# Wind Energy in Europe: Outlook to 2023

October 2019

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This publication, the third in a series of annual reports, analyses how European markets will develop in the next 5 years (2019 to 2023). The outlook is based on WindEurope internal analysis and consultation with its members (surveys with National Associations and dedicated workshop in May 2019).



Wind EUROPE

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# EXECUTIVE SUMMARY

By the end of 2020 European countries are due to deliver on their 2020 renewable energy targets and will start implementing their 2030 National Energy and Climate Plans (NECPs) towards the 32% renewables target. 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 2019-2023

Europe could install 90 GW of new wind energy capacity over the next five years if governments adopt clear and ambitious National Energy & Climate Plans, resolve their current issues around wind farm permitting and continue investing in grid infrastructure. This would give Europe 277 GW of installed wind capacity by 2023.

However, if the NECPs are unambitious and permitting issues remain unresolved, then Europe will install much less new wind power: only 67 GW, 26% less than in our Central Scenario. Permitting issues are already leading to undersubscribed auctions (notably in Germany) and lower installation rates than expected.

If permitting improves significantly and the National Energy & Climate Plans are super ambitious, then Europe could install 112 GW over the next five years, 24% more than in our Central Scenario.

So there's quite a lot of uncertainty over how much new wind energy Europe is going to install over the next five years. It could be anything between 13 and 22 GW a year. This uncertainty weighs heavily on the supply chain and could impact the significant cost reductions achieved in recent years.

Whatever the exact number of new installations, most of them (at least three-quarter) will be onshore wind. Spain, Sweden and Norway are currently leading the growth in onshore wind in Europe. Germany is installing much less

this year than it traditionally has, and its outlook remain uncertain for the rest of the period, not least given recent policy decisions. We expect France to show continued steady growth in onshore wind.

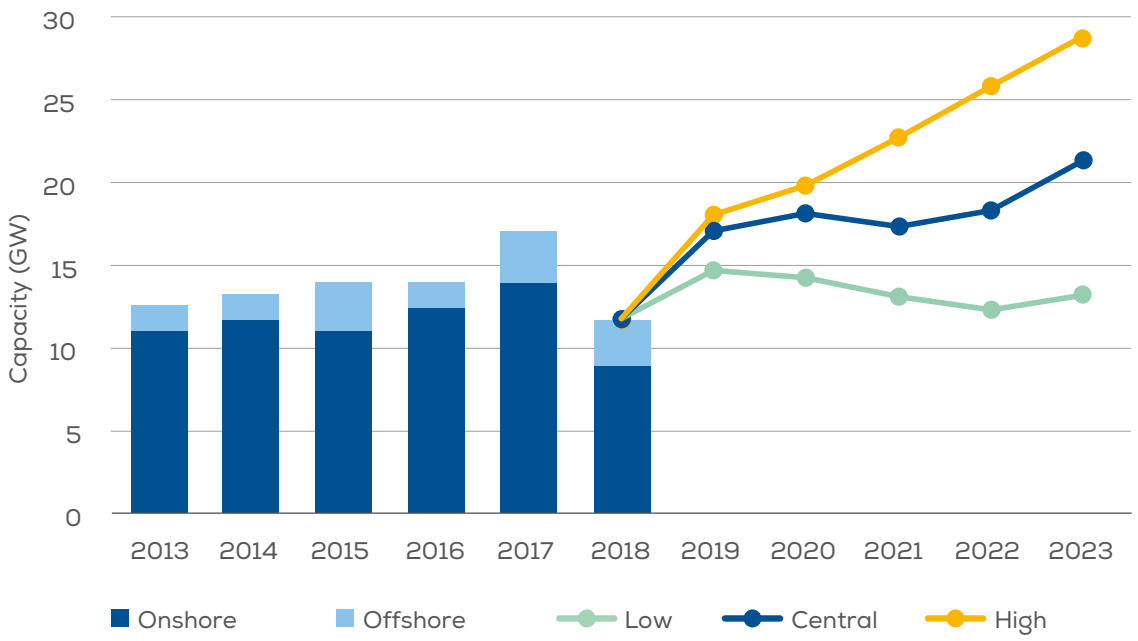
The UK will account for 35% of the growth in offshore wind over the next five years, followed by the Netherlands and Germany.

In the next five years 22 GW of wind energy capacity will reach the end of its theoretical operational life (20 years). Most of this capacity will get a lifetime extension. Around 2 GW will be repowered. And another 2 GW will be fully decommissioned. The wind industry would like to repower more, but government policy and regulation is still not as supportive of repowering as we would like. The 2 GW that is repowered will convert into 4-5 GW of new installations.

The various Government auction and tender schedules for wind energy across Europe over the next five years amount to 65 GW of potential new capacity additions. 32 GW of of those are wind-specific auctions and tenders. The other 33 GW are renewable energy auctions in which wind can bid.

