Wind energy in Europe: Outlook to 2022

September 2018

Wind EUROPE

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This publication, the second in a series of annual reports, analyses how European markets will develop in the next 5 years (2018 to 2022). The outlook is based on WindEurope internal analysis and consultation with its members (surveys with national associations and dedicated workshop in June 2018).

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EXECUTIVE SUMMARY

Over the next 5 years European countries will (we hope) deliver on their 2020 renewable energy targets and will prepare their 2030 National Energy and Climate Plans (NECP) outlining their renewables trajectories to 2030. Wind energy will play a key role over the period, allowing many European countries to continue decarbonising their power systems in a cost-effective way and to continue the transformation of their energy systems.

Deployment in 2018-2022

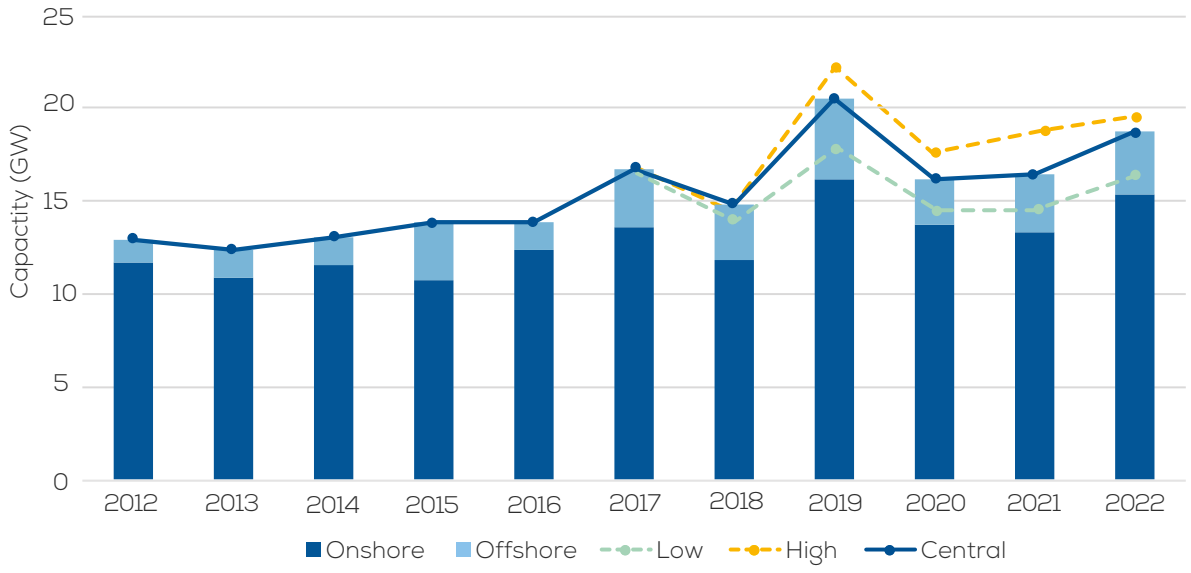
Europe can expect to see new installations of wind energy capacity at an average rate of 17.4 GW a year from 2018-22. The growth will come in both onshore and offshore wind. We expect 2019 to mark a new record in annual installations, with 20.5 GW. We expect Europe to reach a cumulative installed capacity of 258 GW by 2022.

We identified around 52 GW of planned capacity in auctions and tenders over the next 5 years.

European governments are driving much of this growth with auctions for new wind capacity. We currently anticipate around 26 GW of wind-specific auctions and tenders and a further 26 GW of auctions in which wind could bid.

However, policy uncertainty and lack of ambition for 2030 could have a significant negative impact on the sector. Visibility and regulatory certainty could increase by the end of the year, once EU countries submit their NECPs.

FIGURE A
Gross annual installations in Europe – WindEurope's Central Scenario



Source: WindEurope

New installations will remain concentrated in a small number of countries, with Germany, the UK, France, Spain and the Netherlands accounting for 62% of gross capacity additions. Germany's share of installations will fall significantly in 2019 due to record high installations in Spain and Sweden. Following this, France and non-EU countries will also increase their share.

Germany will remain the largest market over the next 5 years, with 24% of gross capacity additions. France will be second, with 14%.

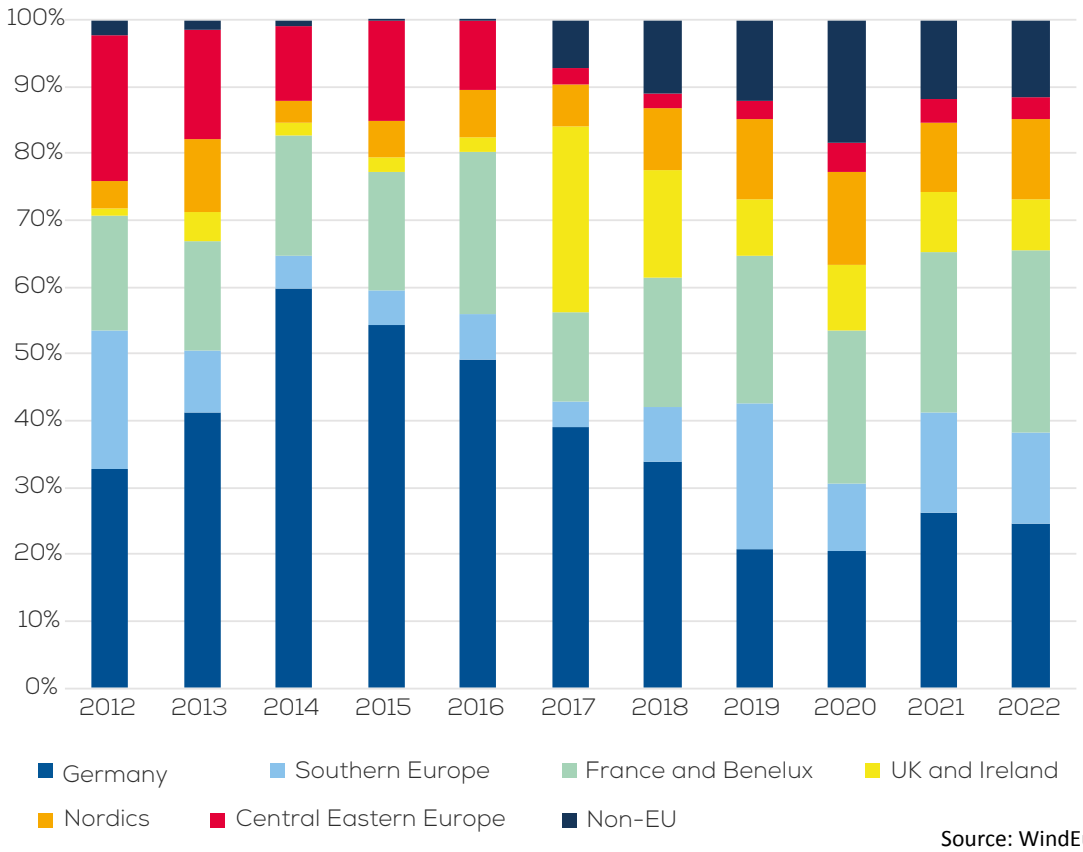
2019 will see a significant fall in new onshore installations in Germany but high installations in Spain, France and Sweden will make 2019 a record year overall. France and Turkey will increase their share of new installations from 2020. Total new installations will fall slightly in 2021 before another strong year in 2022.

Offshore wind will account for 19% of new installations over the period with volumes peaking in 2019 and 2022. Growth in offshore wind will come from the UK, the Netherlands, Germany, Denmark, Belgium and (for the 1st time) France.

Decommissioning volumes will be significant from 2020 onwards, impacting the rate of net additions and cumulative capacity. We expect between 4.3 and 6.4 GW to be fully decommissioned in the next 5 years.

The repowering market is becoming increasingly important as an important part of the the installed fleet will become older than 20 years by 2022. We expect between 4.7 and 7.3 GW of repowering projects in the next 5 years.

FIGURE B
Share of annual gross installations – WindEurope's Central Scenario



Source: WindEurope

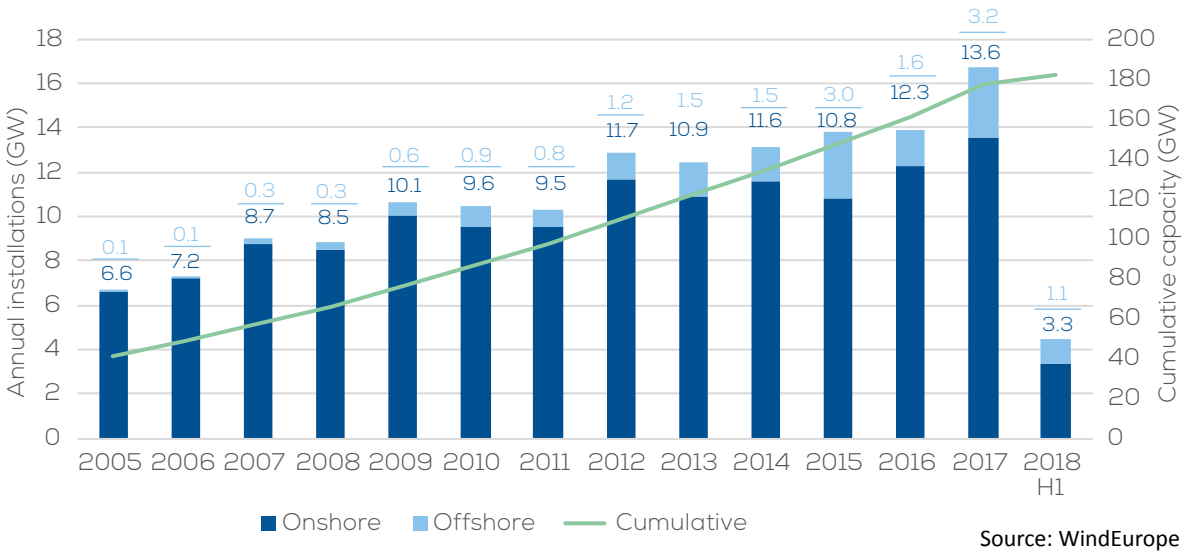
1. THE EUROPEAN WIND ENERGY MARKET TODAY

1.1 MARKET EVOLUTION

Annual wind power installations in Europe have increased more or less steadily over the past 11 years, from 6.7 GW in 2005 to 13.9 GW in 2016. 2017 has been a record year with 16.8 GW.

At the end of June 2018, Europe had a total of 182 GW of wind power capacity installed (165 GW onshore and 16.9 GW offshore). Germany remains the market with the largest installed capacity in Europe, followed by Spain, the UK, France and Italy. Five other European countries (Turkey, Sweden, Poland, Denmark and Portugal) have more than 5 GW installed. Eight additional European countries have over 1 GW of installed capacity: Austria, Belgium, Finland, Greece, Ireland, the Netherlands, Norway and Romania.

FIGURE 1
Wind energy gross annual and cumulative installations in Europe



Source: WindEurope

1.2 FIRST HALF OF 2018

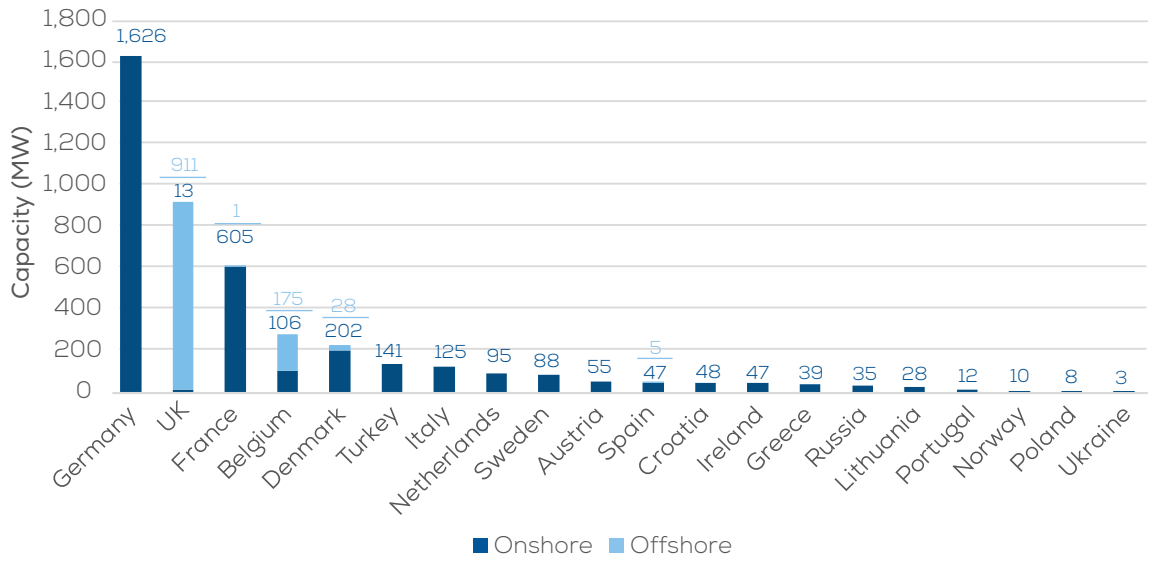
During H1 of 2018, project developers installed 4,451 MW of wind energy in Europe (3,333 MW onshore and 1,120 MW offshore). 13 out of 33 countries had no wind energy installations in the first half of 2018, while seven countries installed more than 100 MW.

71%

OF THE NEW WIND CAPACITY IN THE FIRST HALF OF 2018 WAS CONCENTRATED IN

3 COUNTRIES

FIGURE 2
Wind energy installations in H1 of 2018



Source: WindEurope

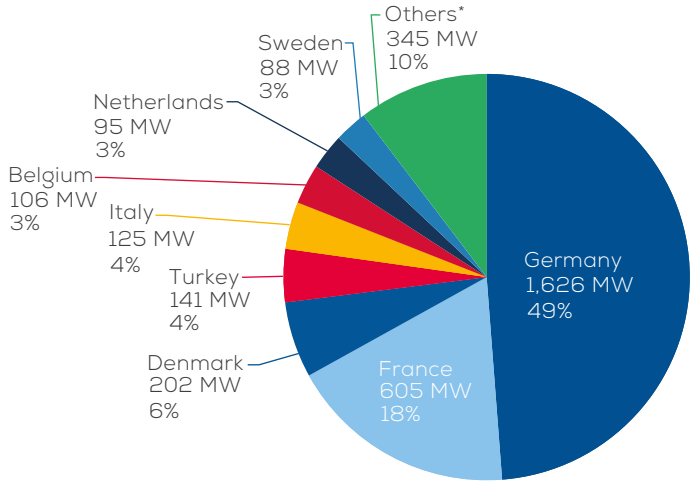
Onshore

In the first six months of 2018, Germany installed 1,626 MW, almost half of Europe's new onshore wind energy capacity. France followed with 605 MW, almost one fifth of the total installations. While Denmark started off the year with 202 MW of new installed capacity, the rest of the year does not look so optimistic. These three countries combined accounted for more than 73% of Europe's onshore installations.

17 more countries had new onshore installations in the first half of 2018. Turkey, Italy and Belgium installed 141 MW, 125 MW and 106 MW respectively. All three are expecting a better second half of the year. Similarly, the second half of 2018 should counteract slow starts to the year from Norway (9.9 MW), the UK (13 MW), and Ireland (47 MW).

