Offshore Wind in Europe

Key trends and statistics 2020

WindEurope

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WindEurope

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This report summarises construction and financing activity in European offshore wind farms from 1 January to 31 December 2020.

WindEurope regularly surveys the industry to determine the level of installations of foundations and turbines, and the subsequent dispatch of first power to the grid. The data includes demonstration sites and factors in decommissioning where it has occurred. Annual installations are expressed in gross figures while cumulative capacity represents net installations per site and country. Rounding of figures is at the discretion of the author.

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PHOTO COVER:
Kriegers Flak substation, Courtesy of Van Oord.

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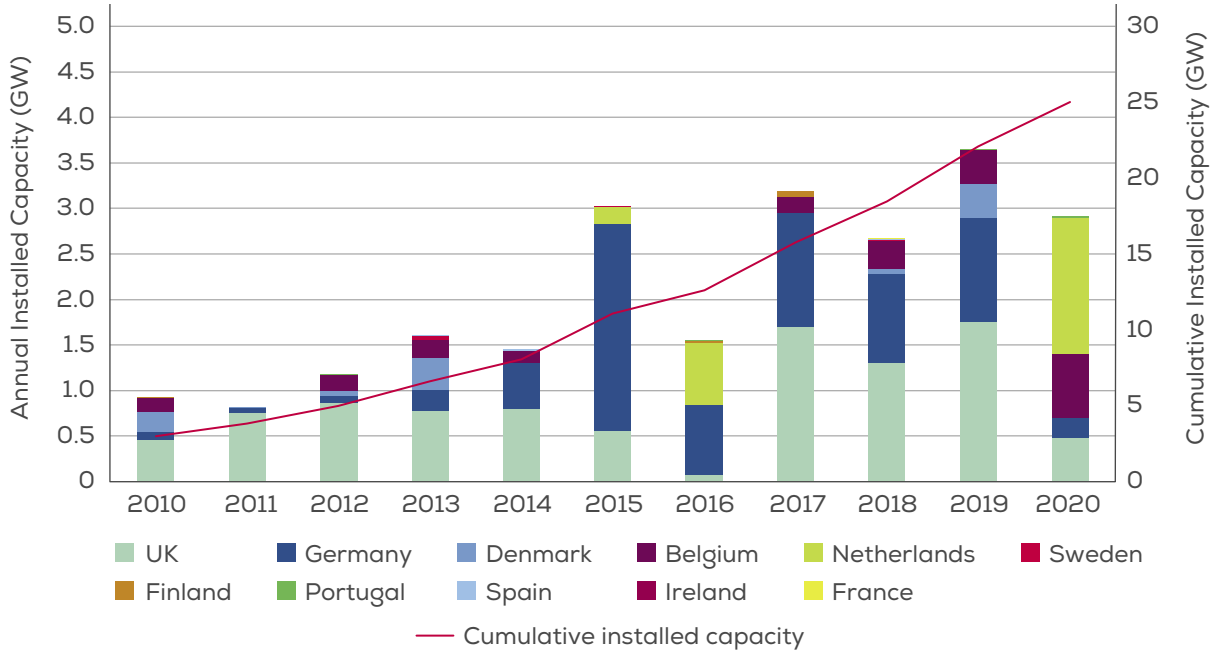
EXECUTIVE SUMMARY

Europe added 2.9 GW of offshore capacity during 2020. That's 356 new offshore wind turbines connected to the grid, across nine wind farms.

Europe now has a total installed offshore wind capacity of 25 GW. That corresponds to 5,402 grid-connected wind turbines across 12 countries.

FIGURE A

Annual offshore wind installations by country (left axis) and cumulative capacity (right axis) (GW)



Source: WindEurope

Eight new offshore wind projects reached Final Investment Decision (FID) in four different countries during 2020, with construction due to start in the coming years.

Investments in new assets accounted for €26.3bn and 7.1 GW of additional capacity was financed.

Installations in 2020

- Europe added 2,918 MW of new capacity. The Netherlands (1,493 MW), Belgium (706 MW), the UK (483 MW), Germany (219 MW) and Portugal (17 MW) supplied this new capacity to the grid.
- The European grid saw 356 offshore wind turbines connected across nine wind farms in 2020.
- Europe saw nine new wind farms completed (grid-connected). One has partial grid connection and will be fully commissioned in 2021. Construction work started on six other wind farms where no turbines have yet been grid-connected.
- Siemens Gamesa Renewable Energy connected 63% of new turbines to the grid. Vestas Wind Systems connected 34%, while the remaining 3% were Senvion turbines.

Financing highlights

- Europe saw a financing record of €26.3bn for new projects. There was 7.1 GW of new capacity financed in France, the Netherlands and the UK.
- The two largest wind farms - Hollandse Kust Zuid 1-4 (1.5 GW) and Dogger Bank A and B (2.4 GW) - together raised almost €13bn in capital.
- Overall, the UK and Germany have attracted the most investments over the past ten years.
- Corporates signed six offshore Power Purchase Agreements in 2020 in Germany, Belgium, and the UK.

Trends: turbine and wind farm size, depth, distance from shore, auctions

- The average rated capacity of turbines installed in 2020 was 8.2 MW, with two-thirds of the wind farms with offshore works in 2020 using turbines larger than this.
- The average size of wind farms was 788 MW, 26% larger than last year.
- The average distance to shore was 52 km and the water depth 44 m.
- The Hollandse Kust Noord V was the only auction this year – a consortium of Shell New Energies and Eneco won.
- GE Renewable Energy received the largest order for wind turbines, from SSE and Equinor for the Dogger Bank (A and B) in the UK. The project will feature 190 GE Haliade-X 13 MW turbines.

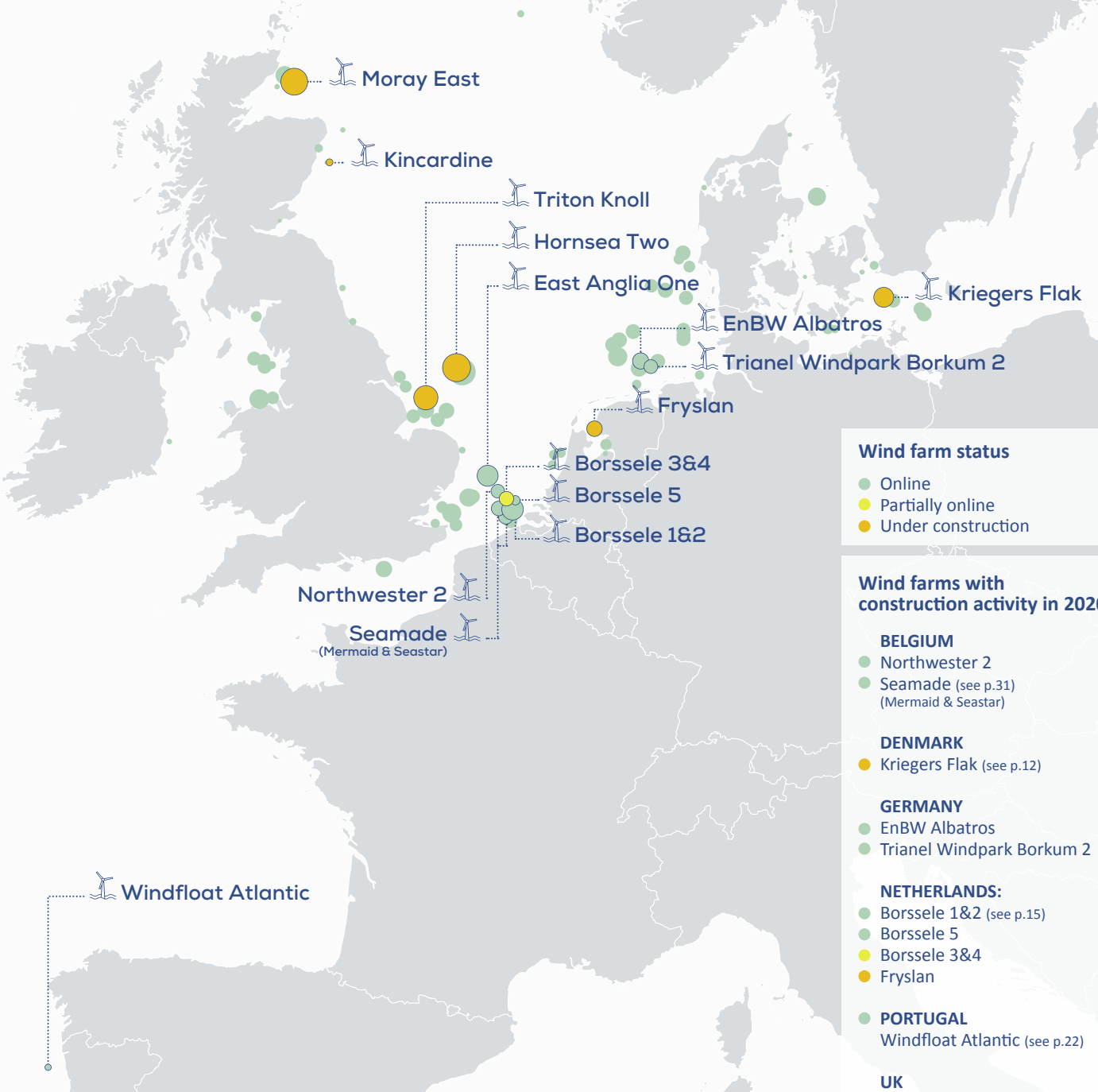
Cumulative installations

- There are 5,402 turbines connected to the grid, totalling 25,014 MW.
- There are now 116 offshore wind farms in 12 European countries (including one site with partial grid- connected turbines).
- The UK has the largest offshore wind capacity in Europe, with 42% of all installations. Germany is second with 31%, followed by the Netherlands (10%), Belgium (9%) and Denmark (7%).
- Ørsted (17%), RWE Renewables (10%), Vattenfall (6%) and Macquarie Capital (6%) are the largest owners of offshore wind farms.

Offshore wind farms in Europe

2.9 GW
NEW CAPACITY
INSTALLED IN 2020

25 GW
TOTAL CAPACITY
NOW INSTALLED



Wind farm status

- Online
- Partially online
- Under construction

Wind farms with construction activity in 2020

BELGIUM
- Northwester 2
- Seamade (see p.31) (Mermaid & Seastar)

DENMARK
- Kriegers Flak (see p.12)

GERMANY
- EnBW Albatros
- Trianel Windpark Borkum 2

NETHERLANDS:
- Borssele 1&2 (see p.15)
- Borssele 5
- Borssele 3&4
- Fryslan

PORTUGAL
- Windfloat Atlantic (see p.22)

UK
- East Anglia One
- Hornsea Two
- Kincardine
- Moray East (see p.22)
- Triton Knoll

Source: WindEurope

1. OFFSHORE WIND INSTALLATIONS

1.1 OVERVIEW

Europe connected 2,918 MW of offshore wind power capacity in 2020, a 20% decrease on 2019, but in line with our pre-COVID-19 forecast, a sign of the commitment of the wind industry to deliver on their installation plans. The Netherlands (1,493 MW), Belgium (706 MW), the UK (483 MW), Germany (219 MW) and Portugal (17 MW) supplied this new capacity to the grid.

The Netherlands connected almost half of all the capacity to the grid with the connection of most turbines at Borssele 1-5 sites. Belgium also set a national installation record and Seamade became its largest operational wind farm (487 MW). The UK connected fewer turbines to the grid but installed foundations at three wind farms, in preparation for a wave of GW-scale wind farms, following the commissioning of Hornsea One in 2019.

