore wind procurement.

2.4.2 PIPELINE

The focus of offshore wind activity in the US is off the Eastern seaboard. The first operational offshore wind farm is the 30MW Block Island Wind Farm, which reached first power in December 2016. Site types on the West coast require deep-water foundation solutions, representing a good opportunity for floating foundation technology providers.

The National Offshore Wind Strategy from the Bureau of Ocean Energy Management (BOEM) maps out US ambitions for offshore wind and the Department of Energy's publication Wind Vision: A New Era for Wind Power in the United States, outlines a deployment scenario of 86 GW of offshore wind by 2050. As of March 2017, the BOEM held seven competitive auctions for project developers to purchase sites. For detailed information on the US market and its pipeline, please see the National Renewable Energy Laboratory 2016 Offshore Wind Technologies report.

For detailed US market forecasts, see Appendix 1: Further market data. Please also see market reports from the American Wind Energy Association, for more information about the US offshore wind pipeline. There is also a host of publications at the state-level e.g. the New York State Offshore Wind Master Plan.

2.5 ASIA

2.5.1 OVERVIEW

Asia's offshore wind market is rapidly emerging. Asia had 2,164MW installed generating capacity and 72,000MW in planning at the end of 2017. It represented 12% of the global market, by installed capacity, at the end of 2017.

China leads Asia's offshore wind market by installed capacity with 1,943MW installed in the South China Sea to date. Japan also had an installed capacity of 72.73MW at the end of 2017. India, Taiwan, South Korea and Vietnam have begun activity in offshore wind either by auctioning sites or developing Government strategies. The site conditions in many Asian locations drive different technology requirements. Japan and India for example have deep water sites (greater than 50m) and are subject to typhoon conditions.

Asian manufacturers offer lower cost alternative technologies to the European supply chain. There is a significant opportunity for UK innovators to break into these markets due to local appetite for new solutions and low presence of European competitors. Asian turbine manufacturers are mostly located in China and include Goldwind, Shanghai Electric (manufacturing under license agreement from Siemens Gamesa) and Sinovel.

2.5.2 PIPELINE

China has set a target of 5GW of offshore wind by 2020 in its **Five Year Plan (2016)**.
Fuelled by concerns of a further disaster like Fukishima in 2011, both the Japanese and Taiwanese governments have implemented renewable energy plans that include offshore wind. Taiwan is aiming for 9.95GW of capacity by 2030, through the 2009 Renewable Energy Development Act (REDA). For detailed information on the Japanese market, please see the **Appraisal of the Offshore Wind Industry in Japan** from the Carbon Trust.

India is yet to build an offshore wind farm but has a healthy onshore wind market. There is rumour of a 5GW offshore wind auction in 2018. For more information on India's market, please see the **Supply Chain, Port Infrastructure and Logistics Study** from the Facilitating Offshore Wind in India (FOWIND) group.

For detailed Asian market forecasts, see Appendix 1: Further market data. Please also see the Global Wind Energy Council's **series of publications**, for more detailed market data and information about global onshore and offshore wind markets.

3 MARKET STRUCTURE

This section provides an overview of the structure of the market and the supply chain, to support innovators to identify routes to market.

3.1 WIND FARM PROJECT LIFECYCLE

Figure 5 outlines a typical wind farm project lifecycle. Associated cost breakdowns are provided for a reference 500MW site, sourced from the Oil and Gas 'Seize the Opportunity' Guide from Scottish Enterprise.

PROJECT					
Development and consent	Turbine manufacture	Balance of plant manufacture	Installation and commissioning	Operations and maintenance	Decomissioning
3% of LCoE	25% of LCoE	17% of LCoE	11% of LCoE	40% of LCoE	4% of LCoE
5+ Years CAPEX				up to 25 years OPEX	Up to 3 years DECEX

Figure 5: *Offshore wind farm project lifecycle* (Source: ORE Catapult and Scottish Enterprise)

Contracts for manufacture and construction are usually signed two years before construction although in some cases, large supply contracts are sourced earlier via strategic framework agreements or strategic company alliances. For example, Orsted signed a supply agreement with Siemens Gamesa for its SWT-6.0 turbine. The manufacture of balance of plant equipment and installation services may be signed later than turbines but designs are finalised early on in this process. Innovators will need to consider these long-term relationships when approaching customers.

For commercial projects, project developers have contracts with turbine OEMs for supply of established turbine products with a proven track record. The supply chain for commercially available turbines is largely established and closed to new suppliers. Innovators will need to understand whether next generation turbines (and therefore different teams within the OEM) present a greater opportunity for market entry.