13 countries did not install a single MW in the first half of 2018.

FIGURE 3
Onshore wind installations in the first half of 2018. Total 3,333 MW

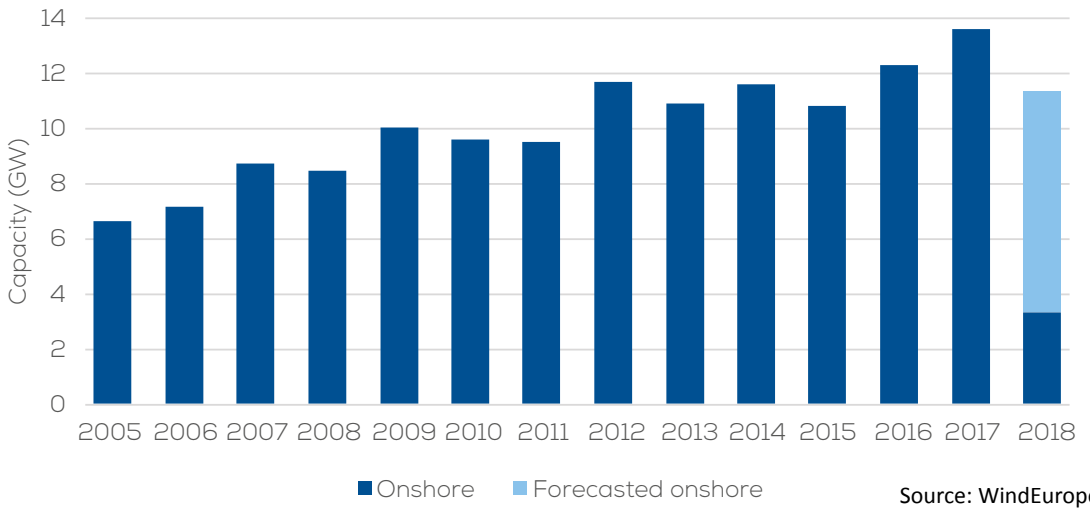


*Others: include Austria (55 MW), Croatia (48 MW), Spain (47 MW), Ireland (47 MW), Greece (39 MW), Russia (35 MW), Lithuania (28 MW), UK (13 MW), Portugal (12 MW), Norway (10 MW), Poland (8 MW) and Ukraine (3 MW)

Source: WindEurope

2017 was a record year for onshore installations. We expect to experience a decline from that record this year, but 2018 will still be a strong year. While the 3.3 GW of new onshore installations in H1 2018 might seem low, completion rates in the first half of a year are usually only around 30%. This is because developers tend to wait for the summer months for installation, as weather conditions are more suitable.

FIGURE 4
Onshore wind installations 2005-2018



Source: WindEurope

Offshore

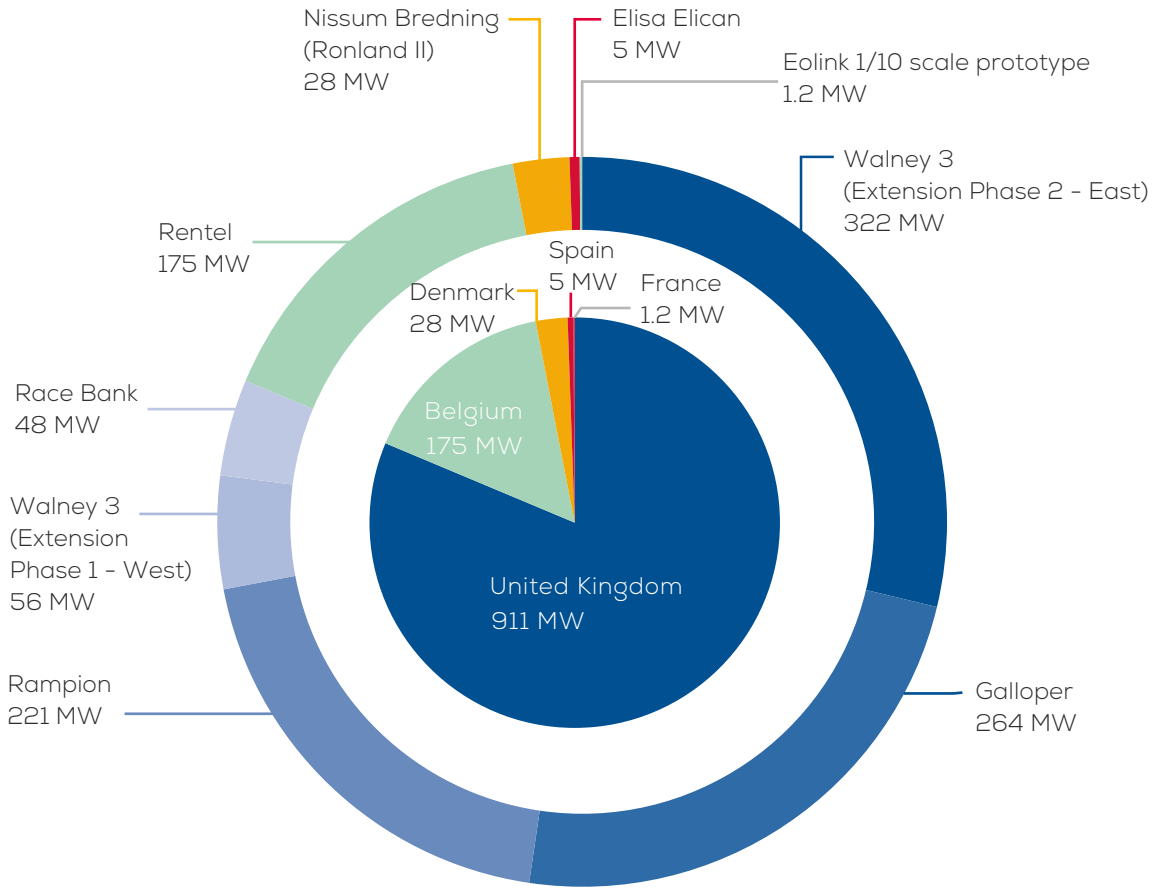
In H1 of 2018, Europe saw a net 1,120 MW of additional grid-connected offshore wind capacity installed. This was 17% below the amount installed in H1 of 2017. The new capacity came from nine offshore wind farms across five countries, totalling 200 grid-connected turbines. 231 new foundations were installed and 149 turbines were erected.

The United Kingdom connected 81% of Europe's new capacity, due to additions in five offshore wind farms. Belgium represented 16% of the total share due to the completion of the Rentel project. Denmark represented under 3% of the additions due to the Nissum Bredning offshore wind farm. France and Spain represented less than 1% of the market with their pilot projects of 1 turbine each.

Siemens Gamesa Renewable Energy (SGRE) provided 74% of the grid-connected turbines in H1 of 2018. MHI Vestas provided 25%. Adwen and Eolink provided the two remaining connected turbines. If we exclude Eolink, a floating demonstration project, connected turbines ranged in size between 3.45 MW and 8.8 MW.

The average size of grid-connected offshore turbines installed during H1 of 2018 is 5.6 MW. This is a 3% decrease from H1 of 2017. Only one of the 18 sites under construction in 2018 uses 3 MW turbines: one site is using 5 MW turbines; four sites are using 6 MW class turbines; eight sites are using 7 MW turbines and four sites are using 8 MW turbines. Aberdeen Bay has installed two 8.8 MW turbines, which are the most powerful wind turbines installed in a wind farm today.

FIGURE 4
Offshore wind installations in first half of 2018. Total 1,120 MW



Source: WindEurope

2. POLICY CONTEXT & MARKET TRENDS

2.1 POLICY CONTEXT

The EU has agreed on a 32% renewable energy target for 2030, with three interim targets and the possibility of upward revision in 2023. This is a significant improvement on the target of 27% the European Commission proposed in November 2016.

The new EU Renewable Energy Directive sets positive rules on the design of support mechanisms aimed at providing investor certainty. Member States will be allowed to have technology-specific auctions. Member States will also have to provide at least five years' visibility on the investment framework, including the timing, volumes and budget for auctions. The Renewable Energy Directive also includes an investment protection clause, preventing retroactive policy changes from impacting existing renewable energy projects. The Renewable Energy Directive will simplify permitting procedures for new and repowered installations, with shorter deadlines allowing for swifter build-out.

Towards market-based support schemes

A large number of European countries have already moved towards market-based support schemes, limiting the use of feed-in-tariffs to small installations and emerging renewable energy technologies. In Turkey, a feed-in-tariff is awarded via an auction. A few countries, such as Austria and Serbia, still remain on feed-in-tariffs, but Serbia has already announced that it will switch to a market-based feed-in-premium, joining the majority of European countries. Green certificates, another market-based instrument, are still in use in Sweden, Norway, Belgium and Romania.

A comprehensive review of national policies in all European markets can be found in our mid-year report: ***Wind Energy in Europe: National Policies and Regulatory developments***[1].

1. https://windeurope.org/members-area/files/protected/market-intelligence/reports/support-mechanisms/wind-energy-in-europe-national-policy-and-regulatory-developments-july-2018.pdf

2.2 MARKET TRENDS

Towards market-based support schemes

After the first offshore Danish auction in 2005 (which led to the Horns Rev 2 wind farm), many offshore projects have been awarded capacity through auctions in Europe (in the UK, the Netherlands, Germany, and France).

Until 2017, less than 10 GW had been allocated to onshore wind via competitive auctions, mainly in the UK, the Netherlands, Italy and Portugal. However, over 15 GW of capacity was awarded via competitive auctions in 2017. Most of the awarded capacity came from Germany, the UK, Spain, Turkey and the Netherlands.

Zero-subsidy bids

Since April 2017, Europe has seen 6 zero-subsidy bids in offshore wind in the Netherlands and Germany.

The first German offshore auction in 2017 awarded capacity to 3 zero-bids for the first time in Europe. The projects are expected to be completed by the 2024-2025, subject to Final Investment Decisions. The long lead time for the completion of the project enabled the developers to plan for larger turbines, potentially of 13 MW and 15 MW. Grid connection costs are covered by the transmission system operators. This is what has allowed developers to make the zero-bid possible. Ørsted, one of the winners, also plans to combine two awarded sites of 240 MW into one site of 480 MW in order to cut costs.

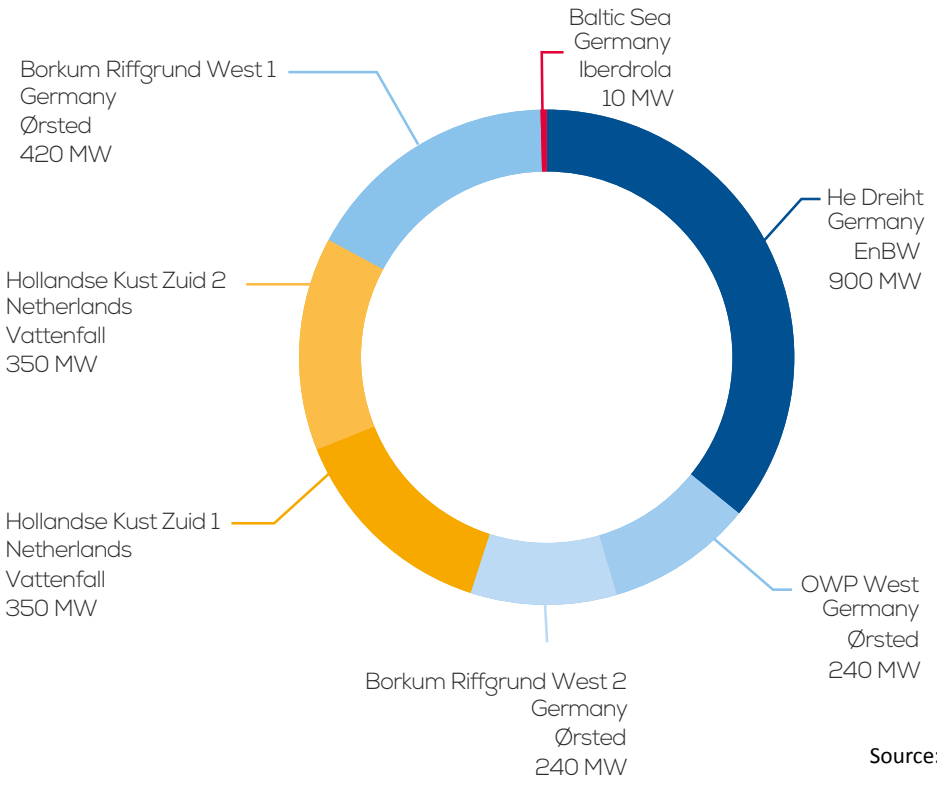
Following the German results, in December 2017 the Dutch government offered the Hollandse Kust Zuid site to developers allowing the submission of zero-bids. There were 4 zero-bids and the government chose Swedish utility Vattenfall via the Chinook unit of its Dutch subsidiary Nuon. The Dutch Government enabled the possibility of the zero-bid by taking care of the grid connections, committing to a carbon floor price at national level and giving clear visibility about future market volumes.

The second offshore auction in Germany again saw a zero-bid from Ørsted, which will cluster the previously awarded 480 MW into a 900 MW project. Additionally, the case for zero-bids was strengthened by the possibility to extend the operational lifetime of the assets from 25 to 30 years, as well as a growing market for long term corporate power purchase agreements (PPAs). Iberdrola also had a zero-bid for 10 MW, which will be used as an extension to a project that is already under development.

2,510 MW

OFFSHORE CAPACITY ALLOCATED UNDER ZERO-SUBSIDY BIDS

FIGURE 6
Confirmed zero-subsidy offshore projects in Europe (2,510 MW)



Source: WindEurope

The future of zero-subsidy bids

Zero-bids are not the new normal. They are only possible in certain markets, for certain players, under specific conditions. These include high competition in the market, the scalability of offshore wind, the optimisation of the value chain and exploited synergies between existing infrastructure and transmission system assets, long lead times and expected decline in technology costs.

All these conditions de-risk projects, therefore, in countries with such policy frameworks zero-bids are possible.

Due to the fact that they do not receive any market premium from the State, the viability of zero-bid projects depends on the level of the wholesale electricity price, or on a corporate PPA.

Zero-bids in onshore wind are not currently foreseeable, given the territorial constraints, generation profile and numerous levels of administrative authorization required. There were attempts for zero-subsidy bids in Spain, where developers didn't bid for investment subsidies. However, the auction offered a guaranteed minimum electricity price that partially addressed the risk of wholesale price volatility.

Unlike in Germany and the Netherlands, a zero-bid in offshore wind in the UK would not be possible given developers' responsibility there to provide both the grid connection and the support scheme design.

The next Dutch offshore tender as the Danish offshore auction, both planned in 2019, might witness new zero-bids.

Because of local content rules, previous auctions in Turkey, as well as the upcoming Turkish offshore tender, were not taken into account in this chapter.