Germany completed the grid-connection of EnBW Albatros and Trianel Windpark Borkum 2 at the beginning of the year.

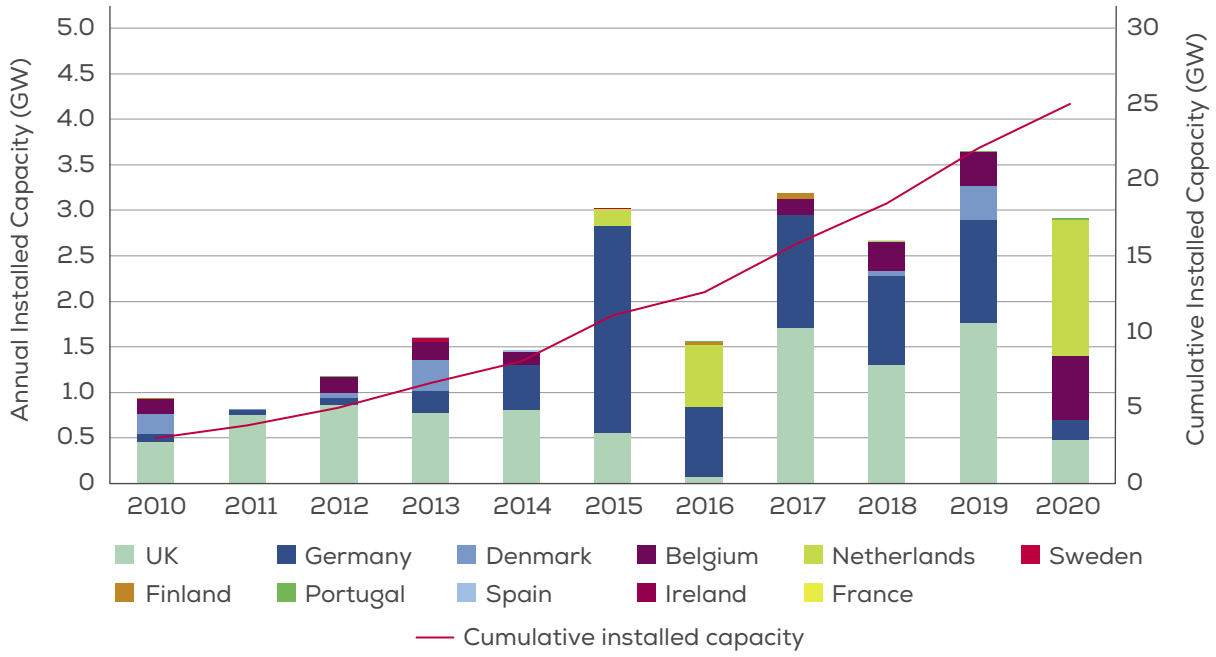
Portugal finalised the installation of Windfloat Atlantic. Denmark completed the monopiles installation at the Kriegers Flak wind farm, the first offshore hybrid project connected simultaneously to Denmark and Germany.

The publication of the Offshore Renewables Energy Strategy (ORES) sets out the EU's ambition to build 300 GW of offshore wind by 2050. European installation rates are still far less than what the sector will need to deliver this and the 2030 National Energy and Climate Plans, as presented in chapter 4.

Europe has a total of 25,014 MW installed at the end of 2020. In total, there are 116 wind farms including sites with partial grid connection across 12 European countries. 5,402 turbines are connected to the grid.

FIGURE 1

Annual offshore wind installations by country (left axis) and cumulative capacity (right axis)



Source: WindEurope

TABLE 1

Overview of grid-connected offshore wind power projects at the end of 2020

COUNTRY	NUMBER OF WIND FARMS CONNECTED[1]	CUMULATIVE CAPACITY (MW)	NUMBER OF TURBINES CONNECTED	CAPACITY CONNECTED IN 2020 (MW)	NUMBER OF TURBINES CONNECTED IN 2020
UK	40	10,428	2,294	483	69
Germany	29	7,689	1,501	219	32
Netherlands	9	2,611	537	1,493	172
Belgium	11	2,261	399	706	81
Denmark	14	1,703	559	0	0
Sweden	5	192	80	0	0
Finland	3	71	19	0	0
Ireland	1	25	7	0	0
Portugal	1	25	3	17	2
Spain	1	5	1	0	0
Norway	1	2	1	0	0
France	1	2	1	0	0
Total	116	**25,014**	**5,402**	**2,918**	**356**

Source: WindEurope

1. It includes 14 demonstrators (single turbine or announced as demonstrator by developer).

1.1 NATIONAL BREAKDOWN OF 2020 INSTALLATIONS

The Netherlands connected 1,493 MW, over half (51.1%) of the capacity brought online in Europe in 2020 completing the installation of all turbines at the Borssele Wind Farm Zone. The zone consists of three wind farms Borssele 1&2 (752 MW), Borssele 3&4 (732 MW) and Borssele 5 (19 MW), all of them awarded in 2016 and 2017 auctions to different consortia. The Dutch TSO Tennet was responsible for the grid connection and installed the Borssele Alpha & Beta platforms ahead of schedule. Borssele 1&2 are fully operational while Borssele 3&4 will connect the last turbine this year. Within the Borssele 5 innovation site, Van Oord is currently testing the slip joint between foundation and transition piece.

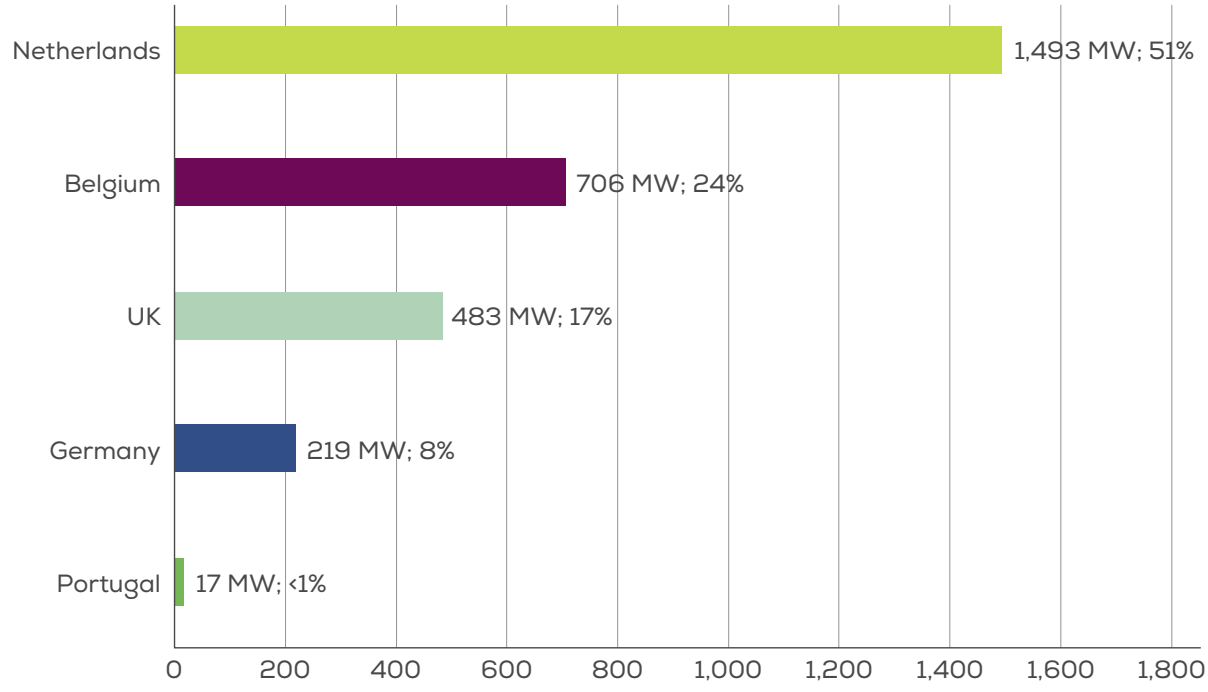
Belgium connected 706 MW (24.2%), almost doubling its installations compared to last year's record. Northwester 2 (218 MW) and Seamade[2] (487 MW) are now fully operational, the latter becoming the largest offshore wind farm in Belgium.

The UK connected 483 MW (16.6%), its lowest level since 2016 with only one wind farm connecting turbines to the grid. East Anglia One (714 MW) became fully operational during the first half of the year. But offshore works started at Kincardine (50 MW), Triton Knoll (857 MW), Moray East (950 MW) and Hornsea Two (1,386 MW). The four projects together will supply an additional 3 GW over the next three years.

Germany connected 219 MW (7.5%), its lowest level in almost 10 years. EnBW Albatros (112 MW) became the most distant operating wind farm, located 105km off the German North Sea coast. Trianel Windpark Borkum 2 (203 MW) was also fully commissioned in the first half of the year installing the last Senvion machines in Europe.

Portugal connected 17 MW (0.6%), completing the installation of two V164-8.4 MW turbines, the largest operational floating wind turbines in the world. Windfloat Atlantic (25 MW) uses semi-submersible technology and is located 30 km off the coast of Viana do Castelo with water depths reaching 100 m.

FIGURE 2
Annual gross offshore wind capacity installations per country in 2020 (MW)



Source: WindEurope

2. Seamade wind farm includes two concessions Seamade and Mermaid.

KRIEGERS FLAK

Denmark

First offshore hybrid* project and largest wind farm in Denmark.

Status:
Under construction

Capacity:
605 MW

No. of turbines:
72

Owners:
Vattenfall (100%)

Turbine model:
SG 8.4-167 DD (SGRE)