The construction phase of an offshore wind farm (turbine manufacturer, balance of plant manufacture and installation) is the most capital intensive, with ~53% of LCoE spent over a brief period of 1-3 years. Although LCoE is decreasing across the industry, CAPEX is trending upwards as the industry builds larger, more efficient and hi-tech turbines.

For more details on project costs, please see the ORE Catapult Offshore Wind Cost Reduction report and the ORE Catapult Cost Reduction Monitoring Framework 2016.

3.2 LOCATION BIAS

The physical demands of product scale and manufacturing volumes mean that large portions of the supply chain are co-located close to tier one manufacturers. Construction bases and assembly facilities are also often created close to projects. Installers require the majority of components to be ready prior to project construction to reduce risks to the offshore deployment programme.

To date, turbine manufacturers sought significant quayside facilities in the UK, to extend their established operations in continental Europe (North Germany and Denmark) and to serve UK project construction. This enables them to manufacture and assemble large components such as blades and towers. Their existing supply chains in continental Europe are largely still intact. Siemens Gamesa has a manufacturing facility in Hull and MHI Vestas is based on the Isle of Wight.

The same requirement for quayside space and colocation to projects applies to other large components such as foundations and electrical infrastructure. Suppliers with large components that cannot be transported by road must have quayside access and there will be a significant benefit for an innovator to be located nearby. O&M ports are located as close to a project as possible and have an ongoing demand for goods and services for over 25 years.

Country-specific factors also drive different behaviours in some markets. For example, the USA imposes high taxes on imported products so the incentive for local manufacture and vessel supply is greater. This can also change technology requirements. For example, the lack of available jack-up vessels in the USA could incentivise innovation in novel floating installation solutions that utilise lower cost barges.

3.3 CONTRACTING

Figure 6 provides a breakdown of a typical offshore wind project supply chain, with a multi-contract structure.

Developers of early UK wind farms used Engineering Procurement Contractor (EPC) contracts (e.g. SSE and Fluor at Greater Gabbard), typical in the Oil and Gas industry. The industry has transitioned away from single wind farm EPC contracts in an attempt to cut costs and to avoid placing too much risk on the prime contractor. Wind farms developers have trended towards use of multi-contract strategies with eight to ten packages for design, manufacture and installation of an offshore wind farm.

Project developers vary in approaches to contracting and managing the supply chain. Developers such as Orsted view contract management as one of its competitive advantages. It drives down project costs by dealing with the supply chain directly, where a project could contain 50+ contracts. Others, such as Iberdrola, work with fewer larger suppliers, limiting exposure to lower tiers of the supply chain. For project-specific opportunities, an innovator needs to consider the nature of a developer's approach and to understand whether it should deepen its relationship with the developer or instead work directly with the supply chain.

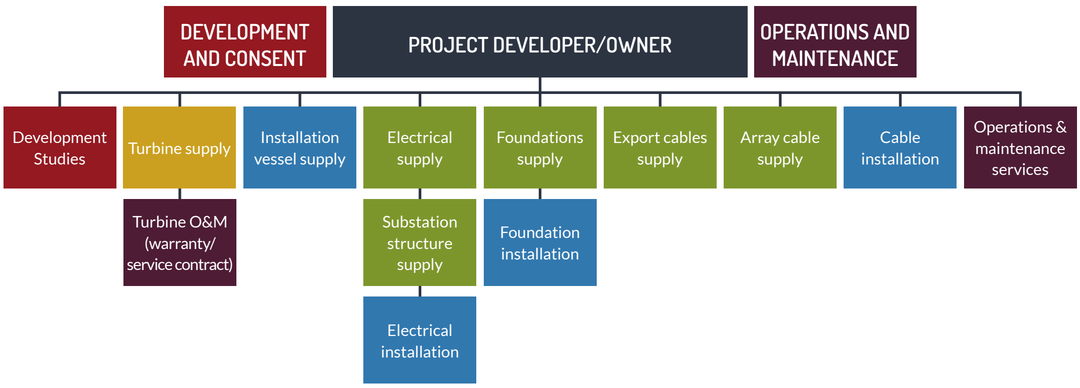


Figure 6: *A typical offshore wind farm multi-contract structure*

Figure 7 provides an overview of the main ways in which an innovator could contract with a customer in the supply chain.

Contract type	Description
Framework	Often covers more than one project and allows the prime contractor to secure supply of critical products or services.
OEM design win	Design is often unique to an OEM product and may be single sourced. Strong relationship with OEM required.
Project contract	Project developer (in most cases) will hold a pre-qualification process before competitive tender. Contract often provided for project duration.
Project sourced	Sourced competitively by project developer, often with a local bias.
Subcontract	Usually sourced on a competitive basis by the tier one OEM and provided based on an OEM design.