ZERO-BIDS ARE AN EXCEPTION

TO THE RULE RATHER THAN THE NEW NORMAL

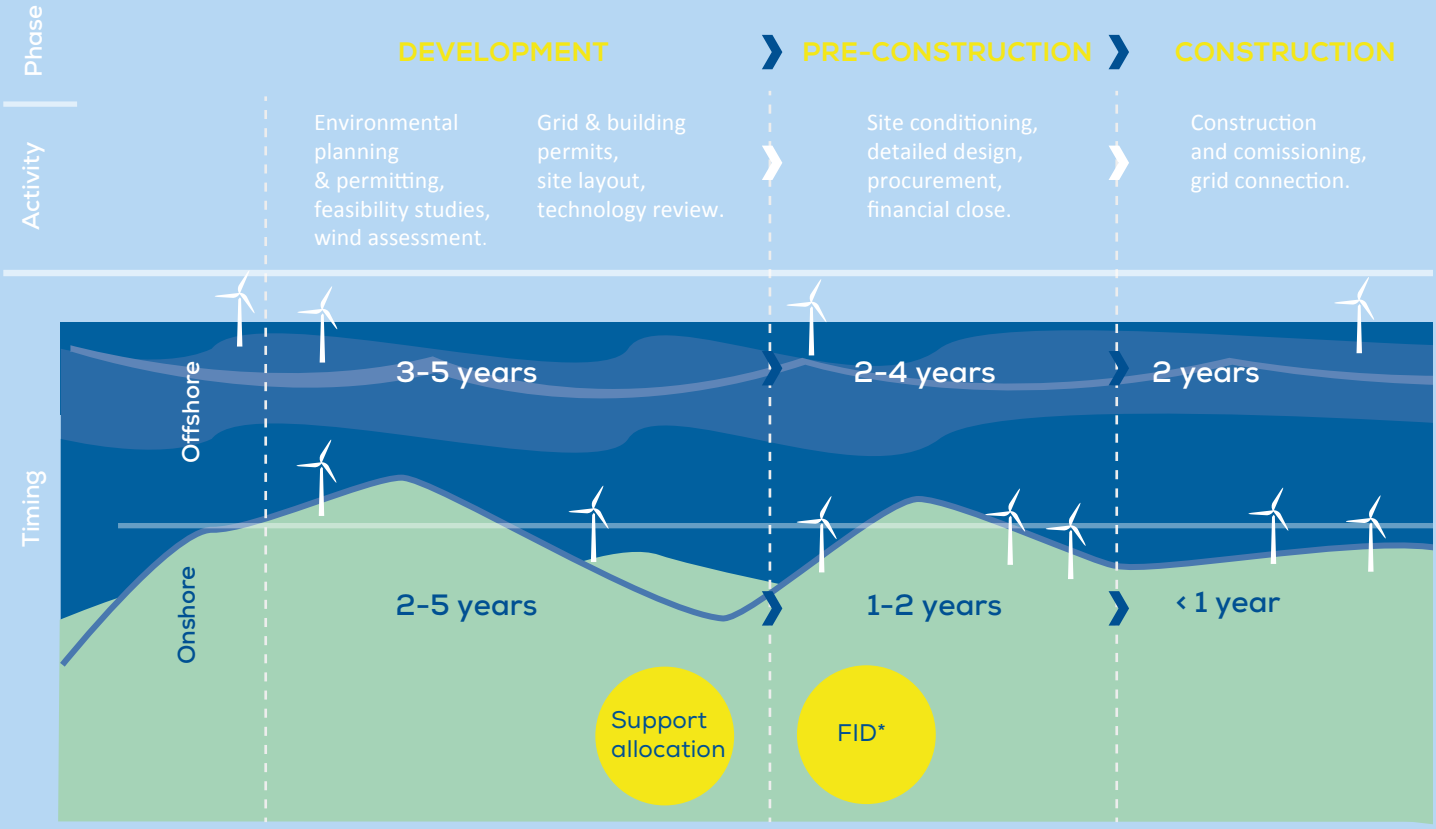
Considerations on projects' development timeline

Wind energy projects are characterised by a significant lapse of time between the moment a promoter is granted a support mechanism (e.g. tender results announcement) and the moment the wind farm starts to operate (grid connection). For onshore wind projects, this time is approximately two years. For offshore wind projects it can take around five years. The overall project timeline is much longer: this includes site investigation, resource assessment, environmental impact assessments and other technical studies and consultations with local communities and other administrative procedures. This is why it is crucial to have a good visibility on upcoming tenders and the regulatory framework.

Once a support mechanisms is granted or the capacity is awarded to the developer, the time allowed to realise projects is largely dependent on the regulatory framework. For instance, in Germany, large developers have a 30-month implementation deadline while community projects awarded in 2017 are allowed to connect their turbines to the grid up to 54 months after auction allocation. This might extend the time gap between auction results and new grid-connection installations.

Considering these times, the offshore volumes presented in this outlook (new installations grid-connected between 2018 and 2022) are based on support allocation that has already taken place. The accuracy, therefore, is high. Nonetheless, there is bound to be a gap between our Central Scenario and actual installations, as was the case last year. For onshore, the installations in 2018 to 2020/2021 are mostly based on the support and volumes allocated before the end of 2017. However, there is a larger degree of uncertainty for installations in 2021 and 2022, which could be affected by upcoming planned tenders (e.g. France and Ireland) and by tenders not yet announced at the time of publication.

For the investment outlook we consider that, for onshore projects, FID takes place 1 year before grid connection while for offshore wind projects the FID time is based on individual project analysis (from 2 to 3 years).



*Final investment decision

Future of tenders

Between October 2018 and 2022, around 52 GW of auction capacity are already set in the plans of eleven countries. Of this, 26 GW are specific to wind energy and approximately 26 GW[2] are technology-neutral, allowing the participation of wind. EU State Aid guidelines highlight technology-neutral auctions as compliant with EU competition rules.

52 GW

OF AUCTIONS PLANNED IN 2018-2022

However, under the recently agreed EU Renewable Energy Directive, Member States can also make use of technology-specific auctions. Countries such as Lithuania and Greece have already given indications that they would like to keep technology-specific auctions after 2020.

The largest technology-neutral auctions are planned in the Netherlands under the SDE+ subsidy program, with an annual budget of €6bn for onshore technologies which last until the end of 2020. The newly released Irish support mechanism (RESS) has technology-neutral auctions totalling around 2.4 GW by 2022.

A large part of the planned 52 GW (approx. 17 GW) will be auctioned already in 2019. We expect other countries to make additional announcements for the next 5-year period.

Germany has established an auction calendar, where 2.8 GW of technology-specific auctions for onshore wind are auctioned annually by 2020, followed by 2.9 GW annually until 2030. This does not include the additional 4 GW technology-specific auctions for onshore wind, promised by the coalition of the new CDU-CSU-SPD government. The next offshore tender will take place in 2021.

France will auction 1 GW of onshore wind annually through technology-specific auctions. The next offshore auction will take place in December 2018 and France has committed to holding the first-ever auction for floating wind in 2019.

The UK has recently announced a new CfD round to take place in May 2019 and 2021. The budget per round will be £557 million (€618 million), mostly for offshore wind, but it will also allow the participation of onshore wind projects in remote islands. The awarded capacity could be up to 2 GW per round.

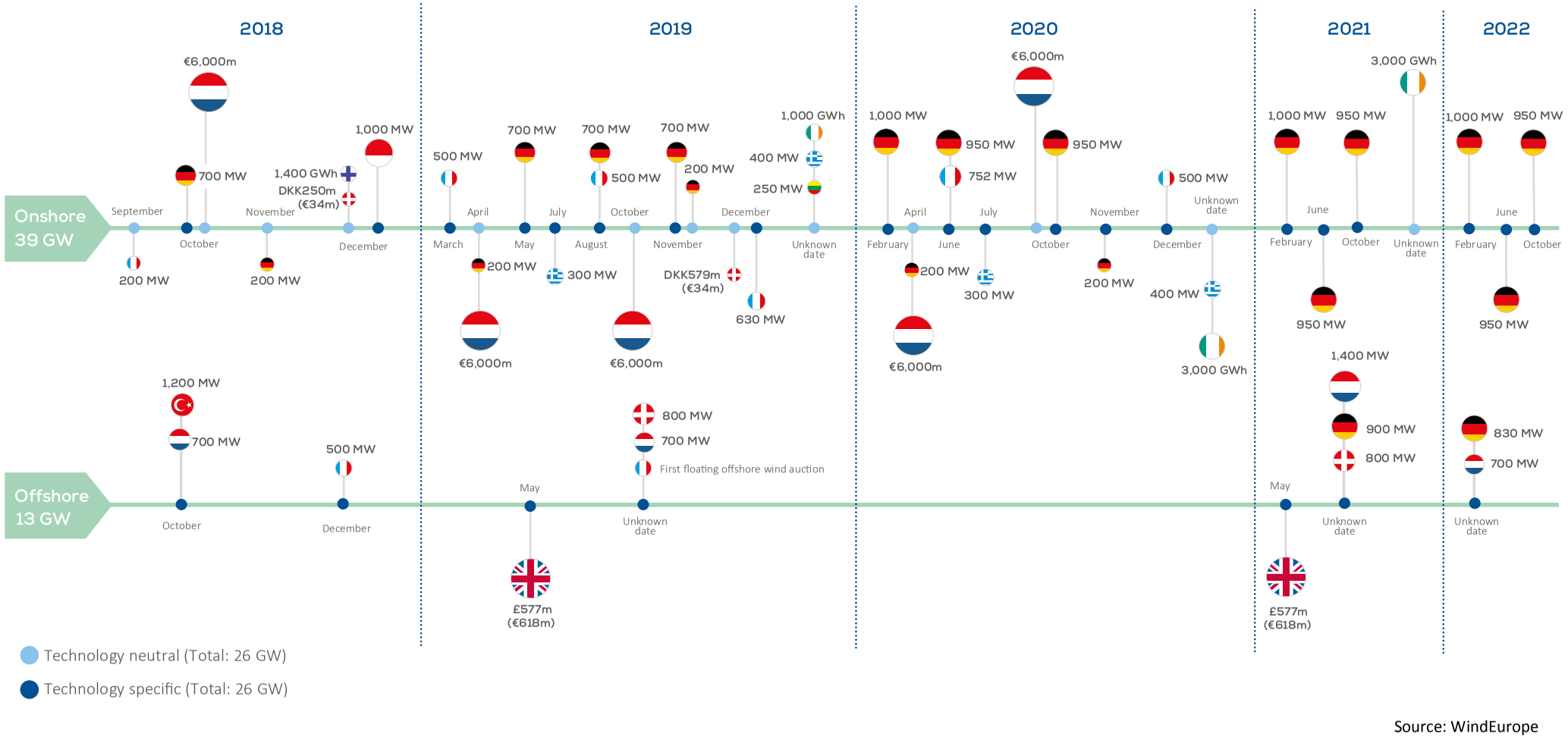
In Poland the recent amendments to the Renewables Act has paved the way for a 1 GW by the end of 2018, which could be split into two separate auctions of 500 MW, where the first would be held in 2018 and the second in early 2019.

The Spanish government has not set any additional auctions for renewable energy, although the recently appointed Government suggested the possibility of new auctions before 2020.

2. Some auctions volumes are defined by budget and not by capacity (e.g. the Netherlands, the UK)

FIGURE 7

Indicative auctions and tenders calendar until 2022



Source: WindEurope

An ageing wind fleet

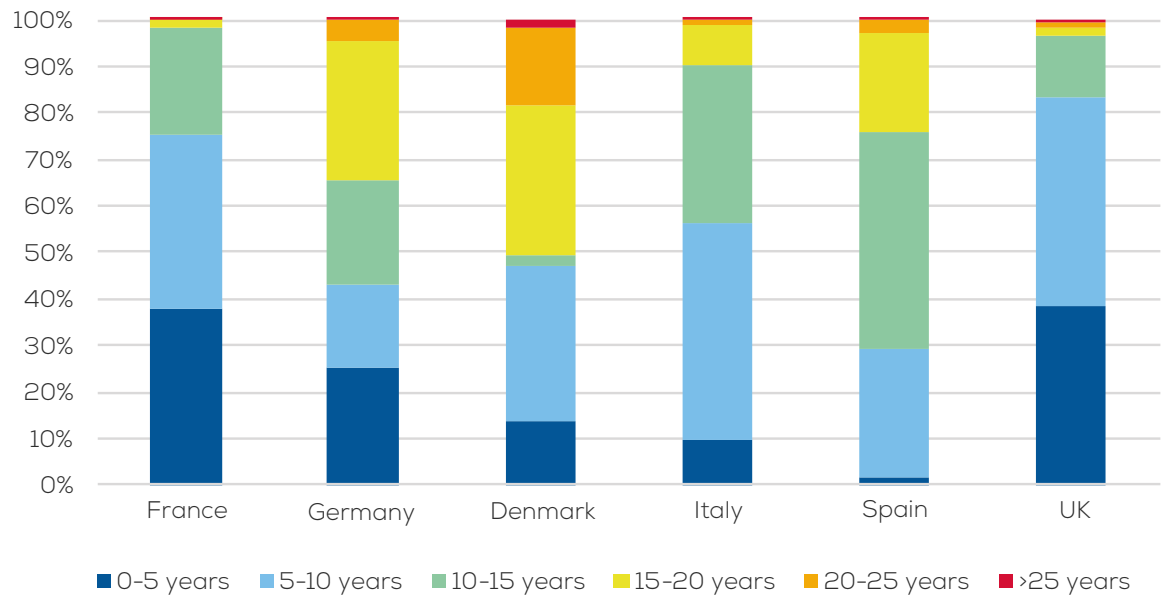
In 2017, 635 MW of wind power were decommissioned. This took place in the pioneering wind energy markets: Denmark, Germany and the Netherlands. Since most of those wind farms have been deployed in the areas with the best wind energy resource, it is clear that developers are looking into the possibility of repowering.

The main drivers for deciding to repower or simply decommission the plant are: the performance of the wind turbines (cost of O&M) and the length of the support frameworks (generally 20 years). And although some wind farms are over 25 and even 30 years old, we consider that, generally, the operational lifetime of wind farms is somewhere between 20 to 25 years.

In Germany, about 35% of the installed fleet is older than 15 years; the same applies for 25% in Spain and 51% in Denmark. To put this in perspective, more than 15 GW of wind farms in Germany are over 15 years old, 2 GW of which more than 20 years old. In Denmark, more than half (around 2.7 GW) of the wind fleet is older than 15 years, while 18% are older than 20 years.

In the next decade there will be a considerable number of wind farms reaching their end-of-life. A strong market will be needed: not just to replace the existing fleet, but to maintain a sustainable growth of the net installed capacity, progressively substituting fossil fuel-based generation.

FIGURE 8
Distribution of age of wind fleets, as of August 2018



Source: WindEurope

The case for repowering

Many of the wind turbines installed in the 90s are of a few hundred kW and are under 60m in hub height. If replaced by taller and more powerful turbines, the increase in energy yields could be considerable.

However, developers and manufacturers need to overcome obstacles to effectively repower existing sites. In some cases, repowering projects might be more cumbersome to develop than greenfield projects. Environmental regulation is much stricter today than it was 20-30 years ago. Regulations limiting the minimum distance between wind turbines and house dwellings have also changed in the last years.

These, and other aspects, lead to a complex permitting process that can delay repowering projects by several years. In Germany, around 40% of existing sites will not be eligible for repowering due to changes in regulation.