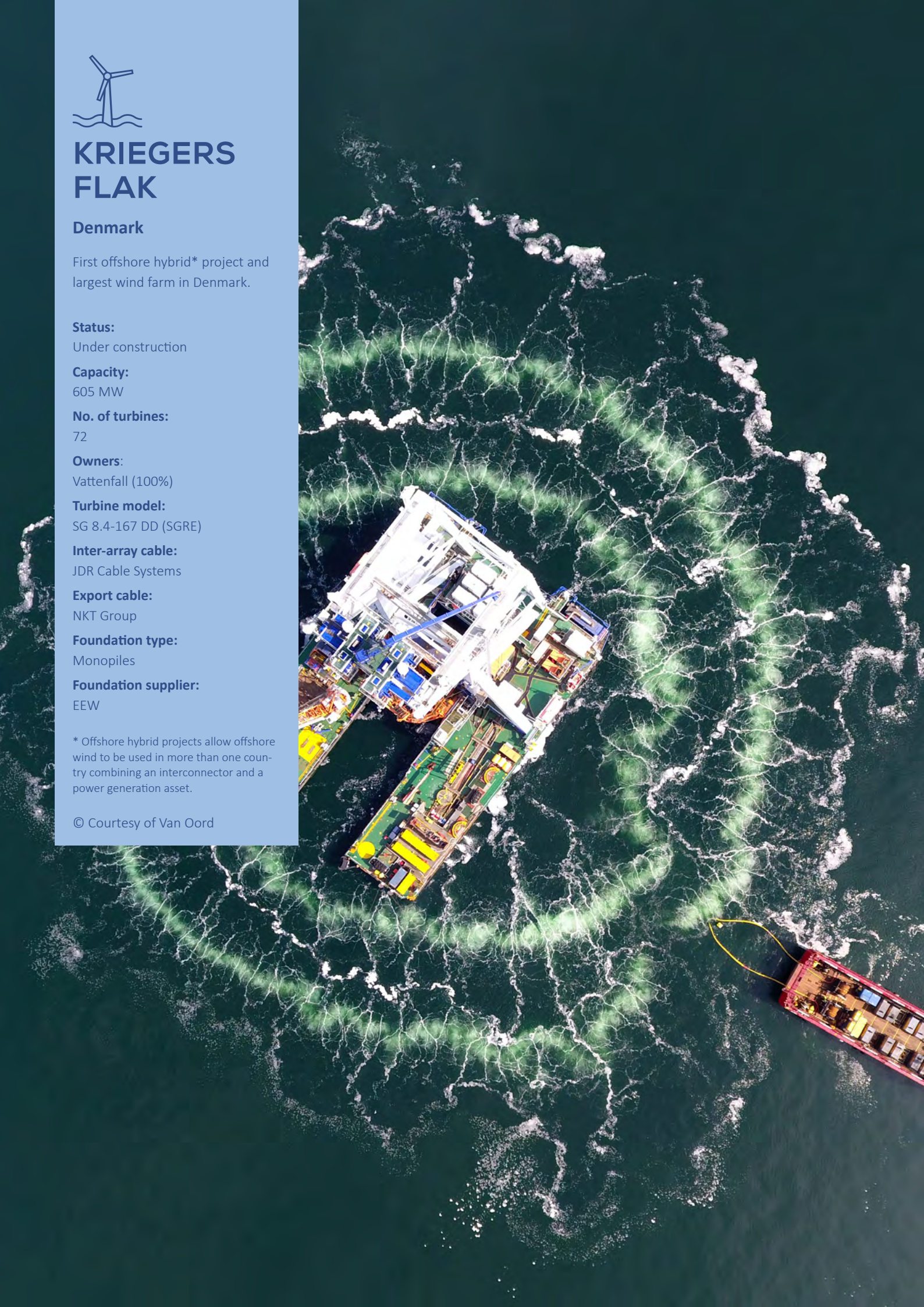
Inter-array cable:
JDR Cable Systems

Export cable:
NKT Group

Foundation type:
Monopiles

Foundation supplier:
EEW

* Offshore hybrid projects allow offshore wind to be used in more than one country combining an interconnector and a power generation asset.



In total, 16 offshore wind farms across six countries saw work take place last year.

Nine wind farms connected turbines to the grid (see table 2). Six wind farms installed foundations but did not connect any turbine to the grid (see table 3).

Last year, all installations took place in the North Sea except for Windfloat Atlantic which connected two floating turbines in the Atlantic Ocean.

TABLE 2
The new offshore wind installations with grid connection in 2020

COUNTRY	WIND FARM	CAPACITY CONNECTED IN 2020 (MW)	NUMBER OF TURBINES CONNECTED	TURBINE MODEL	TYPE OF FOUNDATION	STATUS[3]
Netherlands	Borssele 1&2	752	94	SG 8.0-167 DD	Monopile	●●●●●
	Borssele 3&4	722	76	V164-9.5 MW	Monopile	●●●●●
	Borssele 5	19	2	V164-9.5 MW	Monopile	●●●●○
Belgium	Seamade	487	58	SG 8.4-167 DD	Monopile	●●●●●
	Northwester 2	219	23	V164-9.5 MW	Monopile	●●●●●
UK	East Anglia One	483	69	SWT-7.0-154	3-Legs Jacket	●●●●●
Germany	EnBW Albatros	112	16	SWT-7.0-154	Monopile	●●●●●
	Trianel Windpark Borkum 2	101	16	Senvion 6.2M152	Monopile	●●●●●
Portugal	Windfloat Atlantic	17	2	V164-8.4 MW	Semi-Sub	●●●●●

Source: WindEurope

TABLE 3
Wind farms under construction in 2020 but not yet grid-connected

COUNTRY	WIND FARM	FOUNDATIONS INSTALLED IN 2020	TOTAL NUMBER OF FOUNDATIONS	TURBINE MODEL	TYPE OF FOUNDATION
Netherlands	Fryslan	89	89	SWT-DD-130 4.4 MW	Monopile
UK	Hornsea Two	29	165	SG-8.0-167 DD	Monopile
	Moray East	100	100	V164-9.5 MW	Jacket
	Kincardine	1	5	V164-9.6 MW	Semi-Sub
	Triton Knoll	90	90	V164-9.5 MW	Monopile
Denmark	Kriegers Flak	72	72	SG 8.4-167 DD	Monopile

Source: WindEurope

3. One bar <25% grid connected. Two bars <50% grid connected. Three bars <75% grid connected. Four bars <100% grid connected. Five bars fully grid connected.

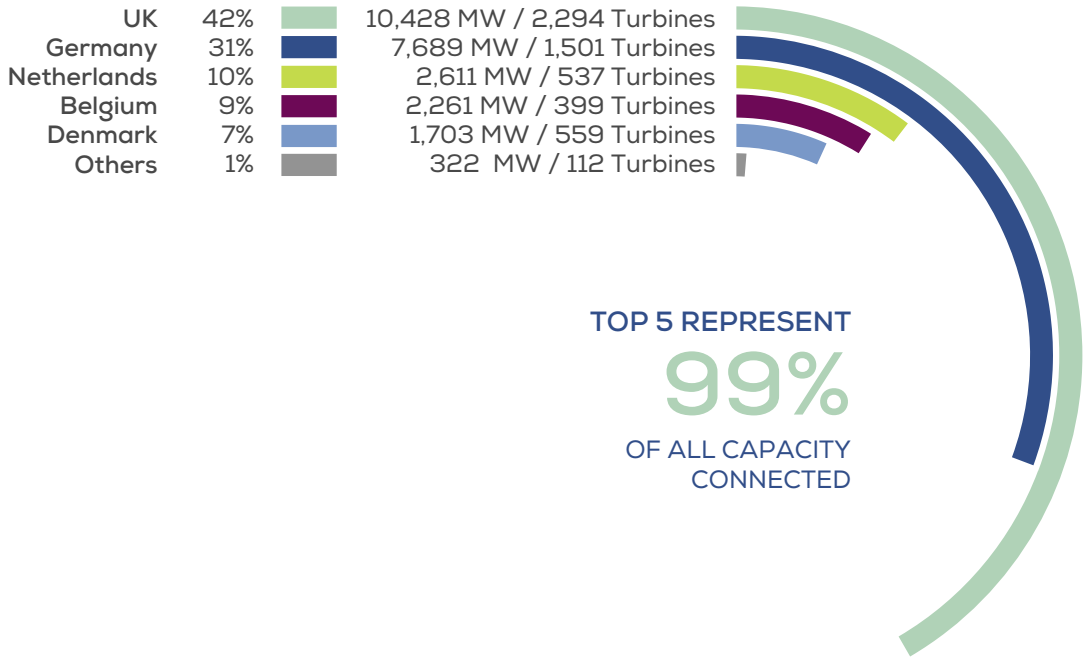
1.2 CUMULATIVE INSTALLATIONS

Today there are 25,014 MW of installed capacity across Europe. This includes a total of 5,402 turbines connected to the grid across 12 countries. Five countries – the UK, Germany, Denmark, Belgium and the Netherlands – still represent 99% of this capacity.

Although the UK saw few installations in 2020, it continues to have the largest offshore wind capacity in Europe with 42% of all installations. Germany is second with 31%, the Netherlands climbed the ranks to third with 10%, followed by Belgium (9%) and Denmark (7%).

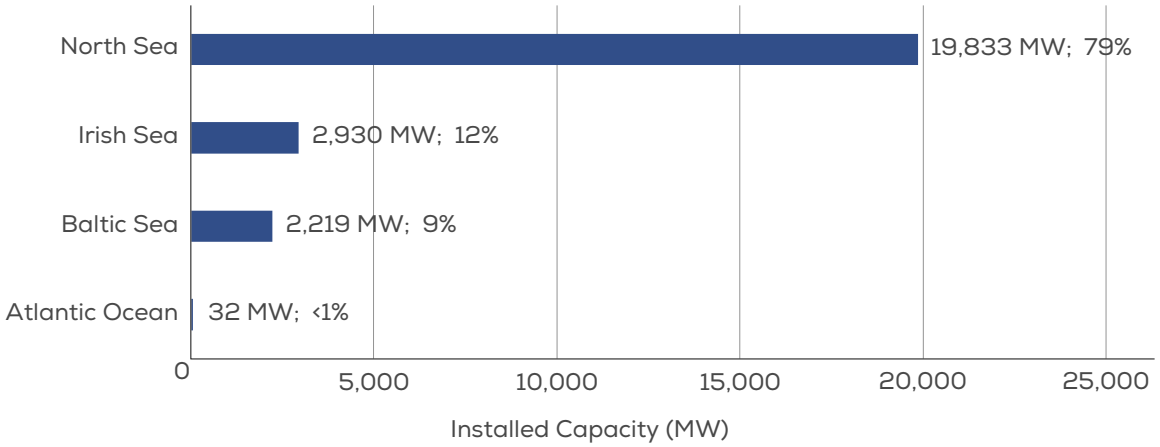
Other countries include, in descending order, Sweden, Finland, Ireland, Portugal, Spain, Norway and France. Together these seven countries provide 1% of the installed capacity with 112 turbines. In terms of cumulative installations the North Sea remains the most established sea basin in Europe with almost 20 GW (79%) of all offshore wind capacity in Europe. The Irish Sea (12%), the Baltic Sea (9%) and the Atlantic Ocean (<1%) make up the rest.

FIGURE 3
Cumulative installed capacity (MW) and number of turbines by country



Source: WindEurope

FIGURE 4
Cumulative installed capacity by sea basin (MW)



Source: WindEurope

BORSSELE 1&2

The Netherlands

Ørsted's first wind farm in the Netherlands

Status:
Fully Commissioned

Capacity:
752 MW

No. of turbines:
94

Owners:
Ørsted (100%)

Turbine model:
SG 8.0-167 DD (SGRE)

Inter-array cable:
Nexans

Export cable:
NKT Group

Foundation type:
Monopiles

Foundation supplier:
EEW (50%) & Sif (50%)

2. TRENDS: TURBINE SIZE AND WIND FARM LOCATION

2.1 WIND TURBINE RATED CAPACITY

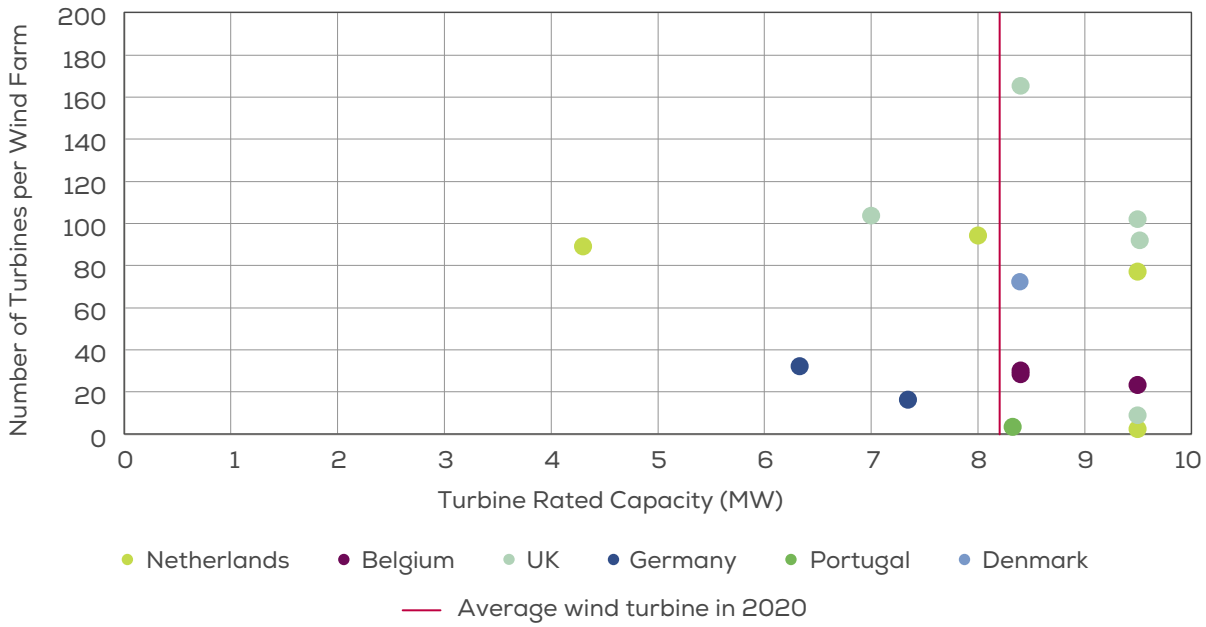
Offshore wind turbines are continuing to grow in power. Since 2015 turbines have grown at a constant 16% rate. In 2020 the average rated capacity of turbines installed was 8.2 MW, which represents only 5% more compared to last year. But turbine orders in 2020 already show a trend towards the next generation in size, with turbines ranging 10 to 13 MW for projects coming online after 2022[4].