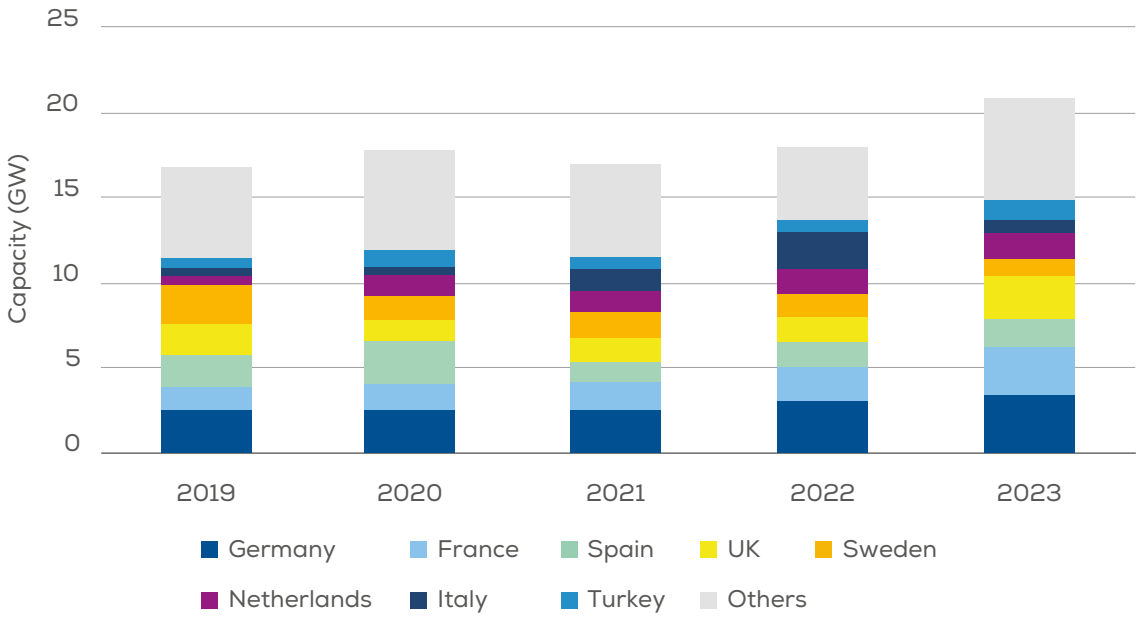
By 2023 Germany will remain the country with the largest wind fleet (72 GW in the Central Scenario), followed by Spain (32 GW) and the UK (29 GW). These three countries will account for just under half of Europe's cumulative installed wind capacity by 2023.

**FIGURE A**
**Gross annual installations in Europe – WindEurope's Scenarios**




Source: WindEurope

**FIGURE B**
**Annual gross installations per country[1] – WindEurope's Central Scenario**




Source: WindEurope

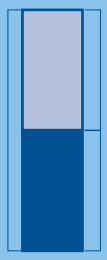
1. To see the data for countries under *Others*, log in to: https://windeurope.org/members-area/market-intelligence/market-da- ta-interactive-tools/