According to the EU Renewable Energy Directive, permitting procedures for repowered installations will be simplified, with shorter deadlines for swifter build-out. It is important to follow this up by stressing the need for a repowering strategy in the National Energy and Climate Plans.

Repowering projects

Examples of repowering projects that are taking place across Europe:

Roter Berg Reinholterode (Germany)

4 Enercon turbines of 1.5 MW are being replaced with **6 Vestas turbines of 3.45 MW**, tripling the output of the wind farm from **6 MW to 20.7 MW**.

El Cabrito (Spain)

90 Kenetech turbines of 333 kW are being replaced with **15 Nordex turbines of 2.3 MW**, which will increase the output of the wind farm **from 30 MW to 36 MW**.

Tauernwindpark in (Austria)

Tauernwindpark in Austria will replace **13 Vestas wind turbines of 1.75 MW** with **9 Vestas turbines** of **3.45 MW**, **increasing** the wind farm's output by **36%**.

3. MID-TERM MARKET OUTLOOK

3.1 INTRODUCTION

The mid-term wind energy market outlook analyses the likely development of wind power capacity in Europe in the next five years. It consists of three scenarios:

- Our Central Scenario, which provides a best estimate of the installed capacity in Europe in the next 5 years. According to this scenario, there will be 258 GW cumulative installed capacity in Europe, with an average annual gross market of 17.4 GW.
- Our Low Scenario, in which European governments propose no positive improvements from current legislation, leading to 248 GW cumulative installed capacity.
- Our High Scenario, in which European countries improved their legislative framework, leading to 264 GW cumulative installed capacity.

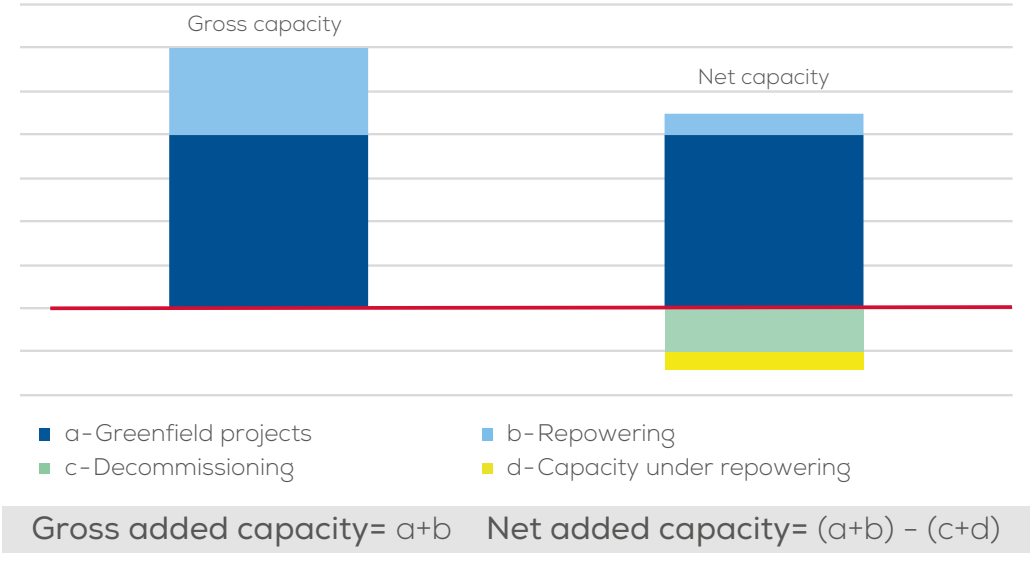
All three scenarios reflect potential developments in EU regulatory frameworks, national policies, project development timelines and the performance of the wind industry in winning capacity in upcoming auctions and tenders.

We use the term gross annual installations to refer to new installations, including greenfield projects and new capacity from repowered projects.

We also account for expected decommissioning volumes, per country and per year. We use the term net additional capacity to refer to the gross annual installations minus decommission capacity.

This net additional capacity is used to calculate the eventual cumulative capacity. See figure 9 for more details.

FIGURE 9
Gross vs. net added capacity - accounting for decommissioning and repowering



Source: WindEurope

In onshore wind: developers in Spain have a 2019 deadline to meet for those projects awarded in the 2016 and 2017 auctions. The government set those times to enable Spain meeting its 2020 RES target.

In Sweden, with an addition 18 TWh of wind target by 2040, new green certificates have been injected in the market. Developers are rushing to obtain this market support and we expect 2019 to be a record year in terms of installations.

In offshore wind: given the number of projects consented and under construction in the UK and Germany, we also expect the offshore market to peak next year.

2019

WILL BE A NEW RECORD YEAR IN WIND INSTALLATIONS

OFFSHORE

WILL REPRESENT

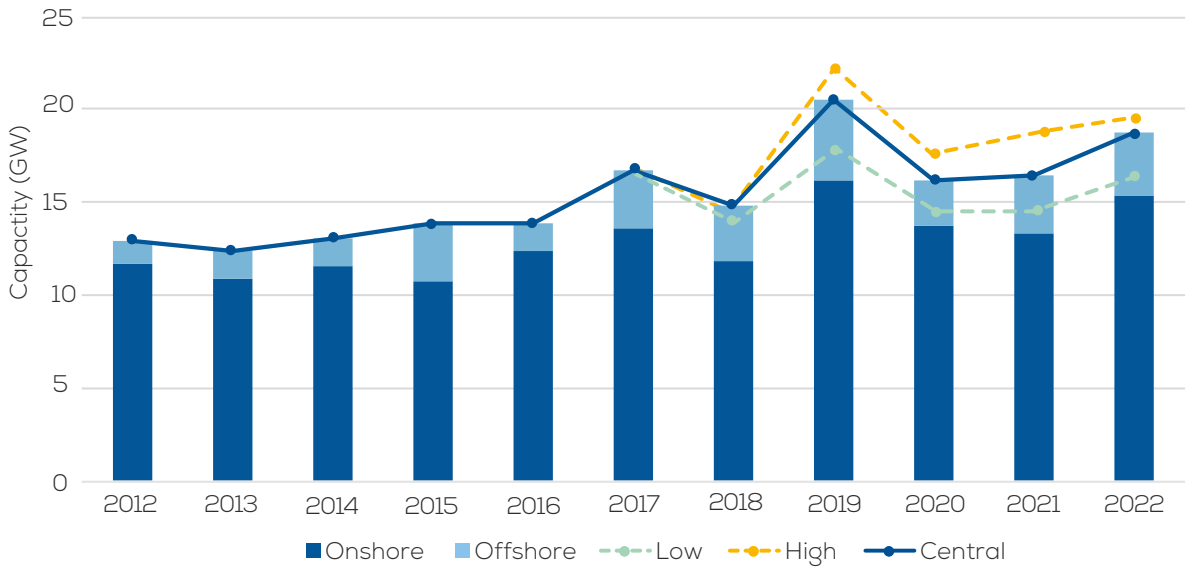
19% OF THE MARKET BY 2022

Overall, installations in 2020 will remain strong (the third best year on record following 2019 and 2017, with the following years experiencing a steady increase. 2019 will also be a record year for offshore, due to strong developments in Germany and the UK. 2022 should also be a strong year due to the French additions of the recently re-negotiated offshore projects.

With an average 3.3 GW/year, the offshore market will represent about 19% of the total market until 2022 (compared to a 15% share in the last 5-year period).

FIGURE 10

Gross annual installations in Europe – WindEurope's Central Scenario

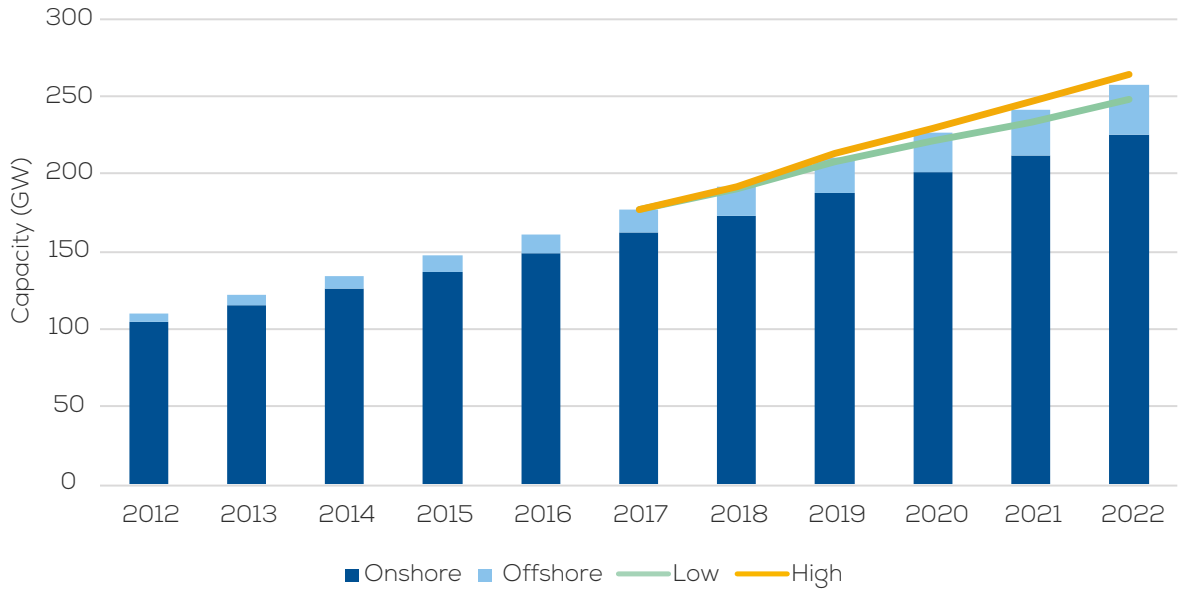


Source: WindEurope

With around 258 GW of cumulative capacity across Europe by 2022, Germany will remain the country with the most capacity installed (between 66.5 to 68.4 GW). Spain will come second, with 27 GW to 31.5 GW.

We expect a significant amount of capacity to be fully decommissioned in the coming years (between 4.7 GW and 7.3 GW in the next 5 year period). This will mostly occur in Germany, Spain and Denmark.

FIGURE 11
Expected cumulative installed capacity until 2022 in Europe



Source: WindEurope

3.2 CENTRAL SCENARIO

WindEurope's Central Scenario provides a best estimate of the installed capacity in Europe in the next 5 years. This scenario takes into account the pipeline of wind energy projects and the ongoing legislation in European countries that could enable the deployment of volumes. In addition, it reflects the impact of the 2020 targets, the existence of longer-term national targets and the calendar for auctions. For offshore wind, the Central Scenario assumes that all projects are built according their currently-projected timeline.

In the Central Scenario, the planned tenders in Germany, France and the Netherlands provide a good visibility on the post-2020 market development. In both Spain and Ireland, 2020 targets are providing a clear guidance on the deployment of wind capacity.

In Greece and Denmark, the new auction rounds give hopes of recovery in 2022. Current economic instability means the Central Scenario for Turkey is significantly downgraded compared to last year's more optimistic expectations.

Under the Central Scenario, 2018 might be the weakest year for the whole 5-year period, with a mere 14.8 GW of gross installations. But 2019 will mark a record year with 20.6 GW, followed with a slow-down in 2020 of 16.3 GW. We expect a steady increase in 2021 and 2022. As we experience more decommissioning in the comings years, annual net additions will stabilise in 2021 and 2022.

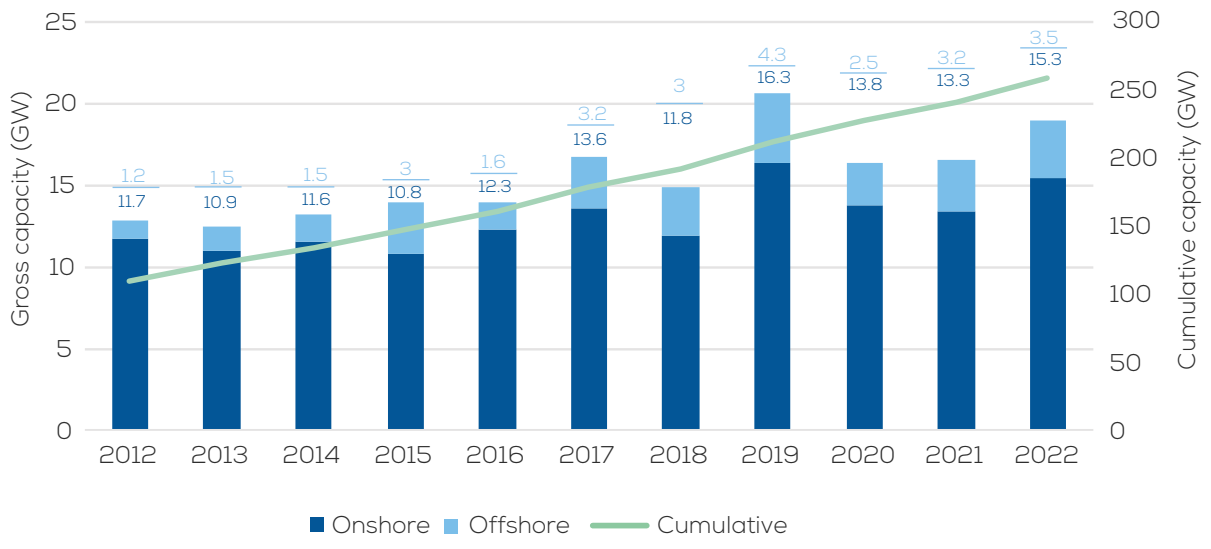
INSTALLED CAPACITY COULD REACH 258 GW IN 2022

Onshore

Between 2018 and 2022 onshore installations will reach 70.4 GW at an average rate of 14.1 GW/ year. Germany will be the leader in onshore wind with 18.5 GW gross additions (26% of the total onshore market), followed by France (9.7 GW), Spain (7.2 GW) and Sweden (4.7 GW). From non-EU countries, Norway and Turkey will be the largest markets, with 3.3 GW each, while Russia will pass the 2 GW threshold. The Netherlands, Italy and Finland will all install over 2 GW onshore wind over the next 5 years.