The turbine most connected to the grid in 2020 was SG 8.0-167 DD ranging between 8 to 8.4 MW at Borssele 1&2 and Seamade. Hornsea Two will feature 165 turbines of the same model and is set to become the largest wind farm in the world by 2022. The V164-9.5 MW (Vestas Wind Systems) was the second most connected model, featuring at Borssele 3&4, Borssele 5 and Northwester 2. Other projects under construction with this model include Moray East, Triton Knoll and Kincardine wind farms, all in the UK.

4. Wind Turbine Order Monitoring report – members only.

FIGURE 5

Average turbine rated capacity and number of turbines at wind farms under construction in 2020

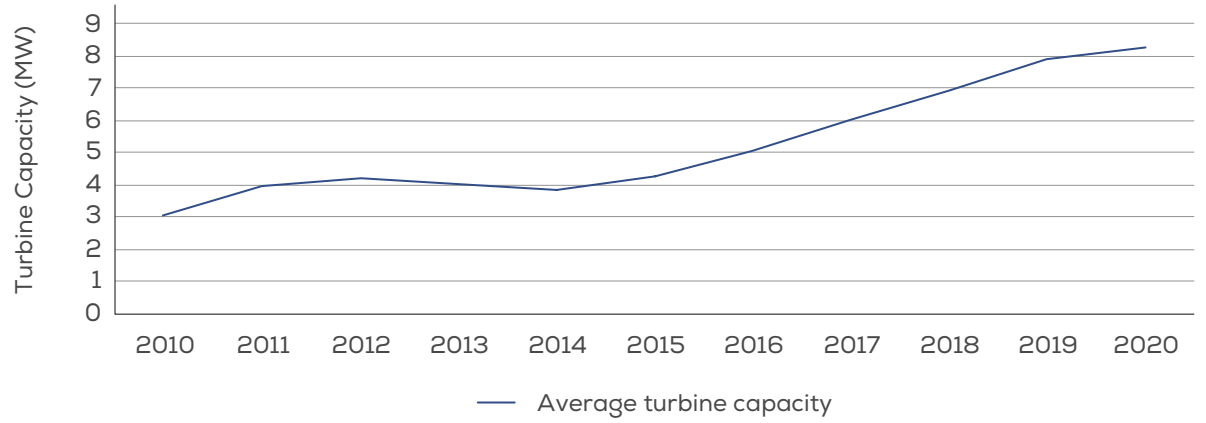


Source: WindEurope

10 out of the 15 wind farms with offshore works in 2020 are using wind turbines above the average (8.2 MW), indicated by the red line in Figure 7. Hornsea Two will hold the record of having installed the most turbines in a single wind farm, with 165 in total. Projects with below-average turbines mostly represent projects that began construction one or two years earlier but underwent grid connection this year. The exception is Fryslan, a wind farm being built in a Dutch lake.

FIGURE 6

Yearly average of newly installed offshore wind turbine rated capacity (MW)

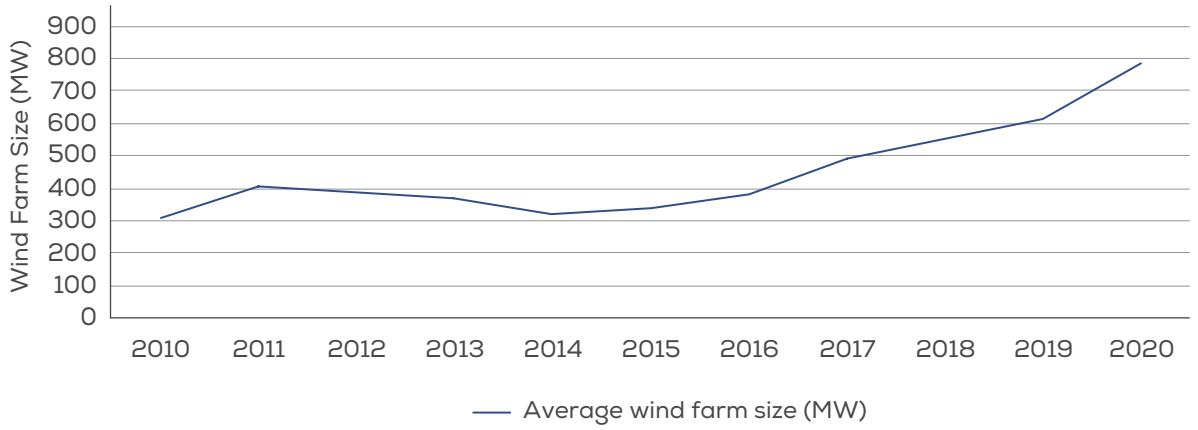


Source: WindEurope

2.2 WIND FARM SIZE

Offshore wind farms have grown steadily for the past five years. The average wind farm was 788 MW – 26% more than last year. And there is an upcoming wave of GW-scale wind farms in the UK, following the commissioning of Hornsea One in 2019, enabling scale and lower costs. In 2020, Borssele 1&2 and East Anglia One were the two largest wind farms fully commissioned, all with over 700 MW capacity.

FIGURE 7
Average size of commercial offshore wind farm projects in the year (MW)



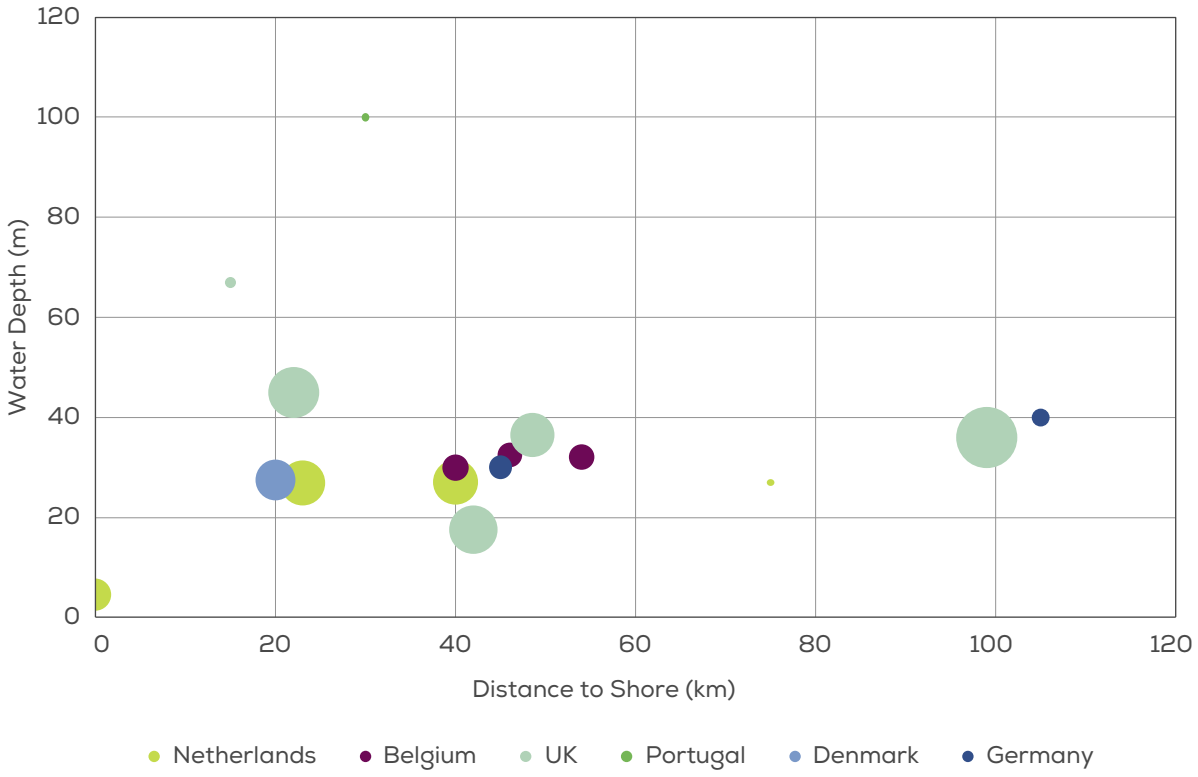
Source: WindEurope

2.3 WATER DEPTH AND DISTANCE TO SHORE

Moving further offshore enables larger sea areas with more stable wind conditions, reduces impact on other economic activities and minimises potential visual impact on the coastline. But transmission costs are higher, and construction and operation are both more expensive.