Figure 7: *Common types of contracts in the offshore wind industry*

Category	Typical procurement model	Procurement approach
Development and consent	Development services	Project sourced and project contracts
	Environmental surveys and analysis	Project sourced and project contracts
	Coastal process surveys	Project sourced and project contracts
	Met station supply and install	Project contract
	Sea bed surveys	Project sourced and project contracts
	Front-end engineering and design	Project sourced
	Human impact studies	Project sourced
Turbine manufacture	Blades	In house, OEM design win or subcontracted
	Hub casting	Subcontracted
	Gearbox	OEM design win
	Generators (inc. direct drive)	OEM design win
	Electrical power and control systems	OEM design win
	Nacelle cover and spinner	OEM design win or subcontracted
	Tower	Subcontracted
Balance of plant manufacture	Foundations	Project contract
	Offshore electrical	Project contract
	Onshore electrical	Project contract
	Subsea cables	Project contract
Installation and commissioning	Turbines	Project or framework contract
	Foundations	Project or framework contract
	Offshore electrical	Project or framework contract
	Subsea cable	Project or framework contract
	Vessels and equipment supply	Project or framework contract
	Construction port services	Strategic agreement or project contract
Operation and maintenance	Remote monitoring	Framework or warranty
	Operations management	In house, framework or warranty
	Port services	Framework or warranty
	Maintenance and service	Framework or warranty

Figure 8: *Differences between contract types for different products and services throughout the supply chain of an offshore wind project.*

For more information on the offshore wind supply chain, please see The Crown Estate report The UK Offshore Wind Supply Chain: A Review of Opportunities and Barriers and the Oil and Gas 'Seize the Opportunity' Guide from Scottish Enterprise.

3.4 REGULATION

3.4.1 PLANNING

In England, Wales and Northern Ireland, The Crown Estate is the landowner of the UK seabed to 12 nautical miles from shoree (in Scotland it is Crown Estate Scotland) and has the rights to explore resources off the continental shelf (excluding fossil fuels). The Energy Act 2004 gives The Crown Estate rights to license construction of renewable energy assets within the Renewable Energy Zone out to 200 nautical miles. Project developers must secure a lease from The Crown Estate (or Marine Scotland in Scotland) before developing a site in the UK.

Planning activities in Europe vary by country and a typical planning process is provided in **Figure 9**. A notable trend across Europe is the socialisation of project development costs in Denmark and the Netherlands (Lithuania also recently announced it will nationalise the planning process). In Denmark, there are defined development zones where initial environmental assessments, geotechnical surveys, wind resource assessments, and meteorological (met) ocean condition studies are implemented prior to holding auctions for development rights. The reason for this was to encourage market growth by reducing the development risk for project developers that on larger projects would need to commit €50m or more in the five or more years prior to construction, with the risk of not achieving a subsidy afterwards.

INITIAL PLANNING	PERMISSION	SUPPLIER MANAGEMENT	FINANCING	INSTALLATION AND CONSTRUCTION
• Identify suitable area • Wind resource assessment • Ground studies • Wind farm layout optimization	• Apply to permitting authority • Conduct environmental studies	• Identify suppliers • Negotiate terms • Allocate contracting risks • Develop installation and logistics concepts • Develop O&M concepts	• Optimize project structure • Prepare financial model for investors • Approach institutional investors • Negotiate financing deal • Financial close	• Align installation schedule with manufacturing schedule • Manage and mitigate contracting interface risks • Commission wind farm
1-3 YEARS	1-2 YEARS	1-2 YEARS	1-2 YEARS	1-2 YEARS
In countries that socialise the development cost of an offshore wind farm (e.g. Denmark), sites are auctioned with much of the site feasibility work already complete		Many national governments encourage the use of local suppliers in wind farm developments so native companies may often be preferential		Different countries and regions will sometimes have location-specific requirements e.g. piling noise mitigation for areas with protected mammals

Figure 9: *Typical offshore wind planning timeline*

3.4.2 CONSTRUCTION & OPERATION

Construction and operation of offshore wind farms must follow a range of standards and guidelines. There are many standards specific to offshore construction that in many cases were developed for offshore oil and gas and have now been adopted in offshore wind. DNV-GL hosts these guidelines and they can be accessed via the **My DNV-GL** online repository. When project construction is complete, it must be certified by a certification body, such as Bureau Veritas, DNV-GL or Lloyds Register. These organisations will approve that a site adheres to offshore guidelines.