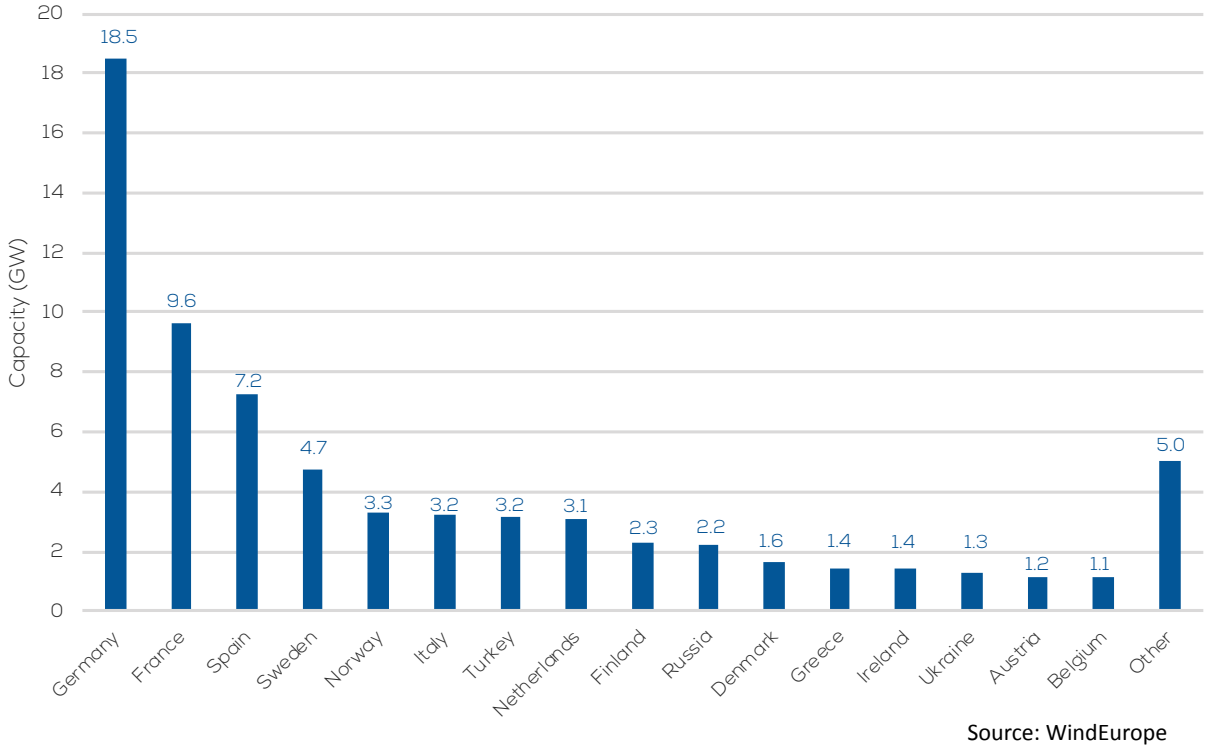
GERMANY WILL CONTINUE BEING THE LARGEST MARKET FOR ONSHORE WIND

FIGURE 12
Annual gross installations in Europe – WindEurope's Central Scenario



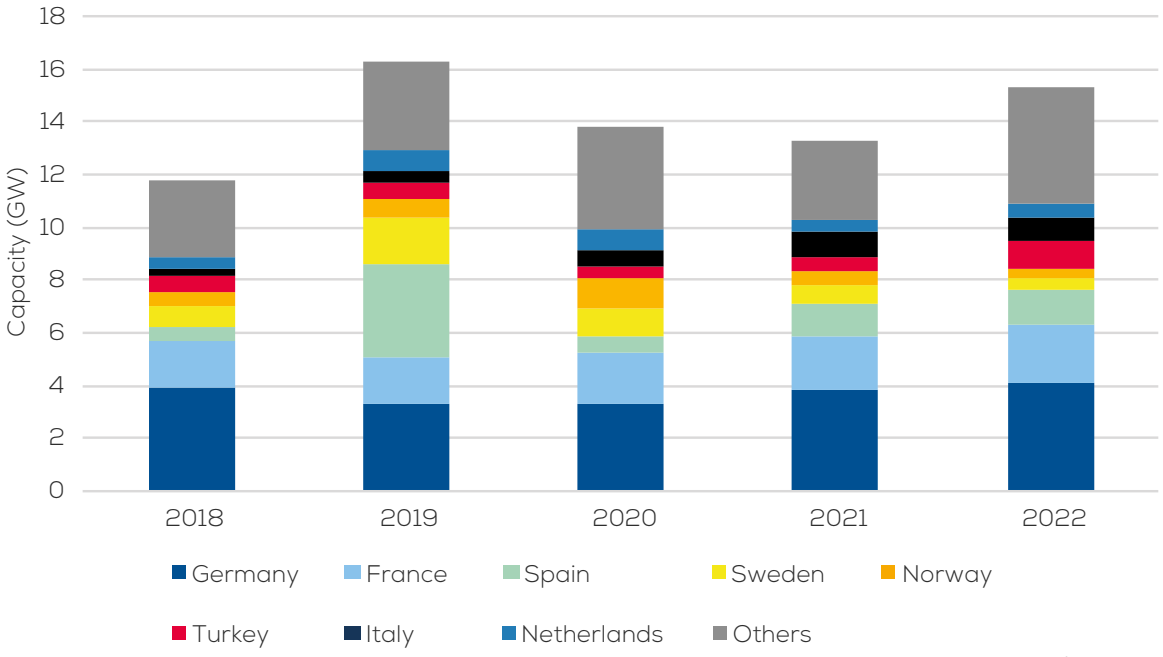
Source: WindEurope

FIGURE 13
2018-2022 gross installations of onshore wind per country[3]



Source: WindEurope

FIGURE 14
Annual gross onshore installations per country[3] – WindEurope's Central Scenario



Source: WindEurope

3. To see the onshore data for countries under Other, login to https://windeurope.org/members-area/market-intelligence/market-data-interactive-tools/

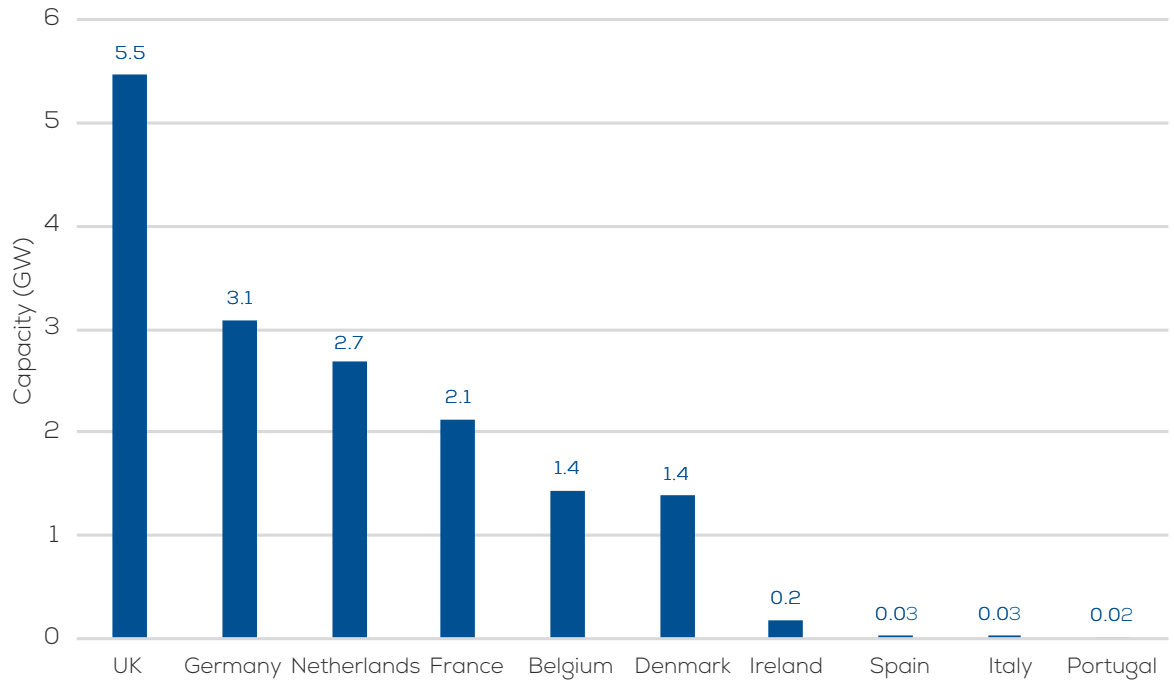
Offshore

According to our Central Scenario, between 2018 and 2022 offshore installations will reach 16.5 GW. With an average 3.3 GW/year, offshore wind will represent about 19% of the total market of the 5-year period (compared to a 15% share in the last 5-year period). Installations will concentrate mainly in the UK, with 5.5 GW or 33% of all the new grid-connected capacity. Another 5 countries will see large offshore installations: Germany (3.1 GW), the Netherlands (2.7 GW), France (2.1 GW), Belgium and Denmark (1.4 GW each). Spain, Italy and Portugal will have small projects.

2018 will be a solid year for offshore wind (3 GW), while 2019 will mark a record year with annual gross installations reaching 4.3 GW thanks to strong activity in both Germany (1 GW) and the UK (1.1 GW). In Germany, projects such as EnBW Hohe See and Deutsche Bucht are expected to connect 552 MW of capacity. In the UK, the Hornsea 1 Heron Wind + Njord and Beatrice 2 will bring an additional 738 MW of offshore capacity.

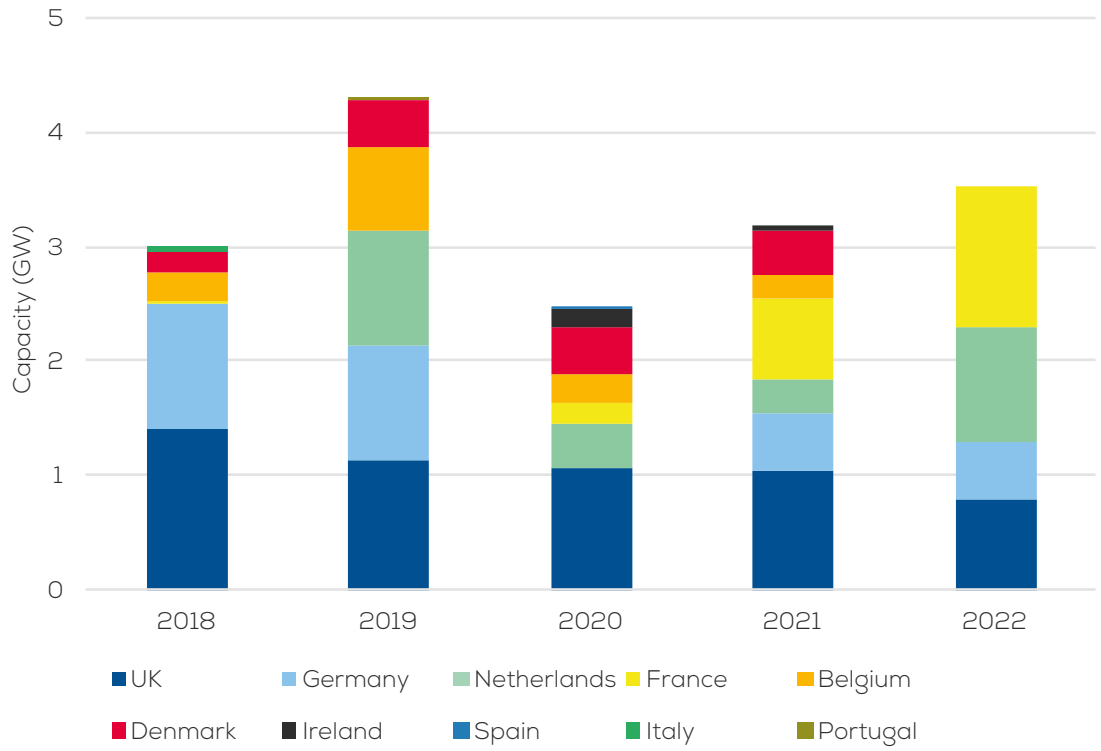
UK TO REMAIN THE LARGEST OFFSHORE MARKET

FIGURE 15
5-year offshore gross installations (2018-2022) per country – WindEurope's Central Scenario



Source: WindEurope

FIGURE 16
Annual gross offshore installations per country – WindEurope's Central Scenario



Source: WindEurope

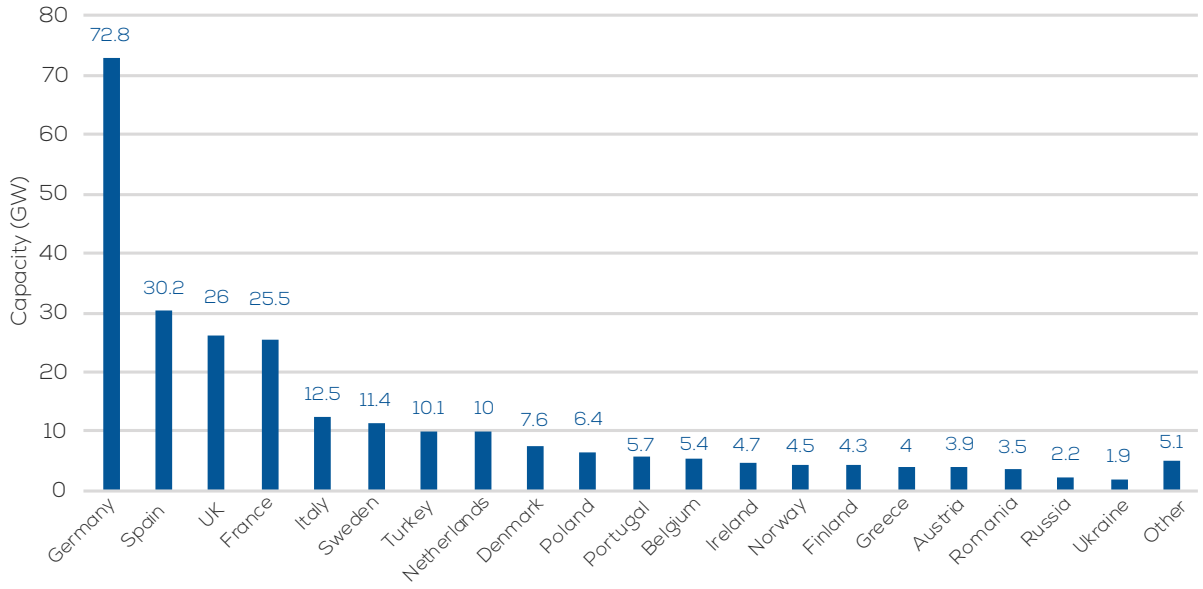
Cumulative capacity and geographical trends

In cumulative terms, Europe will reach 257.6 GW of installed capacity by the end of 2022. Germany will remain the country with the largest wind fleet (72.8 GW), followed by Spain (30.2 GW), the UK (26 GW) and France (25.5 GW). Four other countries will be above the 10 GW threshold (Italy, Sweden, Turkey and the Netherlands).