FIGURE 8

Average water depth and distance to shore of offshore wind farms under construction during 2020. The size of the bubble indicates the capacity of the site



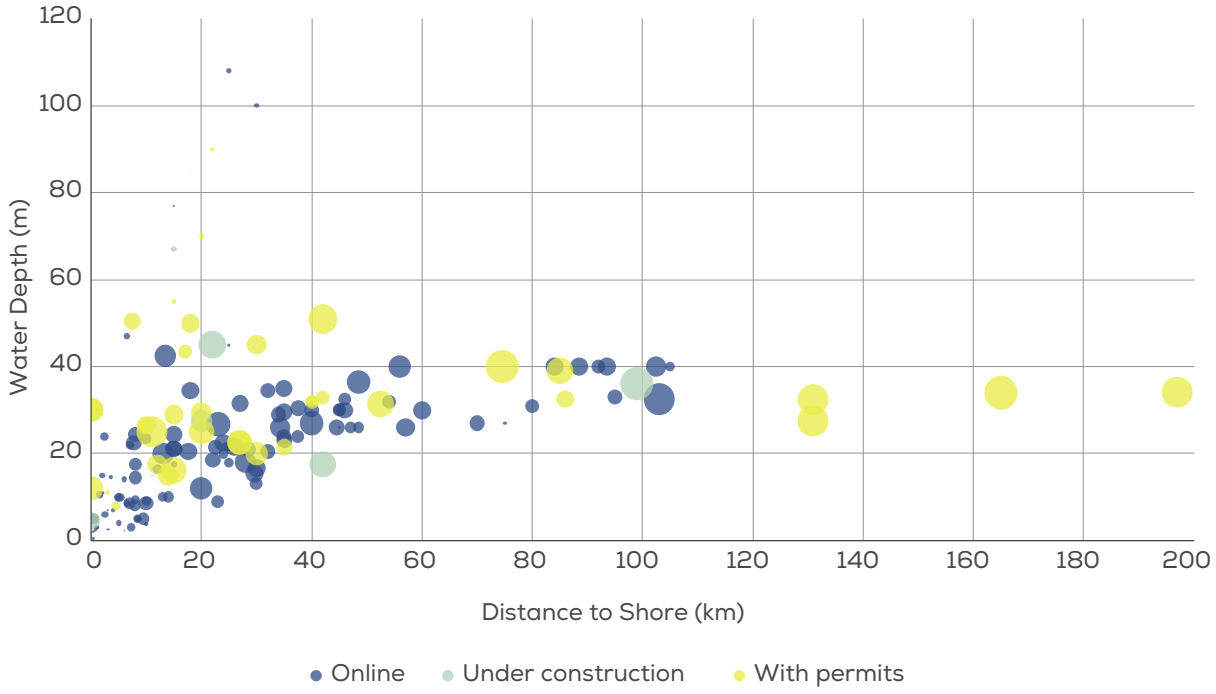
Source: WindEurope

The average water depth of offshore wind farms under construction in 2020 was 36 m, a slight increase on last year (34 m). Two floating projects, Kincardine (UK) and Windfloat Atlantic (Portugal), stand out with depths of 67 and 100 m respectively. Moray East (UK) is the bottom-fixed project with the deepest waters (45 m) and uses jackets. Most of the projects in shallower waters use monopiles.

The average distance to shore of offshore wind farms under construction in 2020 was 44 km, a decrease compared to last year (52 km). The average is lower because last year there were four projects under construction at distances greater than 90 km, while this year only Hornsea Two (UK) and EnBW Albatros (Germany) are located that far out.

FIGURE 9

Average water depth and distance to shore of all offshore wind farms in Europe. The size of the bubble indicates the overall capacity of the site.



Source: WindEurope

Both German and Belgian transmission system operators (TSO) find clustering wind farms into a single offshore substation the most efficient way to bring electricity to shore. EnBW's Albatros shares BorWin2 with three other German wind farms. And Elia, the Belgian TSO, connected three wind farms including Seamade and Northwester 2 to the first Modular Offshore Grid (MOG).

The industry has already built wind farms up to 100 km offshore and deeper than 100 m using bottom-fixed and floating technologies (figure 9 – online wind farms). And it is preparing for a new generation of wind farms, much further out HVDC technology will be commonly used for wind farms located far offshore

2.4 FLOATING WIND

Europe's floating wind fleet stood at a total of 62 MW by the end of 2020, and now makes up 83% of the global floating wind capacity. It grew over the course of the year with the commissioning of Windfloat Atlantic (25 MW) in Portugal. Kincardine (50 MW) is now under construction off the coast of Aberdeen, and when operational, it will become the largest project with five V164-9.5 MW turbines. Hywind Tampen (88 MW) reached Financial Investment Decision in 2019 and is in pre-construction phase. The project aims to reduce the cost by 40% compared to Hywind Scotland, the first spar-buoy demonstrator. Two scale prototypes were tested this year in Germany and Spain with innovative foundation designs. EnBW tested the Nezzy 2 floating offshore platform (1:10) in the Bay of Greifswald in the Baltic Sea. The model combines two tilted turbines in a single platform and will test a full-scale prototype in 2021/22. SAITEC Offshore Technologies tested the BlueSATH (1:6) off the coast of Santander. The SATH (Swinging Around Twin Hull) concept is designed to align itself around a Single Mooring Point following the direction of wind and waves. RWE Renewables signed a cooperation agreement to test a full-scale prototype (DemoSATH) in 2022.

Europe's pipeline of floating projects for the next decade is over 7 GW. France, Norway, and the UK are the most ambitious. But other countries, including Portugal, Ireland, Spain, Italy, and Greece will also be involved. France will auction the first of three 250 MW sites, and Norway will open two areas (4.5 GW in total) for development in 2021 with one suitable for floating. Scotland is currently hosting the largest seabed lease (ScotWind) and is expecting applications for floating projects as water depths are high. This is timely because the Crown Estate amendments to the UK's Contracts for Difference include a separate pot for emerging technologies – with floating wind and bottom-fixed not directly competing for the same auction volumes.

Table 4 gives an overview of the largest projects coming online in the next three years.

TABLE 4
Floating wind farms coming online in the next three years

COUNTRY	WIND FARM	CAPACITY (MW)	FLOATER TYPE	NUMBER OF TURBINES	TURBINE MODEL	EXPECTED COMMISSIONING DATE
France	Éoliennes Flottantes de Groix	28.5	Semi-sub	3	V164-9.5 MW	2022
	EFGL	30	Semi-sub	3	V164-10.0 MW	2023
	EolMed	30	barge	3	V164-10.0 MW	2023
	Provence Grand Large	25	TLP	3	SWT-8.4-154 DD	2023
Norway	Hywind Tampen	88	Spar	11	SWT 8.0-154 DD	2022
UK	Kincardine	50	Semi-sub	5	V164-9.6 MW	2021

Source: WindEurope

MORAY EAST

UK

DEME Offshore developed a special underwater drilling tool to cope with hard and rocky layers

Status:
Under construction

Capacity:
950 MW

No. of turbines:
100

Owners:
Ocean Winds (56.6%), Diamond Green Limited (33.4%) & The China Three Gorges (10%)

Turbine model:
V164-9.5MW
(Vestas Wind Systems)

Inter-array cable:
JDR Cable Systems (66 kV)

Export cable:
NKT Group

Type of foundation:
Jackets

Foundation supplier:
Smulders (55%) & Lamprell (45%)

3. INDUSTRY ACTIVITY AND SUPPLY CHAIN

3.1 WIND TURBINE MANUFACTURERS

Siemens Gamesa Renewable Energy (SGRE) connected 63% of all turbines in 2020. They connected 237 turbines (1,840 MW) across four countries – the Netherlands, Belgium, Germany and the UK. Their largest project in 2020 was Borssele 1&2, with the installation of 94 turbines (SG 8.0-167 DD model) completed in only eight months despite COVID-19 restrictions on the movement of workers and goods. This was also SGRE's most used model in 2020, with capacity ranging between 8 to 8.4 MW. In May 2020, SGRE launched a 14 MW turbine with a 222m rotor that can be boosted up to 15 MW, equipped with the new Siemens Gamesa B108 blades.

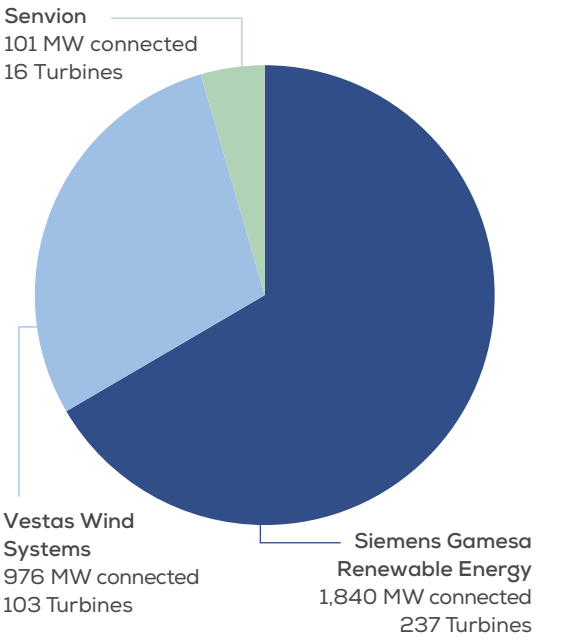
Vestas Wind Systems connected 33% of all turbines in 2020 with 103 turbines (976 MW) across three countries – the Netherlands, Belgium and Portugal. Vestas Wind Systems installed the largest turbines in 2020 (V164-9.5 MW model) at Borssele 3&4, Borssele 5 and Northwester 2. Five units of the same model will be installed this year at Kincardine's floating project. The same turbines, but with increased rated power (V164-10.0 MW model) will be installed in two out of four French demonstration projects, EFGL (30 MW) and EolMed (30 MW).

Senvion turbines were connected, representing 3% of all turbines in 2020.

GE Renewable Energy did not connect any turbines in 2020 but received the largest wind turbine order from SSE and Equinor. Dogger Bank (A and B) will feature 190 GE Haliade-X 13 MW; the installation is expected to begin in 2022. For the third phase of the project (phase C) an upscaled 14 MW version of the same model will be used.

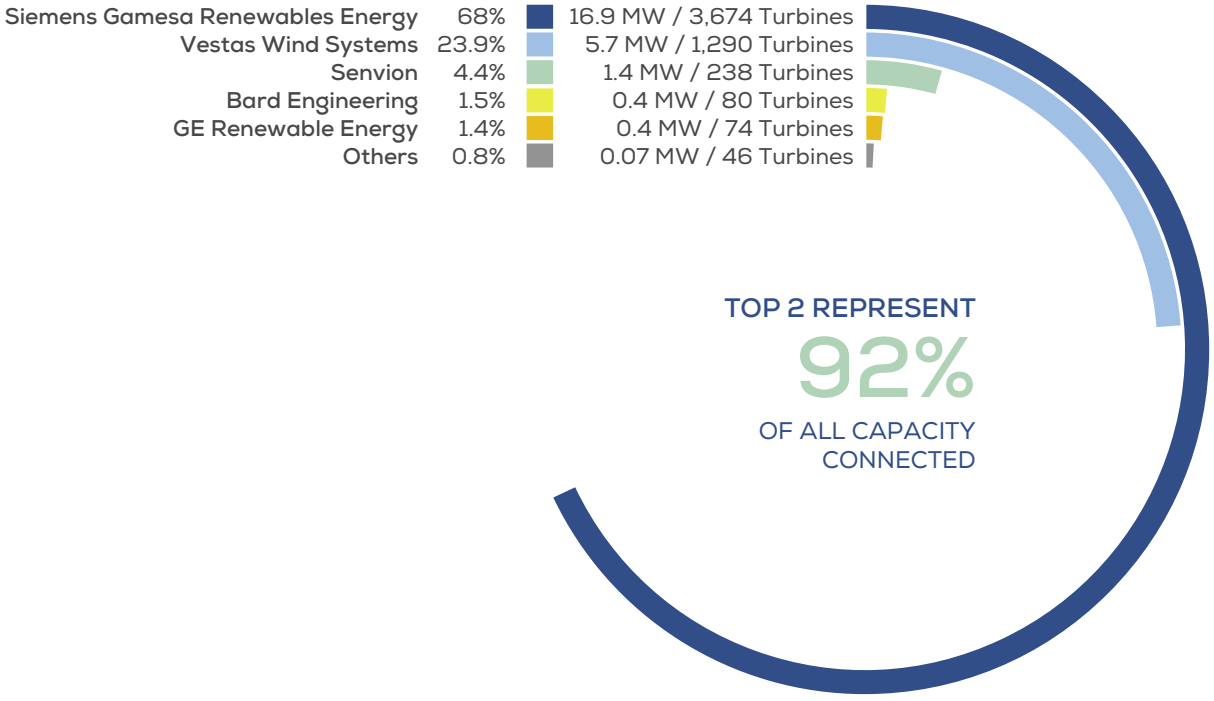
In cumulative terms, Siemens Gamesa Renewable Energy remains the largest supplier with 68% of the total European installed capacity (figure 11). Vestas Wind Systems is the second largest, with a 23.9% market share. These two manufacturers represent 92% of the total offshore capacity connected in Europe by the end of 2020.