Innovators will need to consider the requirement for their technologies to meet relevant standards and health and safety requirements. It is also crucial to understand the impact of a technology on the entire project lifecycle, including the construction phase of a wind farm. Jack-up vessels used during construction can cost £250k per day, may be fully booked for two years in advance and require long weather windows in order to operate. The project developer takes this weather risk so if weather is particularly bad for an extended period, it can significantly impact project costs. For any technology that proposes an improvement to operational performance but increases installation time, the through-life impact must be assessed. The project lifetime benefit of the technology must then be made clear to a prospective customer.

For more information on jack-up vessels, see The Crown Estate report **Jack-up Vessel Optimisation**.

3.4.3 GOVERNMENT INCENTIVES

The global onshore and offshore wind industry has historically benefitted from government subsidies, usually provided on a per unit of electricity generated basis (Feed-in Tariffs). Provision of demand side support like this is designed to encourage development of new wind turbine technology and increases competitiveness with other energy technologies.

While some countries around the world still offer Feed-in tariffs, many European countries (including the UK, France, Germany and the Netherlands) have switched to Contract for Difference (CfD) mechanisms and most EU countries that are yet to implement a CfD system have one in planning. A CfD is a long-term contract between an electricity generator and a subsidy provider, agreeing to pay the generator a pre-agreed level (the Strike Price) for the duration of the contract. Payments can flow bi-directionally from the subsidy provider to the generator, and vice versa. It forces project developers to be more competitive, rather than follow a price set by a subsidy provider who may not have full view of project-specific economic factors. See **Figure 10** for an example of how this would work in practice, taken from a **UK Government White paper in 2011**.

3

MARKET STRUCTURE

Although European countries adopt open market rules, many European governments (including the UK) require evidence of local commitment to supply chain competition, innovation and skills alongside an application for a CfD. This provides an incentive to use local technologies.

CfD auctions have provided evidence that prices are trending downwards across Europe. UK project costs of £142/MWh in 2010-11 have fallen to an average of £60-70 per MWh in 2017 and projects in Germany and the Netherlands will now be constructed on a subsidy-free basis. It is important to note that these costs are predicated on future projections for projects that are expected to be in operation between 2020 and 2025.

Please see The New Economics of Offshore Wind, published by Aurora for more information on subsidy policy trends.

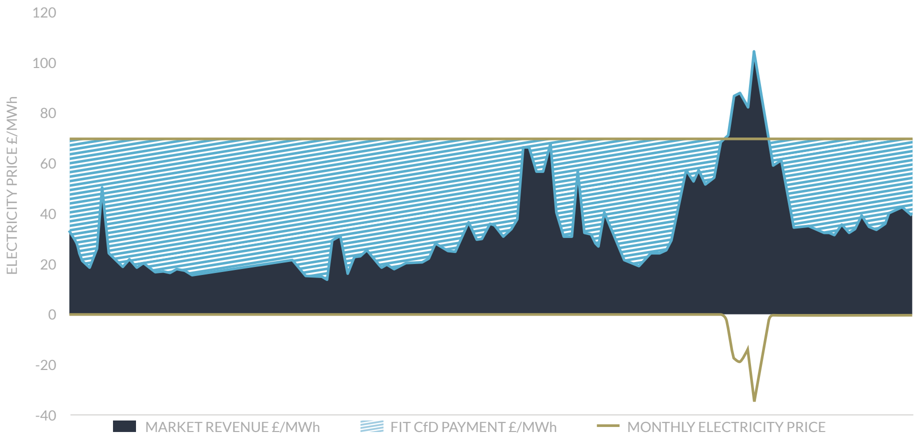


Figure 10: *Diagram of how a Contract for Difference mechanism works* (Source: Department for Energy and Climate Change White Paper 2011)

4 MARKET ENTRY

This section provides an overview of the key players and specific ways an innovator can take their technology to market.

4.1 CUSTOMER SEGMENTATION

Innovators will need to consider whether a project-specific sales opportunity (such as a solution to an engineering challenge on an offshore wind farm) or a more strategic relationship with the customer is more appropriate.

4.1.1 PROJECT DEVELOPERS AND OWNERS

Project developers follow a number of models to project ownership but typically will recycle capital by selling stakes in operational projects to develop further wind farms. The operational phase of an offshore wind farm presents lower financial risk than projects in development and construction, and ownership of offshore wind farms by institutional investors at the operational phase is becoming commonplace. This means that the majority project owner in some cases may not be the operator.

Figure 11 shows that the UK market is dominated by large utilities from across Europe, such as E.ON, Orsted, innogy, and Vattenfall. Early offshore wind farms were small enough to be taken forward by independent developers, who sold on the consented projects to larger companies but the large scale of recent UK projects makes this prohibitive. In continental Europe, there is a greater amount of independent developers and projects are in some instances divided into smaller sites, making it easier for independent developers to operate. The large size of round 3 projects in the UK has also led to joint ventures by project developers via a common service company, creating a greater number of organisations for an innovator to navigate.