60%

OF ALL THE CUMULATIVE WIND FLEET WILL BE IN JUST 4 COUNTRIES

FIGURE 17
Cumulative capacity in 2022 per country – WindEurope's Central Scenario



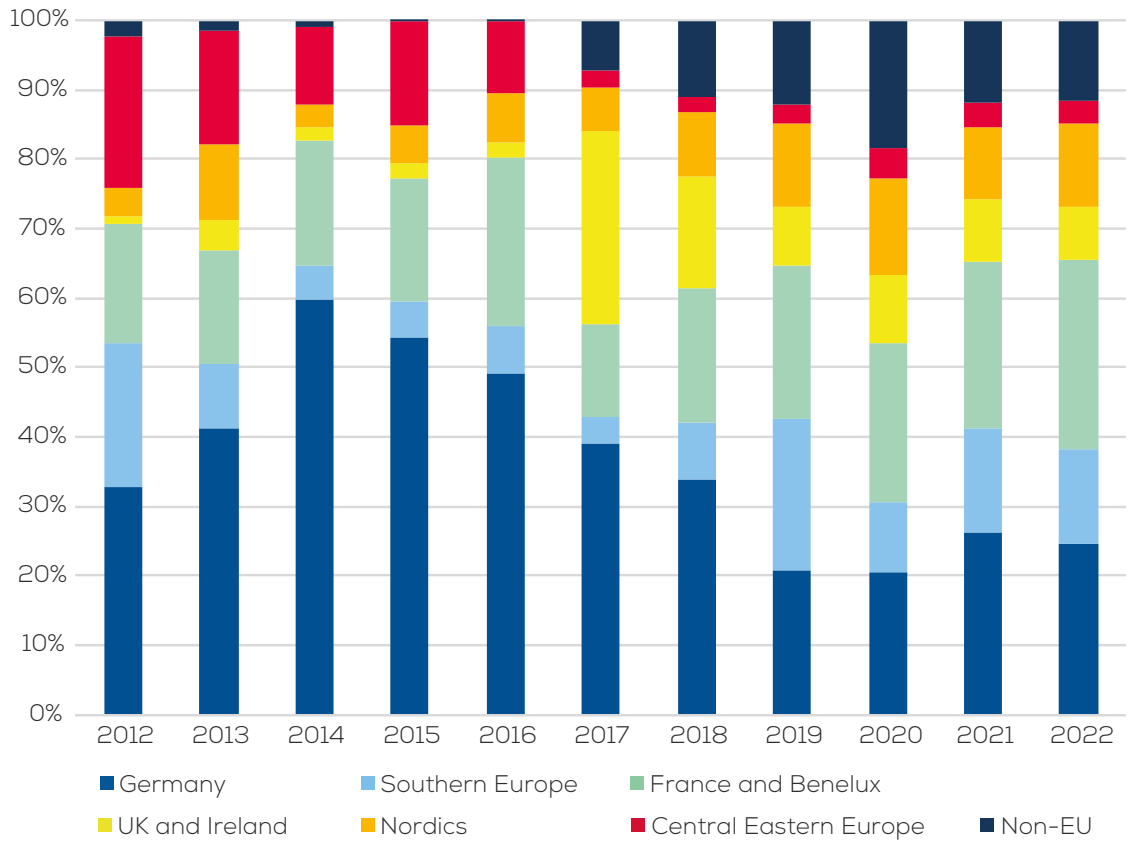
Source: WindEurope

In the Central Scenario, Germany's market dominance (over 40% in the last 5 years) will make way for other regions. The French and Benelux markets will increase from 13% in 2017 to 27% in 2022, thanks in part to growing offshore additions in France and the Netherlands. Non-EU countries will also be significant, with approximately 15% of annual installations driven by a strong Turkish market and growing activity in Russia and Ukraine. Southern Europe will growth to 22% of the market in 2019 thanks to peak installations in Spain and will consolidate with about 13% share due to important activity in Italy and Greece. Nordics will have a stable share of above 10%.

Activity in Central Eastern Europe, despite policy improvements that could lead to improved activity (e.g. Poland), will remain marginal with 14 countries contributing less than a 5% share combined.

FRANCE AND BENELUX:
THE FASTEST GROWING REGION WITH
27% MARKET SHARE BY 2022

FIGURE 18
Share of annual gross installations by region – WindEurope's Central Scenario



Source: WindEurope

ADDITIONAL

80 GW

OF NET CAPACITY WILL BE ADDED IN EUROPE IN THE NEXT 5 YEARS, TOTALING

258 GW in 2022

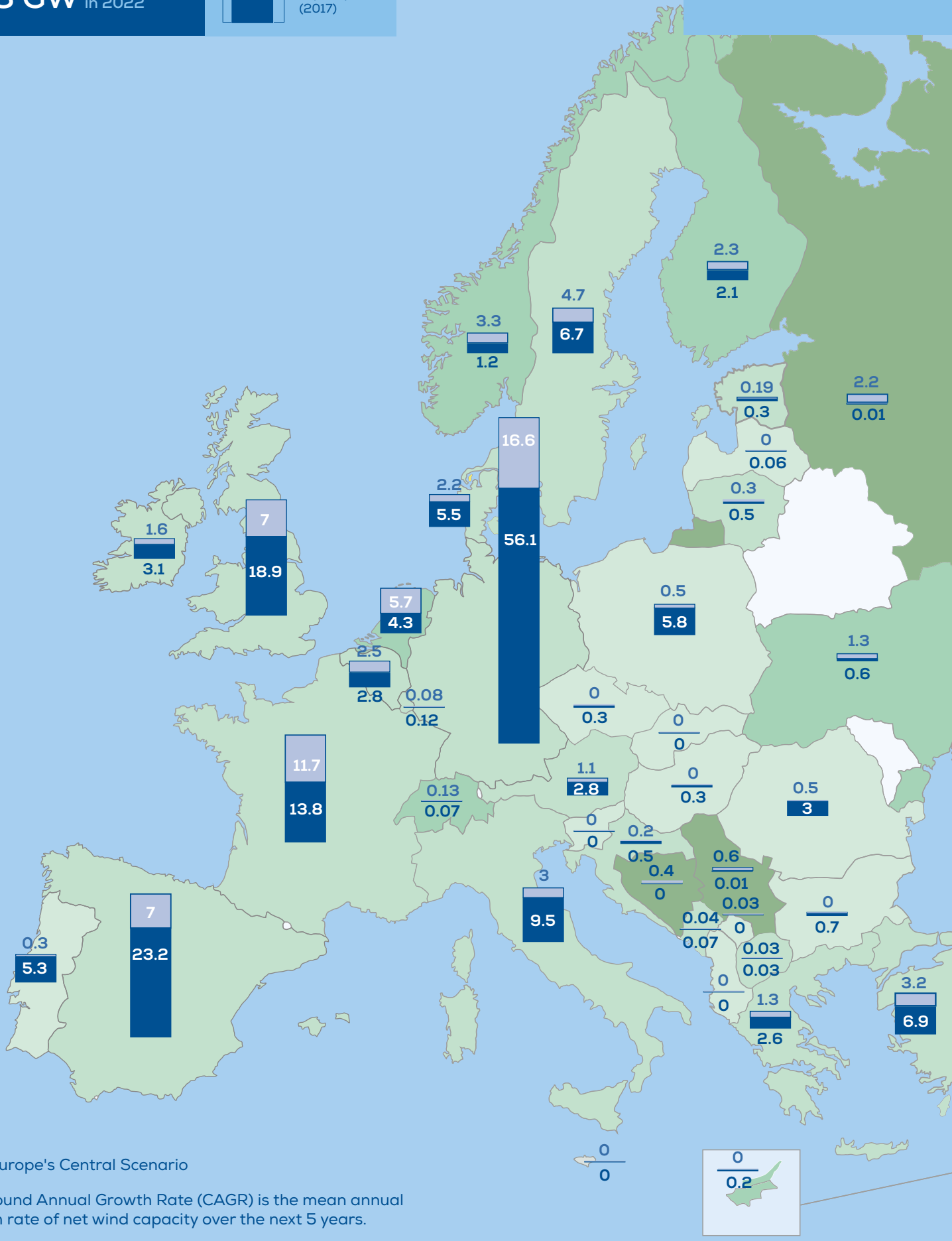
New added net capacity (2018-2022)

GW

Cumulative installed capacity (2017)

Compound annual growth rate (CAGR)

- Above 35%
- 15-35%
- 5-15%
- 0-5%



WindEurope's Central Scenario

Compound Annual Growth Rate (CAGR) is the mean annual growth rate of net wind capacity over the next 5 years.

Repowering

Today, about 4 GW of installed capacity is more than 20 years old. Within the next 5 years an additional 18 GW will become more than 20 years old. This raises the question how many of these wind farms can be repowered.

We have developed two different scenarios for the rate of repowering of the whole installed fleet. The Low repowering scenario assumes that 30% of the installed fleet at any point in time will be repowered. The High repowering scenario assumes a 50% repowering rate. The box in the right shows the different assumptions behind each scenario. The two scenarios would result in a repowering volume of between 4.7 GW and 7.3 GW in the next 5 year period. This means that between 4.3 and 6.4 GW would be fully decommissioned during the same period.

WindEurope assumes that after 20 years of operation, half of the capacity (50%) remains in the system while the other half is either repowered or fully decommissioned. Of the half that remains in the system, 80% (i.e. 40% of the total capacity) will be decommissioned or repowered after 25 years. Another 20% (i.e. 10% of the total capacity) will operate for 30 years, followed by full decommissioning.

Overall 10.4 GW of old turbines would be dismantled between 2018 and 2022 (irrespective of whether the sites are fully decommissioned or repowered) which would require the significant scaling-up of recycling solutions.

When calculating onshore repowering volumes, we assume the new installed capacity is 20% higher than the capacity of the original wind farm. So if a 10 MW wind farm is repowered, we assume the new capacity will be 12 MW.

Assumptions

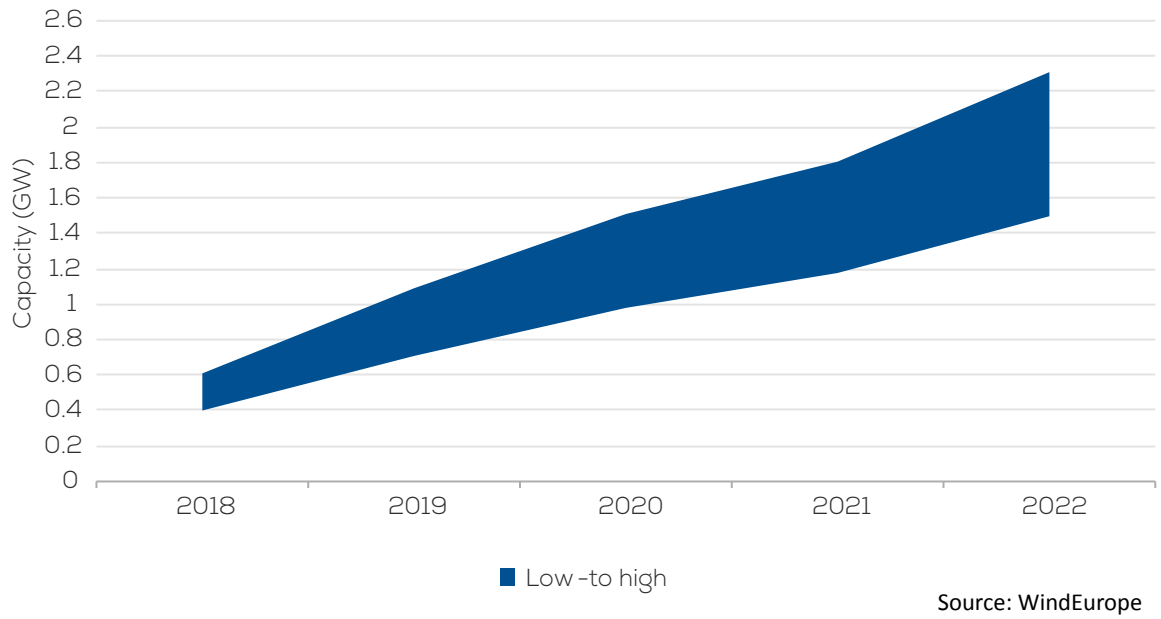
LOW REPOWERING SCENARIO

- **30% Repowered**
  - 20% after 20 years
  - 10% after 25 years
- **70% not repowered**
  - 30% decommissioned after 20
  - 30% decommissioned after 25
  - 10% after 30 years

HIGH REPOWERING SCENARIO

- **50% Repowered**
  - 30% after 20 years
  - 20% after 25 years
- **50% not repowered**
  - 20% decommissioned after 20
  - 20% decommissioned after 25
  - 10% after 30 years

FIGURE 19
Expected repowering capacity



Source: WindEurope

3.3 LOW SCENARIO

In our Low Scenario, we assume that European governments propose no positive improvements from current legislation. Consequently, all countries with no incentives for wind energy remain with no new installations, despite failing to reach their renewable energy targets. The permitted and already supported pipeline is built but unfavourable national policies for permitting and planning persist; this results in a slow pace of installations for existing permitted projects and a significant slowdown for awarding new projects. The outlook remains positive in countries that have sent strong political signals to the wind energy industry in recent years.

Nonetheless, even under the Low Scenario, 2019 is still a record year for installations with 18 GW.

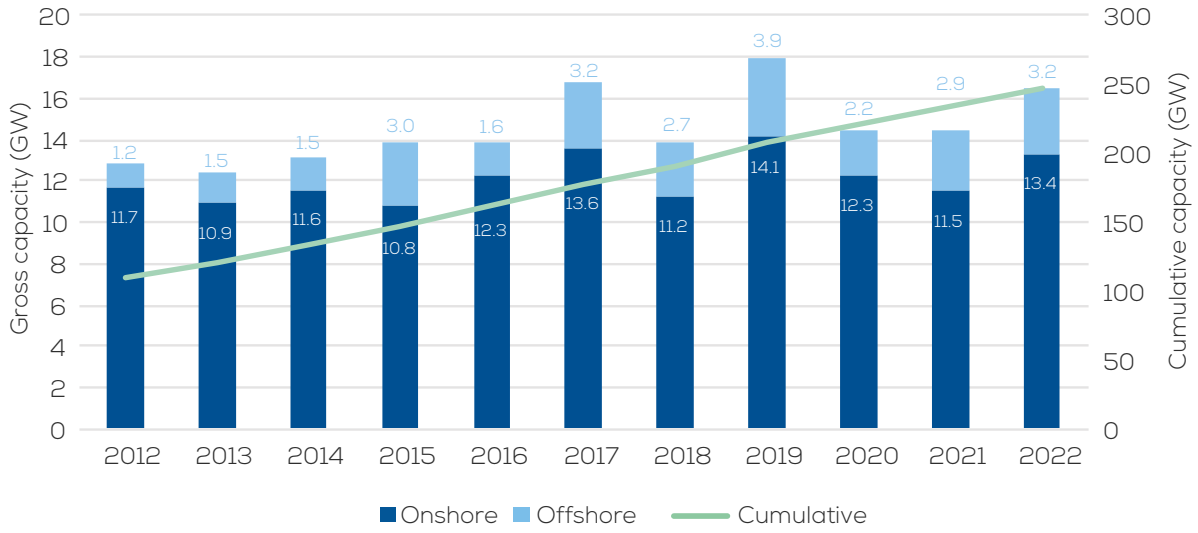
Overall, we expect a 9.3 GW drop from the Central to the Low Scenario in 2018-2022 installations, with an annual installation rate of 15.5 GW/year. This would lead to a cumulative capacity of 248 GW by 2022.

The Low Scenario assumes no new auctions for wind energy in Spain, with the market would only relying on merchant projects. This would represent a 3.2 GW drop in foreseen installations for the 5 year-period.

In Germany, the citizens' projects awarded in 2017 onshore auctions (without permits) are causing a lower realization rate. This would lead to a 0.9 GW drop compared to the Central Scenario.

With regards to offshore, the Low Scenario foresees a slower installation rate mainly due to delays, causing a 10% lower installation capacity over the next 5 years.

FIGURE 20
Annual Gross installations – WindEurope's Low Scenario



Source: WindEurope

3.4 HIGH SCENARIO

In the High Scenario, the legislative framework in European countries is improved. Those changes would allow developers to build the current project pipeline entirely. In the High Scenario, governments also boost the auction volumes to accelerate the pace of installations and also ensure more cost reduction. Offshore, all projects are built according to their more optimistic schedule.