FIGURE 10
Wind turbine manufacturers' share of the 2020 new installations (MW) and number of turbines connected to the grid



Source: WindEurope

FIGURE 11
Wind turbine manufacturers' share at the end of 2020

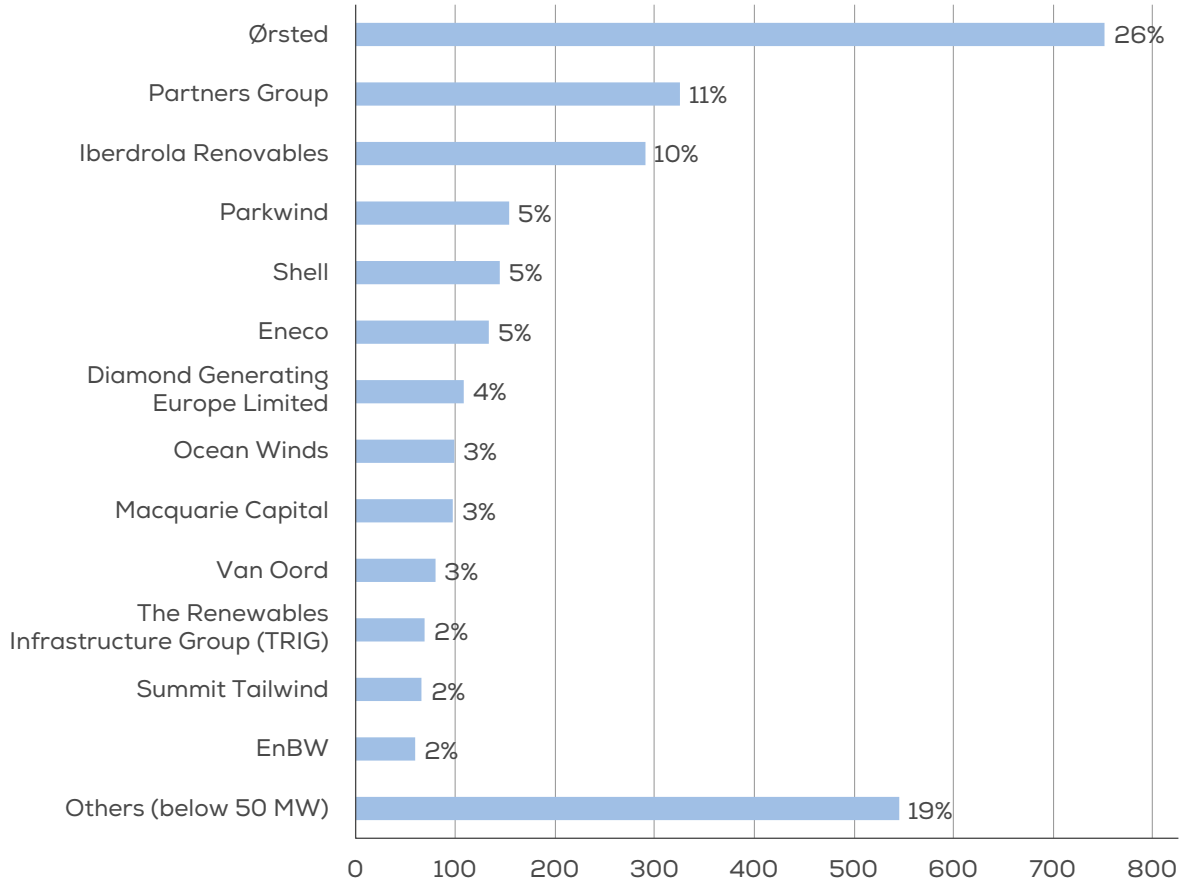


Source: WindEurope

3.2 WIND FARM OWNERS

Ørsted (26%), Partners Group (11%) and Iberdrola Renovables (10%) together own almost half of all the capacity connected to the grid in 2020[5]. These represent the connection of the Borssele 1&2, Borssele 3&4 and East Anglia One respectively. Other owners include developers, electricity suppliers, investment trusts and maritime contractors.

FIGURE 12
Owners' share of 2020 new installations (MW)

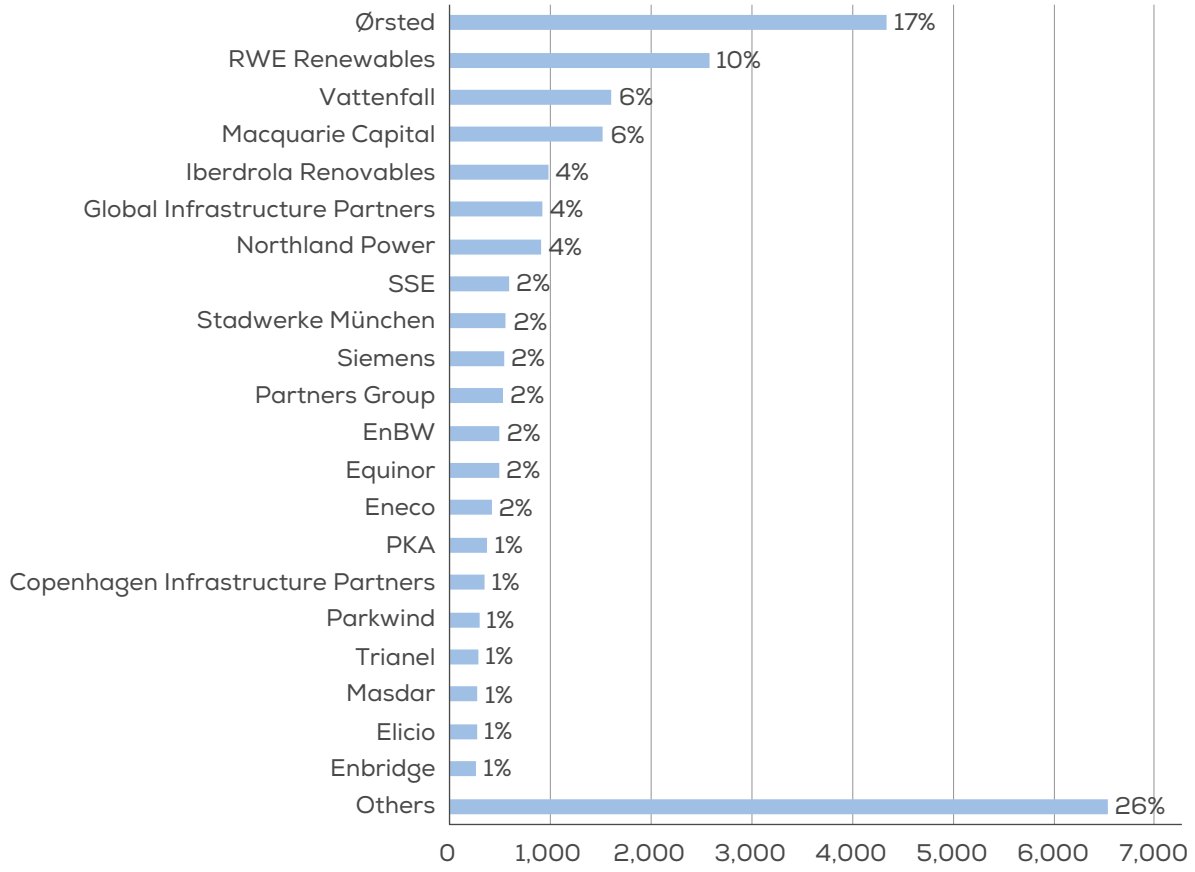


Source: WindEurope

Ørsted has the largest share of offshore wind power in Europe (17%) by the end of 2020 (figure 13). Despite not connecting turbines in 2020, RWE Renewables remains the second largest (10%). Vattenfall (6%) and Macquarie Capital (6%) were the next largest. Along with Iberdrola Renovables, Global Infrastructure Partners and Northland Power, these seven companies together own 51% of the installed capacity in Europe by the end of 2020.

5. Grid-connected market shares are indicative only. Projects owned or developed by several companies have been split according to their respective shared. Where the shares are not known, they have been split in equal parts between the partners.

FIGURE 13
Owners' share of total cumulative installed capacity at the end of 2020 (MW)



Source: WindEurope

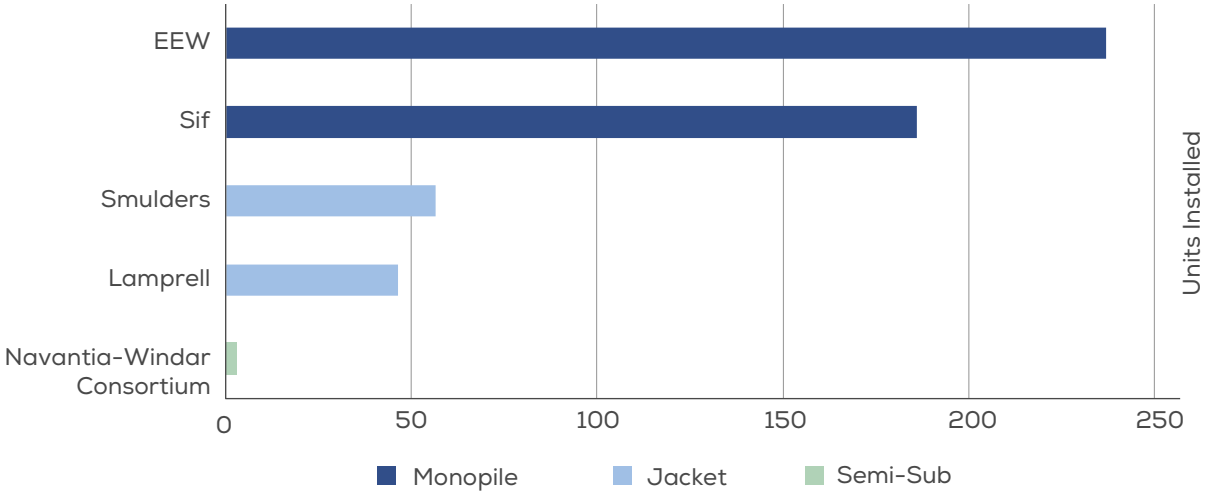
3.3 SUBSTRUCTURES AND FOUNDATIONS

Monopiles remain the preferred choice of developers with over two-thirds of all installations in 2020 (80.5%). EEW and Sif together provided 423 monopiles across three countries.

Jackets were second (19%) with the installation of 100 foundations. Lamprell and Smulders supplied all jackets for Moray East (UK).

Three semi-subs structures were installed at Windfloat Atlantic and Kincardine. Navantia-Windar Consortium continues to be in most cases the preferred supplier for floating projects – including spar-buoys.