Market share of offshore wind farm ownership (GW)

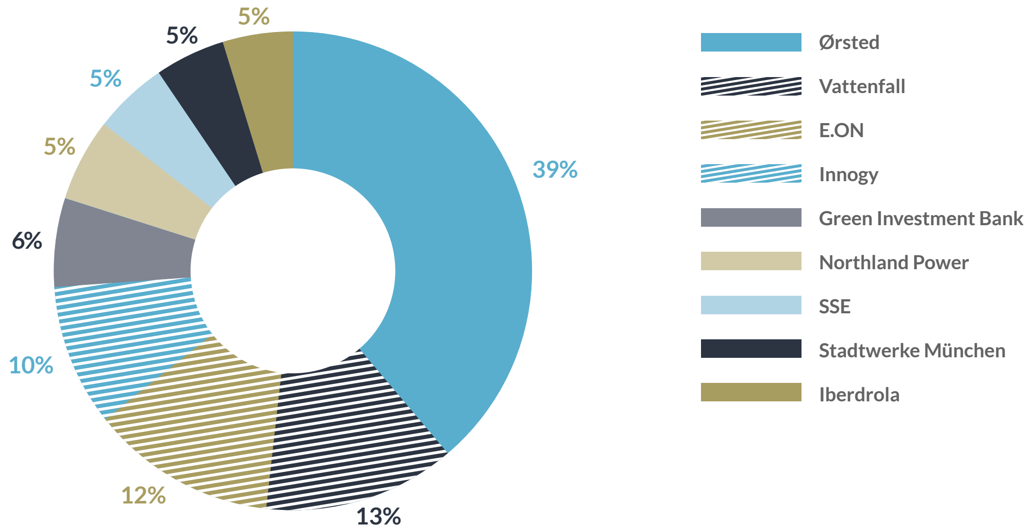


Figure 11: *Market share of offshore wind ownership, as of January 2018, including projects fully commissioned and under construction/ partial generation* (Source: 4C Offshore)

4 MARKET ENTRY

Wind turbine manufacturers typically sell turbines to project developers with a five-year warranty, which includes operation and maintenance (O&M) services. At the end of a warranty period, project owners will hold an end-of-warranty inspection campaign to assess the need for any final warranty repairs and to confirm plans for the next phase of O&M. After this period, the project developer will either deliver O&M in house, sign a long-term service agreement (LTSA) with the turbine manufacturer or contract out O&M to a third party Independent Service Provider (ISP). To date, the industry has adopted both in-house O&M and turbine OEM LTSA approaches but turnkey third-party maintenance is yet to materialise. There are also some hybrid models, where a project owner will retain OEM servicing agreements for certain components only, while following a different model for the rest of the wind farm. For projects owned through joint venture, it is most likely that the project owner will sign an LTSA with the turbine manufacturer.

Figure12 shows a European market forecast to 2030, staggered from the date of first power of a project to indicate when wind farms are likely to reach end of warranty. The data is based on ORE Catapult assumptions and factors in current trends in project-specific and company-specific approaches to O&M. These forecasts outline the opportunity for innovators with O&M technologies targeting projects post warranty.

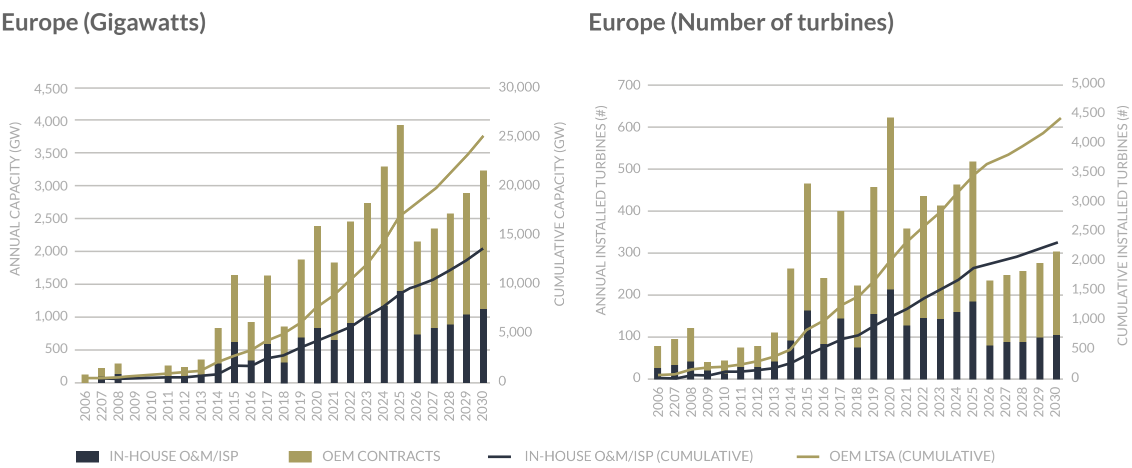


Figure 12: *European O&M market forecast for turbines coming out of warranty* (Source: ORE Catapult and 4C Offshore)

For more information on opportunities in operations and maintenance, see The Crown Estate Guide to Offshore wind Operations and Maintenance. Further data on O&M costs can be found in Future Renewable Energy Costs: Offshore Wind from KIC InnoEnergy.