After an impressive 2019 year record with almost 22.4 GW of gross installed capacity (1.8 GW more than in the Central Scenario), 2020 would still be a strong year with 17.7 GW. Afterwards, 2021 would experience a rebound year of 18.8 GW of gross added capacity, followed by an even better 2022 of 19.4 GW.

Overall, we expect about 6.3 GW more installations in the High Scenario when compared to the Central Scenario, with an annual installation rate of 18.6 GW/year. This would lead to a cumulative net capacity of 264 GW by 2022.

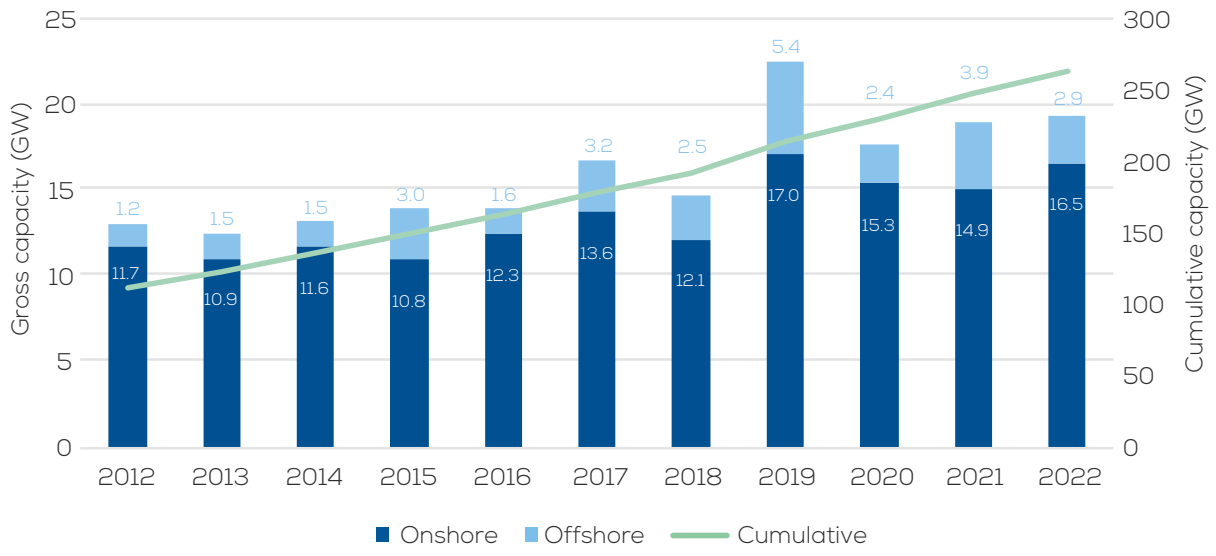
In Germany the promised additional volumes for onshore wind and solar PV (German's new government coalition agreement) would be auctioned in 2019, bringing an additional 1.1 GW of onshore wind in the period 2018-2022 (as compared to the Central Scenario).

Spain would hold additional auctions to compensate for the planned phase-out of nuclear power plants. The deployment of new onshore auctions in Spain, Poland and Turkey could add new installations after 2019 (bringing an additional 1.1 GW in Spain and 0.7 in Poland and Turkey combined).

An improved permitting process in France would also increase onshore installations by an additional 0.5 GW.

For offshore wind, the High Scenario anticipates a faster buildout, bringing forward some capacity expected in 2023 or later under the Central Scenario, such as 400 MW in Turkey, 300 MW in Italy and 200 MW in Spain

FIGURE 21
Annual Gross installations – WindEurope's High Scenario



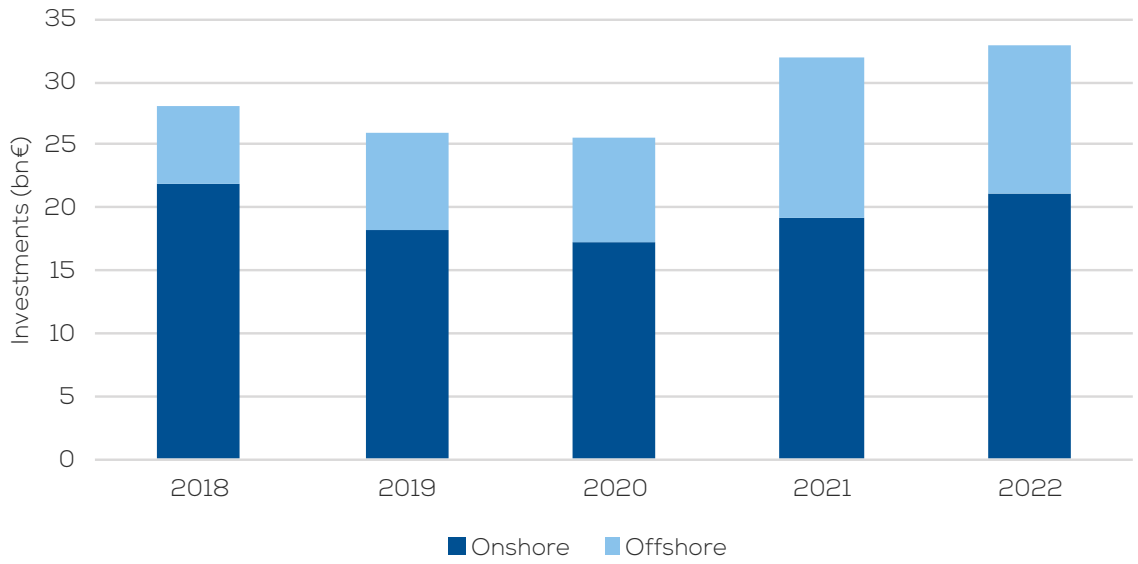
Source: WindEurope

3.5 INVESTMENT OUTLOOK

According to WindEurope, €128-155bn of investments in new assets will be needed moving forward to 2022. Under the Central Scenario, €145bn of investments in new assets will be needed.

2018 will be a strong year for financing, especially for onshore wind, with Final Investment Decisions being reached for many projects forecasted to start operations in 2019. We could experience a record year of investments in 2021 and larger installation rates of offshore wind after 2022.

FIGURE 22
Investment outlook in new assets for the period 2018-2022 – WindEurope's Central Scenario



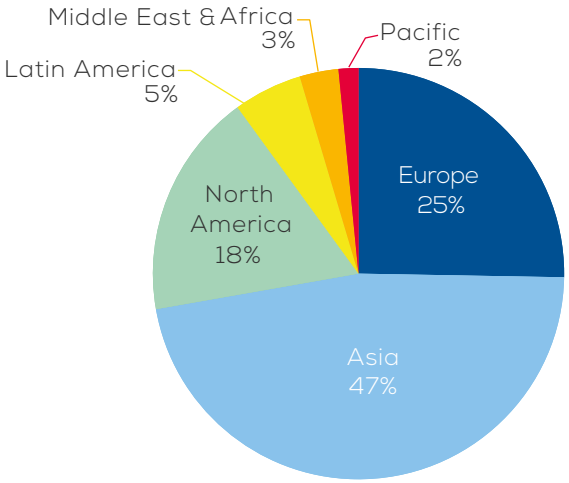
Source: WindEurope

3.6 GLOBAL WIND ENERGY MARKET OUTLOOK

With more than 80.1 GW of new net additions in the 2018-2022 period under the Central Scenario, Europe could represent more than 25% of new net global installations. Asia will be leading the race in bringing additional capacity, with an expected 141.7 GW representing almost half of all net global additions in the next 5 years. We expect North America to add 53.6 GW of additional capacity. Latin America, together with the Middle East, Africa and the Pacific will have around 30 GW of net additions.

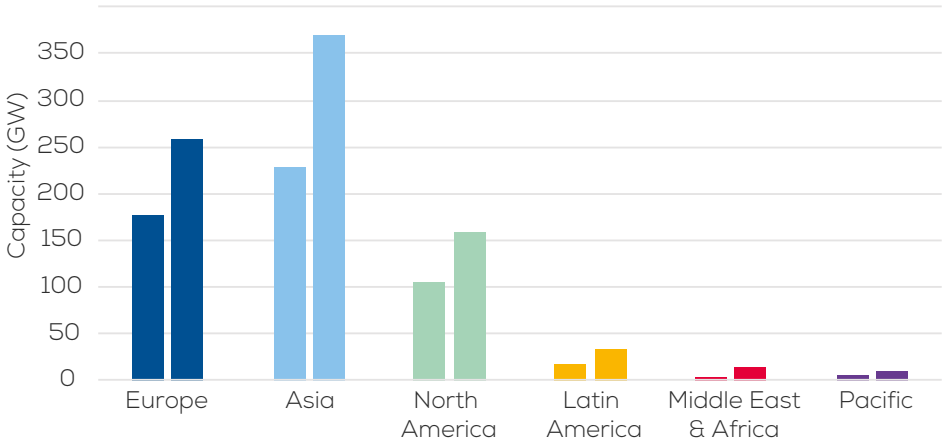
NEW INSTALLATIONS IN EUROPE WILL REPRESENT 25% OF GLOBAL MARKET

FIGURE 23
Net wind additions in 2018-2022



Source: WindEurope, GWEC Global Wind Report 2017

FIGURE 24
Global cumulative capacity in 2022



Source: WindEurope, GWEC Global Wind Report 2017

Photo: P. Heitmann

4. TECHNOLOGY TRENDS

4.1 WIND TURBINE SIZE

Wind turbine technology is facing a dramatic shift in both onshore and offshore markets, with a constant increase of turbine capacity and new design concepts to maximise energy yields.

Beyond 4 MW onshore wind platforms – a new normal?

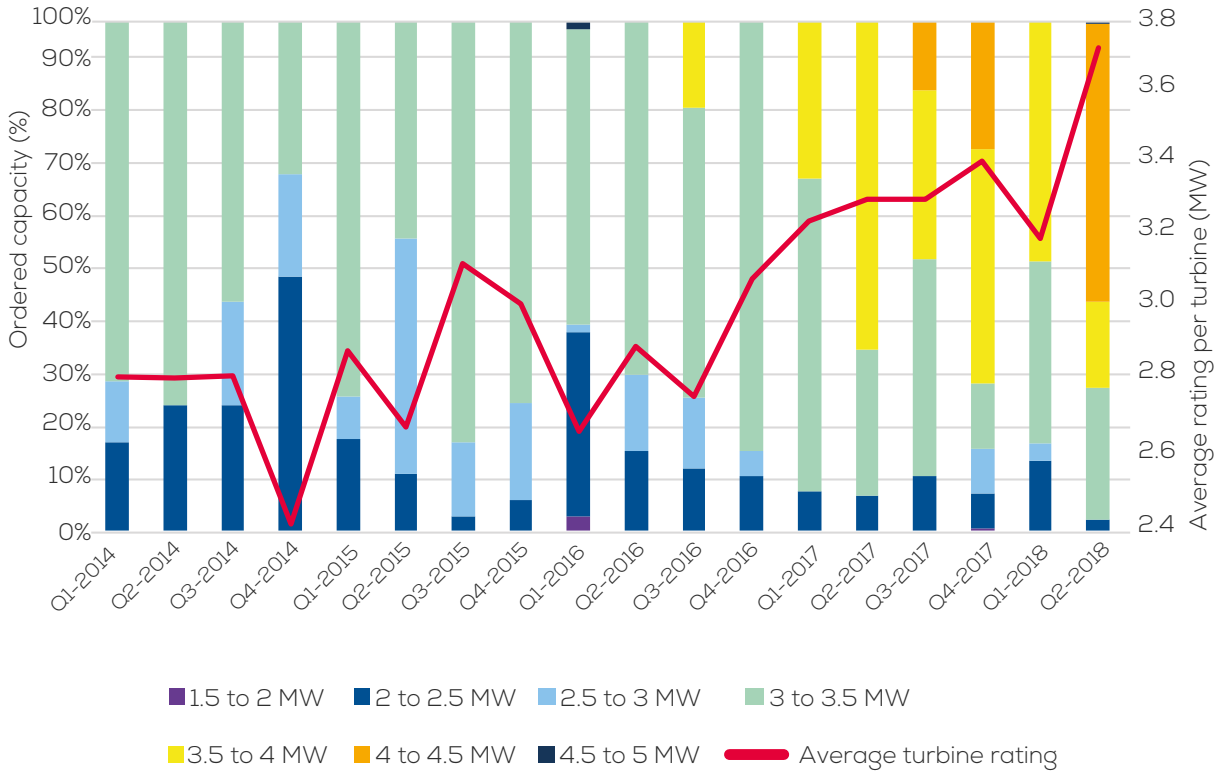
In the Q2 of 2018, more than 55% of ordered onshore wind capacity was for turbines above 4 MW[4]. We expect those turbines to be installed between 2018 and 2022 – a trend that is set to continue towards larger and more powerful turbines. The average power rating is thus growing quickly. Over 80% of the turbines that will be installed in the 2018-2022 period are going to be 3 MW or higher.

HALF OF THE ONSHORE TURBINES ORDERED IN Q2 2018 WERE

4 MW OR ABOVE

4. See WindEurope's quarterly turbines order monitoring (members only)

FIGURE 25
Ordered onshore wind turbine power ratings in Europe



Source: WindEurope

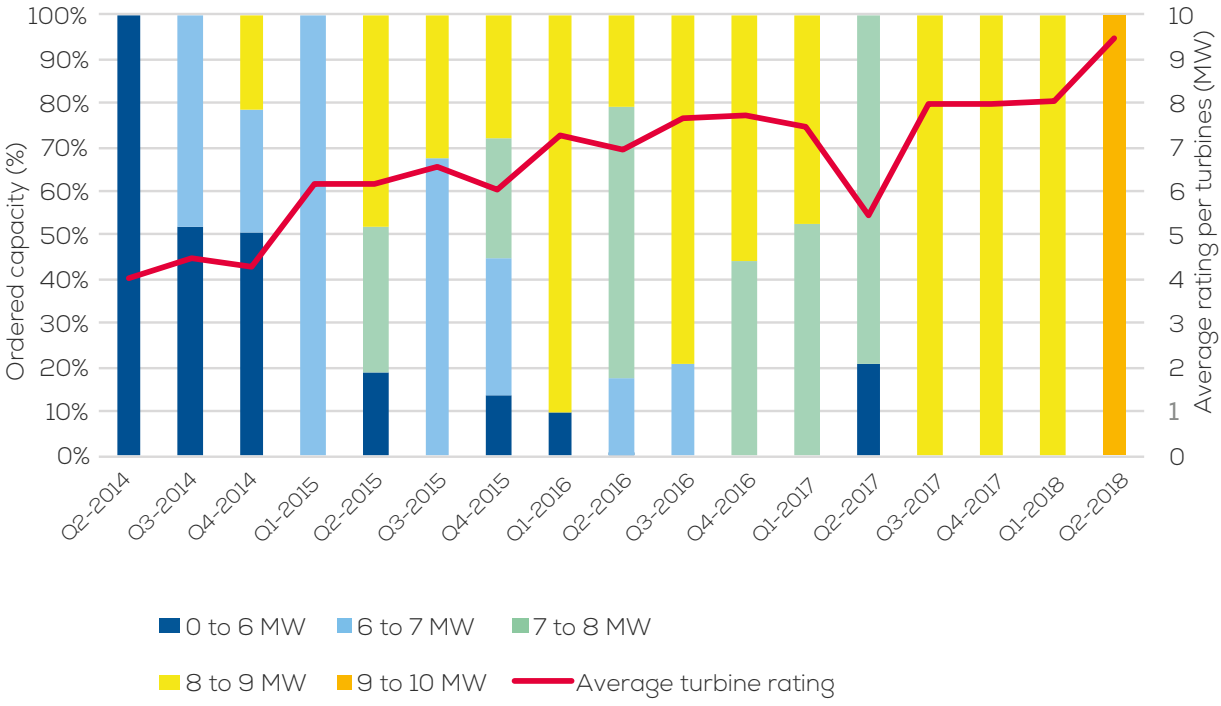
Beyond 8 MW offshore wind turbines

In the last 12 months, all offshore wind turbines ordered were in the 8-9.5 MW range. The increased size has resulted in an increased average rating per turbine, crossing the 9 MW threshold.