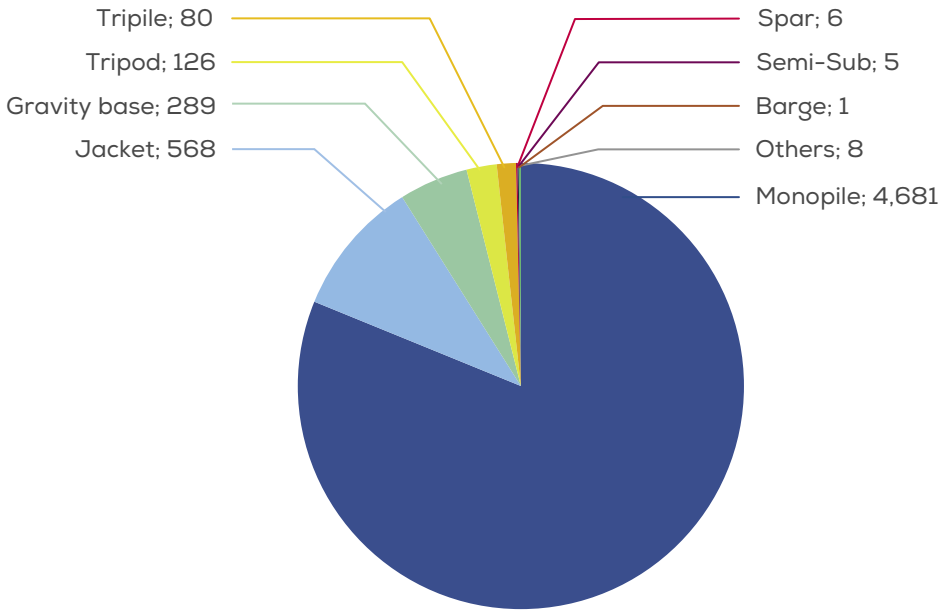
FIGURE 14
Foundations and substructures installed in 2020 by manufacturing company[6]



Source: WindEurope

Monopiles increase to a cumulative 4,681 units and remain the most used type of foundation (81.2%). Jackets are second and increase their share (9.9%), because of installations at Moray East this year. Gravity base (5%), tripod (2.2%), and tripile (1.4%) also featured but saw their cumulative share reduced because none were installed in 2020. Together all floating foundations – spar, semi-sub and barge – represent a cumulative 0.2%.

FIGURE 15
Cumulative number of foundations installed by substructure type[7]



Source: WindEurope

6. Shares are calculated according to the actual number of individual foundations installed in 2020. Where the project developers contracted more than one company to manufacture, and where the respective shares (in case of consortia/joint venture) were not specified, foundations installed were split in equal part between the partners.
7. This includes all foundations installed with and without grid connection by the end of 2020.

WINDFLOAT ATLANTIC

Portugal

Largest floating turbines operational in the world.

Status:
Fully commissioned

Capacity:
25 MW

No. of turbines:
3

Owners:
Ocean Winds (79.4%), Repsol (19.4%) & Principle Power (1.2%)

Turbine model:
V164-8.4 MW
(Vestas Wind Systems)

Inter-array cable:
JDR Cable systems

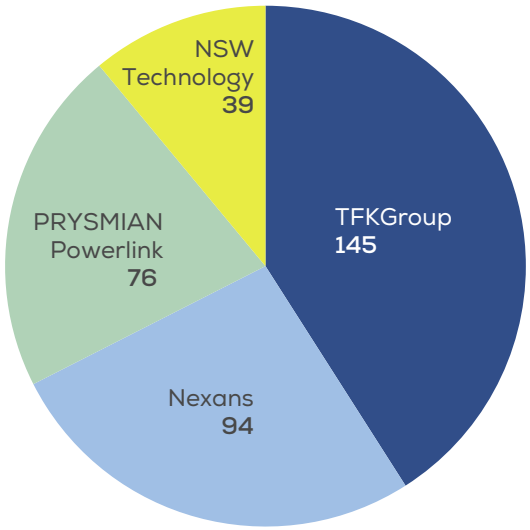
Export cable:
Hengtong

Foundation type:
Semi-sub

Foundation supplier:
ASM Industries (66%) &
Navantia-Windrar Consortium (34%)

3.4 CABLES

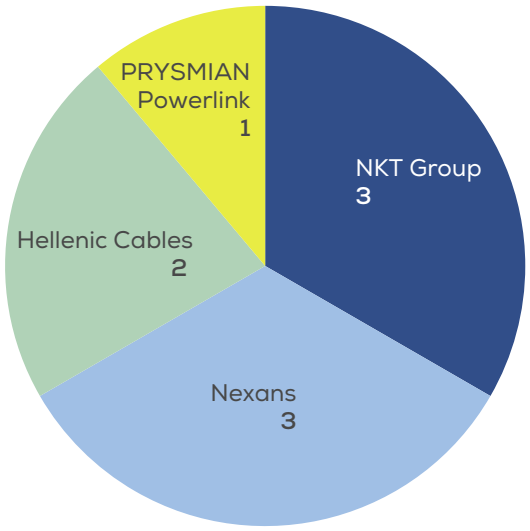
FIGURE 16
Share of inter-array cable suppliers for energised cables in 2020[9]



Source: WindEurope

Inter-array cables (i.e. the cables used to connect turbines with each other and with the main substations at the wind farm) were supplied in 2020 by four companies. TFK-Group[8] continues to be the primary supplier of inter-array cables (41%) with 145 cables across Germany, Portugal, Belgium, and the UK. Nexans was second (27%) with the connection of turbines at Borssele 1&2. Prysmian was third (21%) with the connection of turbines at Borssele 3&4. And NSW Technology was fourth (11%). One-third of the wind farms used 66kV inter-array cables over 33kV.

FIGURE 17
Share of export cable suppliers for energised cables in 2020[10]



Source: WindEurope

NKT Group (33%) and Nexans (33%) represent together more than half of the export cables energised in 2020. This includes wind farms in the Netherlands, Belgium, and the UK. These were followed by Hellenic Cables (22%) and Prysmian (11%).

8. Represents cables supplied by JDR Cable Systems and TFKable.
9. Number of inter-array cables is estimated with the number of turbines connected in the year.
10. Shares are calculated considering the number of cables once wind farms are fully completed (see table 2).

3.5 VESSELS

In 2020 at least nine different vessel providers were active in the installation of foundations, turbines, inter-array, export cables and substations . The heavy-lift jack-up vessels Aeolus (Van Oord) and Seaway Strashnov (Seaway 7) were the most used vessels for these activities.

Van Oord started the installation of export cables at Hollandse Kust Zuid 1&2 (760 MW) and led the foundations installation at Fryslan (383 MW), both coming online in the next two years. Seaway 7 installed substations weighing up to 3,700 tonnes at three wind farms.

DEME Offshore, Van Oord and NKT Cables Group undertook the installation and grid connection of Borssele 1&2 (92 turbines) in just eight months during the COVID-19 pandemic. Van Oord, Seaway 7 and Boskalis finalised installations at Borssele 3&4.

Bourbon Subsea Services towed the last two turbines and cables at Windfloat Atlantic in 2020, but this achievement required a previous installation of anchors and pre-lay operation before hook-up. Boskalis oversaw the installation of anchors, mooring lines, and the transport to assembly site for the first floating foundations at Kincardine, due to be operation in 2021.

TABLE 5

Wind farms serviced by vessel provider that were installing turbines, foundations, inter-array cables, export cables, and substations in 2020

VESSEL PROVIDER	INSTALLATION OF				
	TURBINES	FOUNDATION	INTER-ARRAY CABLE	EXPORT CABLE	SUBSTATION
Boskalis Subsea			Moray East	Borssele 3&4	
			Triton Knoll	Triton Knoll	
	Kincardine	Kincardine			
Bourbon Subsea Services	Windfloat Atlantic		Windfloat Atlantic	Windfloat Atlantic	
DEME Offshore	Borssele 1&2	Borssele 1&2	Moray East		Seamade (Mermaid & Seastar)
	East Anglia One	Hornsea Two			
	Seamade (Mermaid & Seastar)	Moray East			
Fred Olsen Windcarrier	Trianel Windpark Borkum 2				Moray East
Global Offshore			Kriegers Flak		
Jan de Nul	Northwester 2				
NKT Cables Group				Borssele 1&2	
				Moray East	
Seaway 7		Triton Knoll			Borssele 1&2
					Borssele 3&4
					Triton Knoll
Van Oord	Borssele 3&4	Borssele 3&4	Borssele 1&2	Hollandse Kust Zuid 1&2	
	Borssele 5	Borssele 5	Borssele 3&4		
		Fryslan	Borssele 5		
		Kriegers Flak			

Source: WindEurope

11. Vessels used for pre-construction, other installation services and support are not highlighted in this analysis.

SEAMADE (Seastar & Mermaid)

Belgium

Largest Belgian offshore wind farm.

Status:
Fully commissioned

Capacity:
487 MW

No. of turbines:
58

Owners:
Otary* (70%), Ocean Winds (17.5%) & Eneco (12.5%)

Turbine model:
SG 8.4-167 DD(SGRE)

Inter-array cable:
JDR Cable systems

Export cable:
Hellenic Cables

Foundation type:
Monopiles

Foundation supplier:
Sif (100%)

*Otary is a partnership of eight Belgian companies (Aspiravi, DEME NV, Elicio, Power at Sea, Rent a Port, Socofe, SRIW & Z-Krach). Ownership's share has been equally divided between partners.

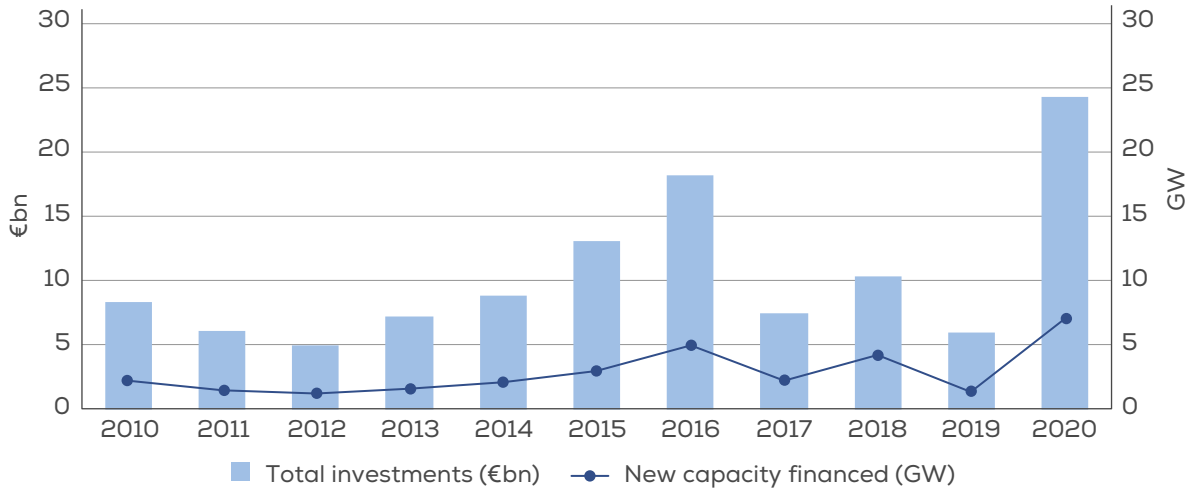
4. INVESTMENTS AND POLICY DEVELOPMENTS

4.1 FINANCING ACTIVITY

Despite COVID-19, 2020 was a record year for offshore wind financing in Europe with €26.3bn raised for the financing of new offshore wind farms, including €2.1bn in offshore transmission infrastructure. It was also a record for new capacity financed with 7.1 GW, indicating an important shift of speed and volume in the European offshore wind sector. Notably 2020 saw the final investment decisions taken on two mammoth offshore wind farms, the 1.5 GW Hollandse Kust Zuid (1-4) wind farm in the Netherlands and the first two phases of Dogger Bank wind farm in the UK, Dogger Bank A and B, with a combined capacity of 2.4 GW. The capital raised for these two alone was almost €13bn which, on their own, would have been amongst the highest annual amounts on record in Europe.