4.1.2 TIER ONE MANUFACTURERS

Turbine manufacturers and other tier one manufacturers are large multinational corporations with multiple business units that an innovator may need to engage. Innovation teams will be interested in technology that adds value to future products, while manufacturing and servicing teams will be interested in technologies that are applicable to current commercial products. An innovator must consider its initial audience before promoting its technology.

The European offshore wind turbine market consolidated over recent years and a number of mergers and acquisitions have taken place. **Figure 13** shows that the market is dominated by Siemens Gamesa and MHI Vestas, which together have been responsible for most installed capacity to date. Both have Danish headquarters and UK facilities. Others with commercially available turbines are the Germany-based Senvion, and France-based GE Renewable Energy, which has acquired Alstom and LM Wind Power.

European turbine manufacturer market share (GW)

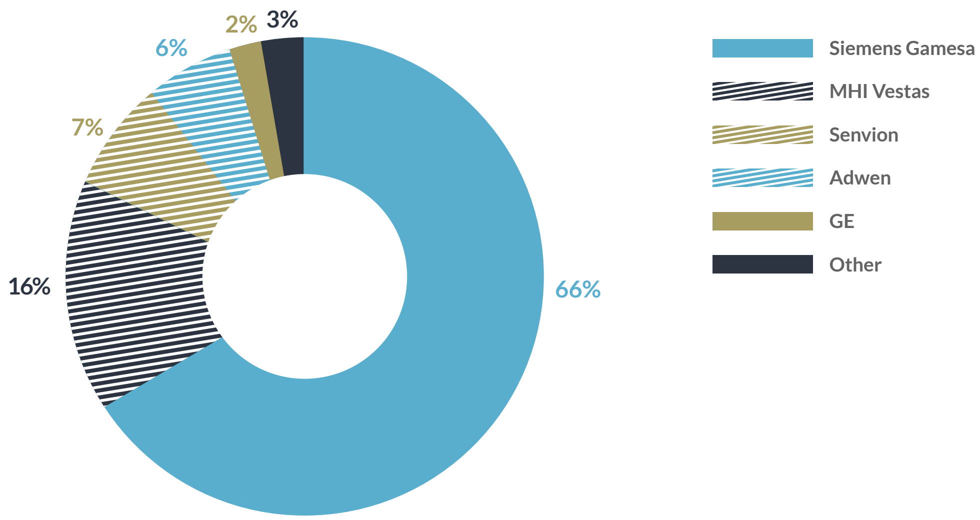


Figure 13: *Turbine manufacturer market share, constructed 2010 onwards* (Source: 4C Offshore)

4.1.3 SERVICE PROVIDERS

Service providers deliver into companies throughout the supply chain. Service companies often present a quicker route to market for an innovator because they can move more quickly and often cover a broader range of customers in the offshore wind industry.

4.2 APPROACHING CUSTOMERS

Innovators will need to consider the structure and dynamics of their customer's activities and relationships with other stakeholders in order to best target sales. See **Figure 14** for an overview of suggested ways for innovators to approach customers in different areas of the supply chain.