The average power rating is thus growing quickly. We expect most of the turbines installed from 2018-2022 to be 8 MW or above. The period until 2022 will also see the introduction of larger turbines (+10 MW), following industry announcements and developer plans to reduce the cost of offshore.

OFFSHORE TURBINES ORDERED IN THE LAST 12 MONTHS ARE LARGER THAN 8 MW

FIGURE 26
Ordered offshore wind turbine power ratings in Europe



Source: WindEurope

4.2 WIND TURBINE DESIGNS

Higher capacity factors for onshore wind

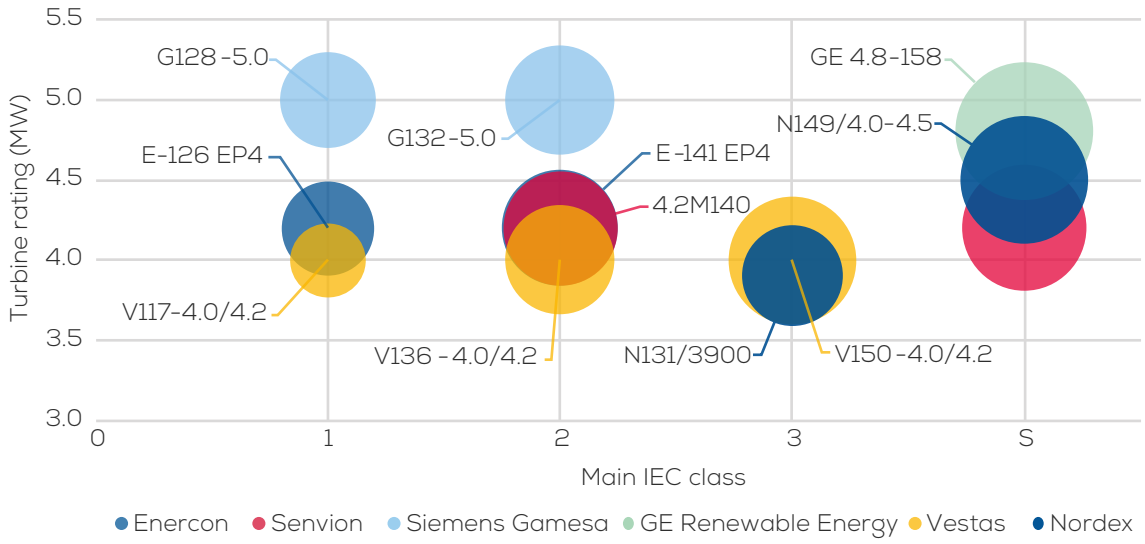
In 2018, 4 MW onshore platforms have appeared in all the largest European turbine manufacturers' books and are ready for installation as of 2018. The product diversity will allow operations from all wind sites between IEC I (high winds) to IEC III (light winds). Within these platforms, there is a very wide range of rotor diameters from 117m (for high winds) up to 158m (light winds), aiming to maximise the wind resource at lower wind speeds

In many of these models the size of the rotor is growing relatively faster than the size of the generator (featuring longer blades in order to increase the swept area). This enables turbines to capture energy in areas with lower wind speeds and to operate for more hours closer to their nominal power. The relation between generator and rotor can be referred as specific power (W/m^2). Lower specific powers leads to greater capacity factors for the same wind conditions. Thus, the evolution of specific power is a factor worth monitoring.

Since 2016, we have observed a decreasing trend in average specific power from ordered turbines in Europe. This indicates that developers are installing taller machines, aiming to exploit areas with lower wind regimes with reasonable yields. The result is a new generation of wind turbines with higher capacity factors. A wind fleet with higher capacity factors presents a large number of benefits vis-a-vis grid integration, as it can reduce the cost of grid connection and the need for balancing.

FIGURE 27

27. 4 MW and above onshore turbines currently available in Europe (size of the bubble represents the rotor diameter)

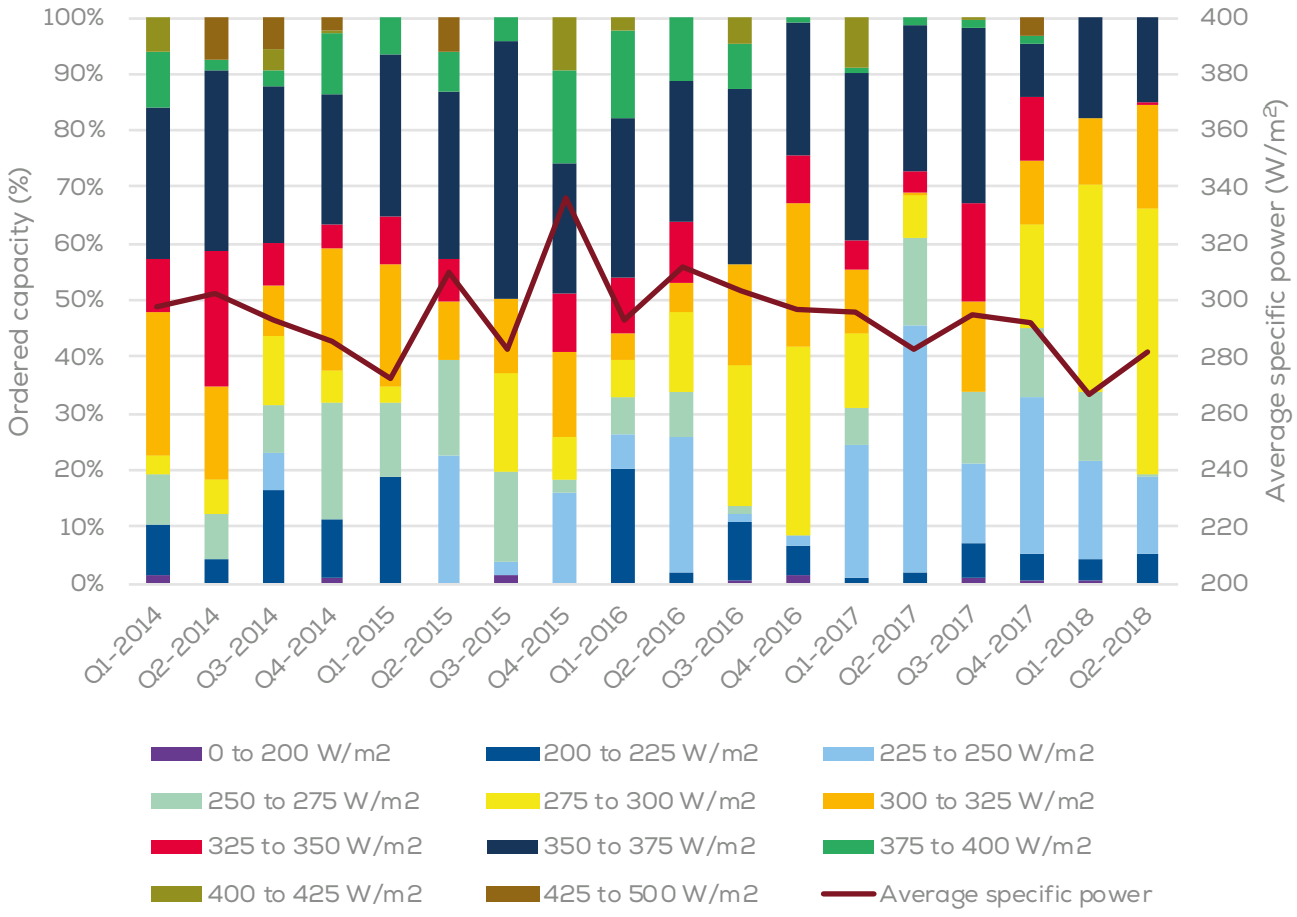


Source: WindEurope

LOWER SPECIFIC POWER RESULTS IN A HIGHER

CAPACITY FACTOR

FIGURE 28
Specific power of ordered onshore wind turbines in Europe



Source: WindEurope

Higher capacity factors for offshore wind

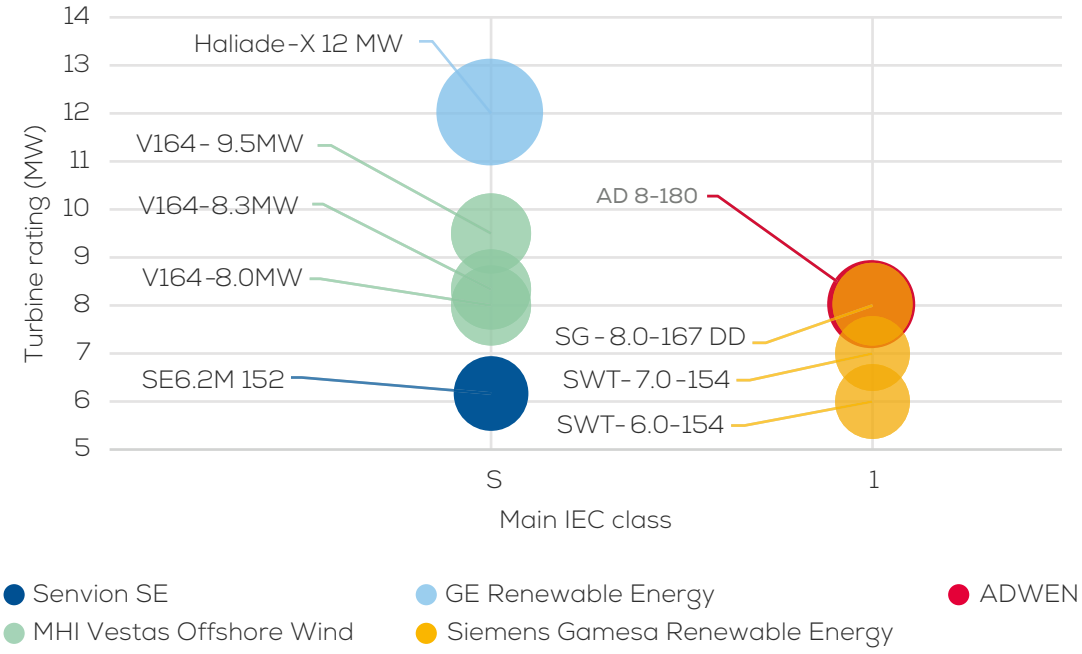
The rated capacity of offshore wind turbines has significantly grown over the past decade, allowing the harnessing of sites with higher wind speeds (IEC 1) and extreme weather conditions (IEC S).

There is a very wide range of rotor diameters from 152m to 220m. The industry forsees that orders for offshore turbines of +10 MW will be the norm in the next 5 years. GE is the first manufacturer to publicly announce a turbine model above 10 MW: the Haliade X 12 MW. We expect other companies to follow suit soon.

For offshore the specific power did not decrease. One of the reasons is that the same turbines (with the same rotor size) have been offered with limited generator capacity. Once the turbines have been fully operational under commercial conditions, the generator size can be uncapped, increasing the nominal power as well as the specific power of those turbines.

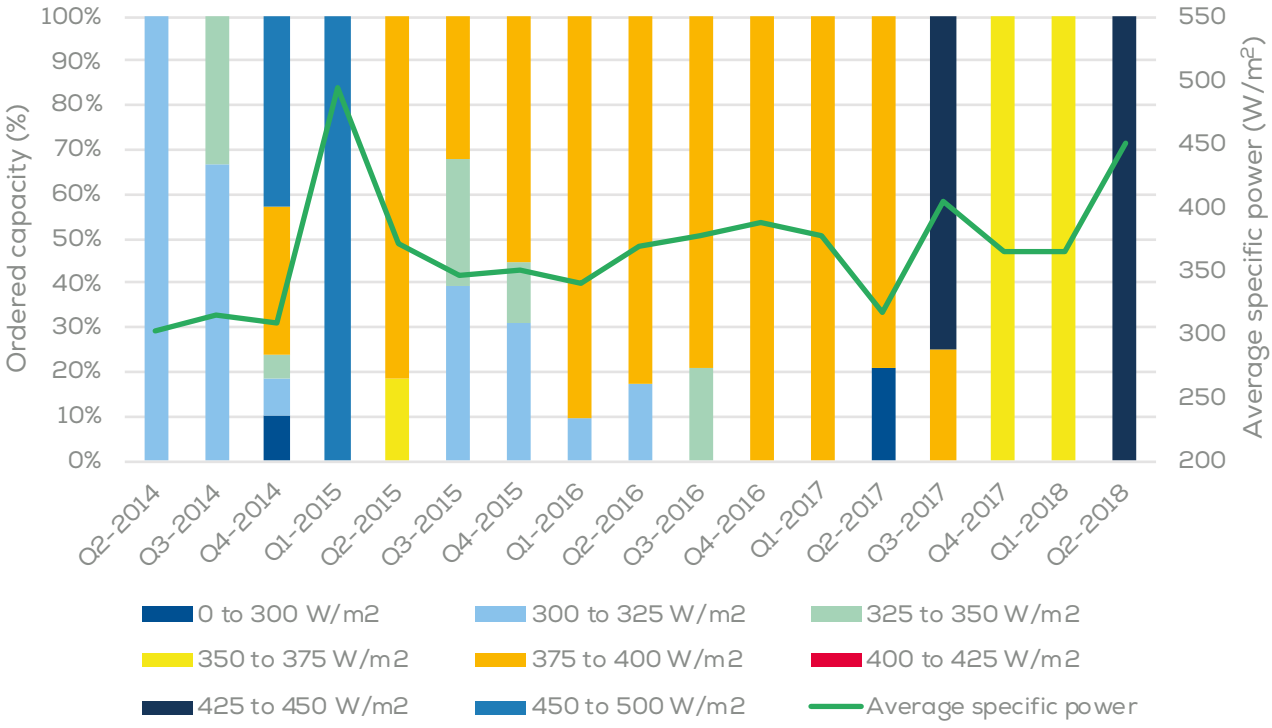
+10 MW
TURBINES ENTER THE MANUFACTURERS OFFER

FIGURE 29
6 MW+ offshore turbines currently available in Europe (size of the bubble represents the rotor diameter)



Source: WindEurope

FIGURE 30
Specific power of ordered offshore wind turbines in Europe



Source: WindEurope

WindEurope is the voice of the wind industry, actively promoting wind power in Europe and worldwide. It has over 450 members with headquarters in more than 40 countries, including the leading wind turbine manufacturers, component suppliers, research institutes, national wind energy associations, developers, contractors, electricity providers, financial institutions, insurance companies and consultants. This combined strength makes WindEurope Europe's largest and most powerful wind energy network.

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