The 7.1 GW of new capacity was financed at an average capital expenditure (CAPEX) per MW of €3.4m. There is however a large spread of capex across projects. The two French wind farms, Fécamp and Saint-Brieuc, come at higher-than-average costs due to long permitting delays and the fact that the tender under which they were selected (in 2011) required that the turbine selected to be built on French territory. The Dogger Bank (A and B) also comes at higher-than-average CAPEX as it includes transmission costs and it is located very far out, at 130km off the east coast of Yorkshire in England. Finally, the pre-commercial Kincardine floating offshore wind farm was financed at €8.3m/MW.

FIGURE 18
New offshore wind investments and capacity financed: 2010 – 2020 (€bn)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total investments (€bn)	8.4	6.1	5	7.2	8.8	13.1	18.2	7.5	10.3	6	24.2
New capacity financed (GW)	2.2	1.5	1.3	1.6	2.1	3	5	2.3	4.2	1.4	7.1

Source: WindEurope

In total, eight projects reached Final Investment Decision (FID) in 2020, in the UK, the Netherlands, France and Germany.

TABLE 6
Investment in European offshore wind farms in 2020[12]

COUNTRY	WIND FARM	CAPACITY (MW)	INVESTMENT (€bn)	COST (€m/MW)	EXPECTED COMMISSIONING DATE
France	Fecamp	497	2.4	4.9	2023
	Saint-Brieuc	496	2.3	4.6	2023
Germany	Kaskasi	342	1.4	4.1	2022
Netherlands	Hollandse Kust Noord	759	1.6	2.0	2023
	Hollandse Kust Zuid 1-4	1,500	3.4	2.3	2022/23
UK	Kincardine	50	0.4	8.3	2021
	Dogger Bank (A and B)	2,400	9.4	3.9	2024/25
	Seagreen	1,075	3.3	3.1	2023

Source: WindEurope

Since 2010 the UK has attracted almost half of all new investments, worth €56bn, making it the biggest offshore wind market for capital spending commitments over the last ten years. Germany was the next largest with 26% or €30bn in investments over the same period.

12. Figures include estimates where transaction values are unavailable.

4.2 OFFSHORE PPAs

The first offshore corporate Power Purchase Agreement (PPA) was signed in 2018 by the pharmaceutical firms Novozymes and Novo Nordisk for approximately 120 MW of the output of Kriegers Flak in Denmark. By the end of 2019, five more corporates had signed PPAs with offshore wind farms. Another six PPAs were signed by corporates in 2020 in Germany, Belgium and the UK, demonstrating that offshore wind PPAs are now a valuable option for corporates looking to source large volumes of renewable electricity. Offshore wind farm developers are looking at corporate PPAs as a way to guarantee their revenue in the long-term. This is particularly important where zero-subsidy bids are being placed and developers are fully exposed to the wholesale market price.

TABLE 7
Investment in European offshore wind farms in 2020

COUNTRY	CORPORATE	CAPACITY (MW)	WIND FARM
Belgium	Ineos	56	Northwester 2
	Ineos	84	Norther
	Borealis	235	Mermaid
Germany	Deutsche Bahn	66	Amrumbank West
	Amazon	250	Borkum Riffgrund 3
UK	Nestlé	31	Race Bank

Source: WindEurope

4.3 AUCTION RESULTS

In 2020 there was only one offshore wind auction. In July, The Dutch Enterprise Agency RVO announced the results of the Hollandse Kust Noord tender. The site has a total 759 MW (125km^2) and is expected be commissioned in 2023.

The development rights were awarded to Crosswind N.V., a consortium of Shell New Energies and Eneco. Both companies have taken financial investment decisions regarding the project. The project is the fifth area of the Dutch roadmap to reach 4.5 GW of offshore wind capacity by 2023. The area is located next to the existing wind farms Egmond and Zee (108 MW) and Prinses Amalia (120 MW), both operational since 2007/08.

TABLE 8
Investment in European offshore wind farms in 2020

COUNTRY	WIND FARM	CAPACITY (MW)	STRIKE PRICE (€/MWh)	TYPE OF SUPPORT	WINNER	EXPECTED COMMISSIONING DATE
Netherlands	Hollandse Kust Noord V	760	-	Zero-subsidy bid	Shell New Energies & Eneco	2023

Source: WindEurope

The project will feature 69 SGRE turbines (SG 11.0-200 DD model) with 200 m rotor diameters and 11 MW rated power. The Dutch TSO TenneT will be responsible for constructing the offshore substation to export electricity. Jan de Nul and LS Cable & System won the contract to carry-on the design, manufacture and execute the high voltage cables (220 kV) for the project.

The Hollandse Kust Noord will combine five technology demonstrations: a floating solar park, a short-term battery storage, tuned to the wake effects on neighbouring ones and renewable hydrogen production with electrolysers, supporting the transition to a renewables-based energy system.

4.4 POLICY DEVELOPMENTS AND OUTLOOK

The initial restrictions on the free movement of workers at the height of the COVID-19 pandemic affected construction and maintenance activities across offshore wind farms in Europe. But Governments lifted these restrictions in a timely fashion and annual capacity connected to the grid in 2020 was largely unaffected.

Europe's long-term energy and climate policies are broadly favourable to offshore wind. And in December, the EU is enshrining in legislation its ambition to become climate neutral by 2050. And EU Heads of State committed 2020 to increase the EU-wide 2030 climate target to at least 55%, up from the current 40%. In June 2021 the European Commission is expected to table a higher 2030 renewable energy target, from today's 32%.

The EU Green Deal, the economic strategy for meeting both climate neutrality and economic recovery, included an Offshore Renewable Energy Strategy. Published at the end of 2020, this strategy proposes legislative and non-legislative actions for the deployment of 300 GW of offshore wind in the EU-27 by 2050. Adding up the ambitions of the UK and Norway, Europe would have 400 GW by 2050. The offshore renewable energy strategy focuses on six key areas to make this happen: maritime spatial planning, grid infrastructure, an EU regulatory framework for offshore grids, private-public investment, research and innovation, and supply and value chain.

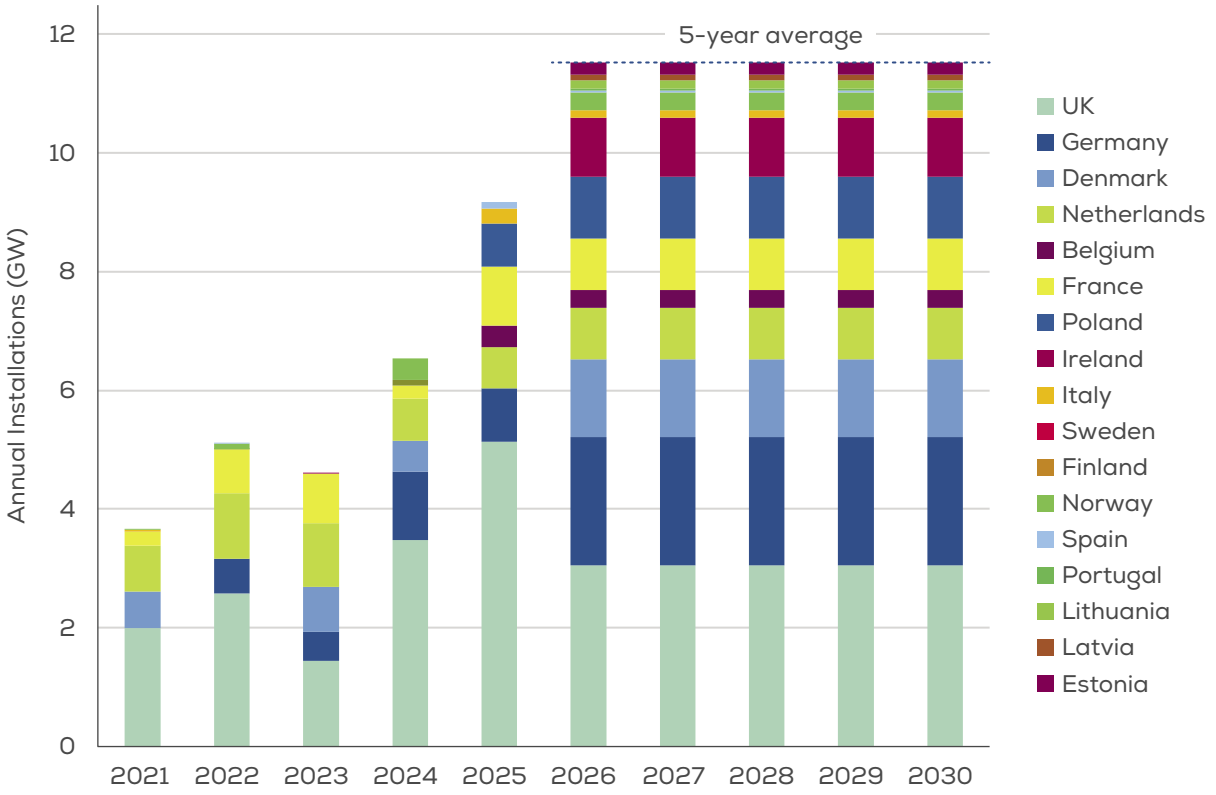
In the coming 2-3 years the implementation of the offshore strategy will determine whether the EU sets the right framework to meet the 25-fold increase of capacity expected by 2050. In the short-term up to 2030, large uncertainties remain on the ability of Governments to expedite permitting, including the coordination of their maritime spatial plans, and on the pace of grid build-out on- and offshore. Regional cooperation will be instrumental to deliver on all these. Delivering these big offshore wind volumes by 2050 will require development such as offshore hybrids, energy islands, offshore renewable hydrogen production, and multi-terminal HVDC systems which will require adjustments to EU legislation, notably on Market Design.

At national level, policy developments remain focused on 2030. The UK pledged to building 40 GW of offshore wind by 2030 and Denmark has identified areas up to 12.4 GW of offshore capacity to be auctioned in the coming decade. Positively, wind is becoming a pan-European story. There were crucial pieces of legislation tabled or adopted in Poland, Lithuania, Ireland, and Spain. And Governments from Greece, Turkey and Romania are in the process of drawing up their frameworks for developing offshore wind.

But policy has not been favourable to offshore wind everywhere. Challenges remained in Germany, which passed the Offshore Wind Bill (WindSeeG) after thorny discussions. The Government's initial proposal was to make developers pay for the right to build offshore wind farms. In the end, the legislation left the auction system unchanged for two years, with a future re-evaluation. Sweden remains closed for offshore wind and Portugal does not offer any government support for deployment.

In total, Government offshore wind commitments across Europe add up to 111 GW of offshore wind by 2030. To meet these volumes, Governments need to ramp up build-out from the current 3 GW/year to 11 GW/year by 2026 and sustain this installation pace And they should provide a clear pipeline of auctions for contracts for difference, which are the most cost-effective instrument for developing offshore wind.

FIGURE 19
European Offshore Wind Outlook to 2030[13]



Source: WindEurope

TABLE 9
European Offshore Wind Installation Forecast to 2030 (GW)

	2021	2022	2023	2024	2025	2026-2030 AVERAGE
Europe	3.7	5.1	4.6	6.5	9.2	11.4

Source: WindEurope

13. Pipeline of projects including tenders and government commitments established by law. The installations for the period 2026-2030 are a yearly average distributed to countries across a five-year period. For a detailed breakdown visit: www.windeurope.org/2030plans

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