Technology for…	Development	Turbine manufacture	Balance of plant manufacture	Installation	Operation and maintenance
Project developer	TRL 7+ Project specific. Approach customer pre-planning. Consider route in via service providers and consultancies.	TRL 8+ Approach customer pre-planning to specify technology from turbine OEM. Consider permissions from turbine OEM.	TRL 8+ Approach customer pre-planning to specify technology from foundation or electrical OEM. Engage with lower tiers of supply to raise technology awareness.	TRL 7+ Approach customer pre-installation to specify technology from installation service provider. Engage with vessel designers and operators to raise technology awareness.	TRL 5+ Consider warranty period and how it affects turbine access. Consider permissions from turbine OEM. Consider project ownership following construction.
Project Owner / operator	Unlikely to contract technology.	TRL 6+ Consider warranty period and how it affects turbine access. Consider permissions from turbine OEM.	Unlikely to contract technology unless require spare parts or replacement.	TRL 7+ May contract technology if large component replacement or major repair required.	TRL 5+ Consider warranty period and how it affects turbine access. Consider permissions from turbine OEM. Consider route in via service providers.
Turbine manufacturer	Unlikely to contract technology.	TRL 3+ Consider warranty period and therefore which organisation will experience the benefit of the new technology.	TRL 3+ Unlikely to contract technology directly but likely any changes to foundations or electrical will require turbine OEM buy in.	TRL 5+ Undertakes large component replacement during warranty period. Consider route in via installation service providers.	TRL 3+ Turbine OEM will seek efficiencies on multiple projects globally. Consider approaching both servicing and innovation teams.
Other tier 1 manufacturer	Unlikely to contract technology.	Unlikely to contract technology.	TRL 3+ Often design companies work closely with fabricators while some have in house design capability. Approach manufacturers and designers.	TRL5+ In many cases the project developer contracts with the installer directly but consider projects that require tier 1s to provide installation services.	Unlikely to have a service contract with the project owner. O&M of balance plant will be undertaken in house by the project owner or subcontracted to a service provider.
Service providers	TRL 3+ Typically will consider technologies that supplement or increase competitiveness of existing services Consider whether to compete or collaborate.	TRL 3+ Approach turbine OEMs for buy in. Consider how technology adds value to service offering to turbine manufacturer.	TRL 3+ Approach OEMs for buy in. Consider how technology adds value to service offering to OEMs.	TRL 3+ Approach vessel owners and developers for buy in and to specify the technology required.	TRL 3+ Typically will consider technologies that supplement or increase competitiveness of existing services. May require specification by turbine OEM or project owner.

Figure 14: *An innovator's guide to approaching customers*

4 MARKET ENTRY

Innovators will find sales opportunities through dialogue with engineering teams of target customers and will often have to work to convince multiple organisations (project developers, OEMs, investors etc.) of the benefit of its technology. Once convinced of the value of the technology, an innovator will then have to be enter into negotiations with procurement teams. Networking with project developers directly or a sub component that may be in critical supply areas where end users seek security of supply.

Project developers have different approaches to procurement, outlined in **Figure 15**. The differing approaches impact the way a innovator would approach different project developers.

Project Developer	Typical procurement approaches					
	Direct contact	Track record in the UK	Supplier databases	Meet the buyer events	Company website	OJEU notices
EDF Energy Renewables	X	X				
E.ON Climate & Renewables	X	X	X	X	X	
Innogy	X	X		X	X	
Mainstream Renewable Power	X	X	X			
Orsted	X	X	X			X
SSE Renewables	X	X	X			X
Vattenfall	X	X	X		X	
Tier 1 suppliers	X	X		X		

Figure 15: *Typical project developer procurement approaches*

4.3 REACHING BEYOND OFFSHORE WIND

An innovator must also consider whether offshore wind presents the easiest opportunity for market entry. In many cases, proving technology concepts in more established markets could present a timelier prospect. Demonstration of the technology in other markets will also raise confidence and awareness of the technology with offshore wind companies. The Knowledge Transfer Network (KTN) is funded by Innovate UK to support companies to find opportunities in different industries. It has Knowledge Transfer Managers in 17 industrial sectors and is ready to support UK innovators. Also, for more information on how to enter other maritime sectors beyond offshore wind, please see Offshore Supply Industry Dynamics from CBS Maritime.

4.4 SEIZING THE OPPORTUNITY

The offshore wind market is growing rapidly and it presents a great opportunity for UK innovators. Although project costs have fallen dramatically, many of the low cost and all of the subsidy free projects are yet to be built. The opportunity for innovators to continue supporting these projects is greater now than ever.

Innovators must pursue a route to market that fits with their technology offering. They must be flexible to adapt and grow with their customers and be sensitive to the technological, physical and financial requirements of offshore wind energy. Organisations such as ORE Catapult are ideally positioned to help innovators on this journey.

5 ADDITIONAL SUPPORT

ONLINE RESOURCES

A Guide to an Offshore wind farm
Encyclopedic guide to an offshore wind farm.

From The Crown Estate

Read now

Offshore Wind Operational Report
Up-to-date annual overview of operational activity in the UK.

From The Crown Estate

Read now

System Performance, Availability and Reliability Trends (SPARTA) Analysis
Insight to operational performance of UK offshore wind farms.

From ORE Catapult

Read now

Technology Roadmaps
Overview of key technology trends.

From the Offshore Wind Innovation Hub

Read now

DELPHOS tool
For a useful tool to help calculate the impact of a technology on the LCoE of an offshore wind farm

From InnoEnergy

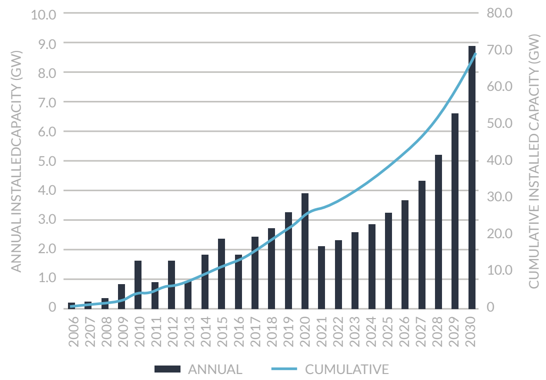
Visit now

A

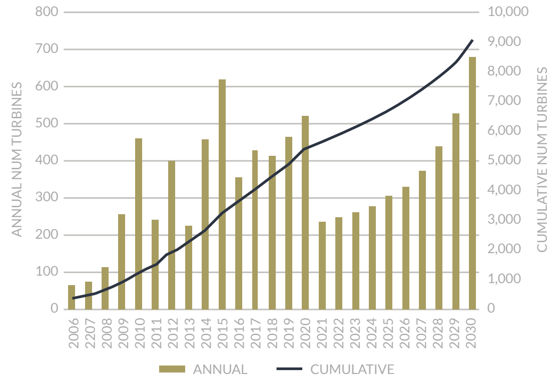
APPENDIX 1: FURTHER MARKET DATA

European offshore wind market size by GW and by number of turbines (source: 4C Offshore wind farm database)

Europe (Gigawatts)

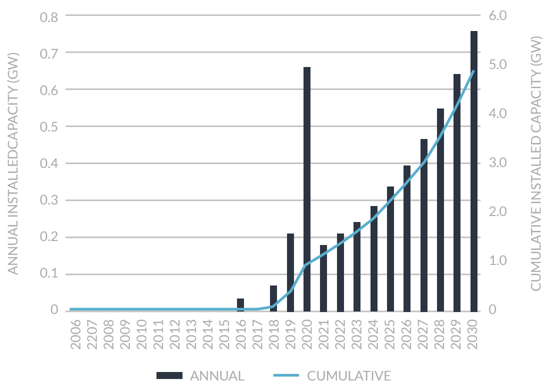


Europe (Number of turbines)

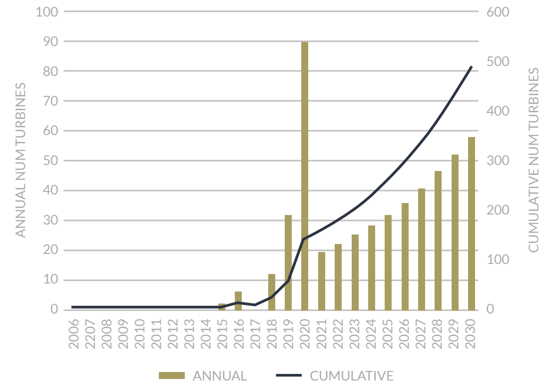


US offshore wind market size by GW and by number of turbines (source: 4C Offshore wind farm database)

America (Gigawatts)

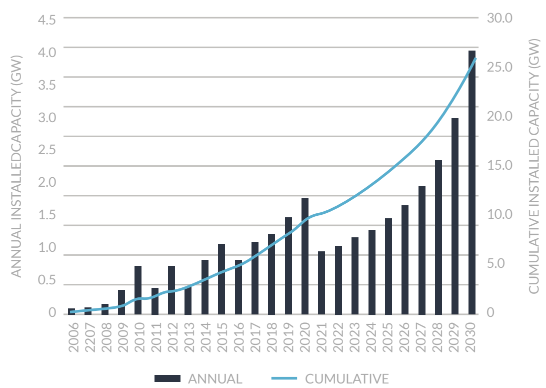


America (Number of turbines)

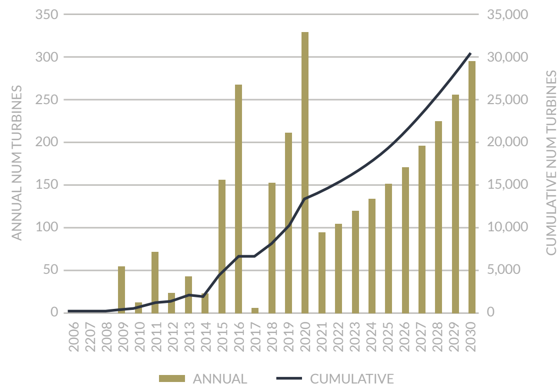


Asia offshore wind market size by GW and by number of turbines (source: 4C Offshore wind farm database)

Asia (Gigawatts)



Asia (Number of turbines)



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