ADDITIONAL

# 88 GW

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

**277 GW** in 2023



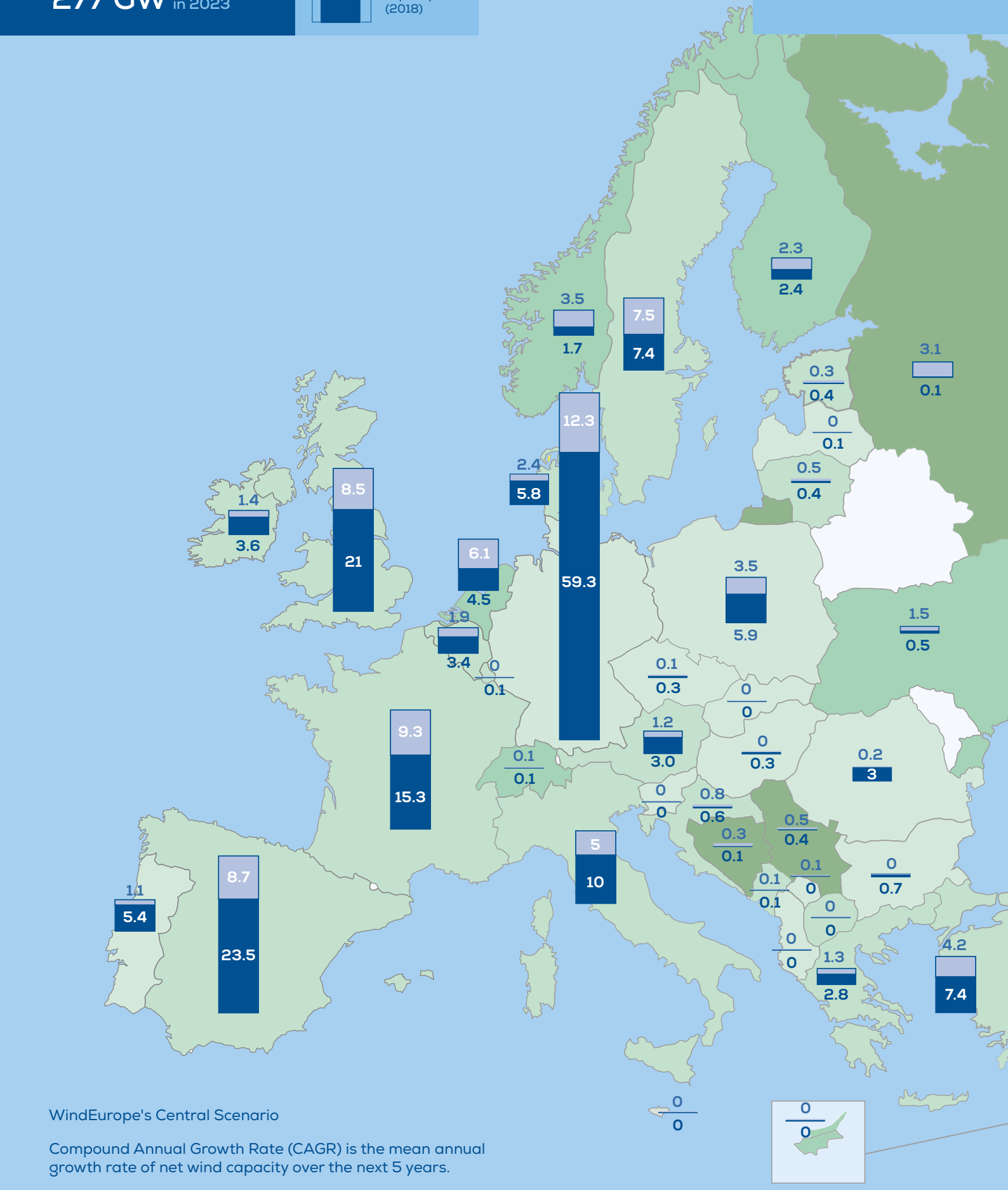
New added net capacity (2019-2023)

**GW**

Cumulative installed capacity (2018)

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.

# 1. POLICY CONTEXT & MARKET TRENDS

## 1.1. POLICY CONTEXT

In June 2019 the European Commission released its recommendations on European countries' draft National Energy and Climate Plans for 2030. It said the drafts were insufficient to deliver on the EU's 32% renewable energy target. The Commission wants Member States to be much more specific on their policy measures to deploy renewables. In particular on: streamlining permitting; repowering wind farms reaching the end of their operational life; removing barriers to Corporate Renewable Power Purchase Agreements; and boosting the electrification of heating, transport and industry. National Governments have until the end of 2019 to finalise the Plans and ensure they become genuine investment brochures for renewables.

The EU has now started its once-every-5-year process of "changing the guard". The European Parliament elections in May were fairly positive for the wind industry. The Centre-right, Social Democrats, Liberals and the Greens hold a commanding majority in the new Parliament, and in principle they support more ambitious Climate and Energy policies. The new European Commission will take office in November with a firm commitment to the decarbonisation of the European economy.

The President-elect of the European Commission, Ursula von der Leyen, has already committed to putting forward a green deal within her first 100 days in office. And EU Member States, led by the Finnish presidency of the European Council, may commit by the end of the year to a 'net-zero carbon' economy by 2050.

On the ground, accelerating the permitting process for wind developers remains the top priority. In Germany the rate of new project permits has dropped significantly, leading to undersubscribed onshore wind auctions and a collapse in installation rates. France still doesn't have a permitting authority to centralise all administrative processes. All around Europe, permitting is becoming more complex and more expensive as land becomes more constrained and the number of legal appeals increases.

The news is not all bad. In recent months we've seen increased ambition on wind from France, Ireland and Portugal, and from the new governments in Denmark and Finland, as well as regulatory progress in Italy. Spain remains very ambitious on renewables (although there is political uncertainty with regards to the future of the government)

and in Poland the outlook for onshore and offshore wind is positive as the Government now sees wind as a key solution to addressing growing energy needs.

A comprehensive review of wind-related national policies in all European markets can be found in our mid-year report: Wind Energy in Europe: *National Policies and Regulatory Developments.*[2]

## 1.2. MARKET TRENDS

### A challenging environment to develop new projects

The wind industry fully understands the necessity to preserve local ecosystems for both fauna and flora and to minimise any potential negative effects to the population (e.g. noise). But there are more and more spatial planning constraints that limit wind sector developments and increase the time to obtain all necessary permits. These spatial constraints include strict minimum setback distances to housing, stringent noise limits, high nature safeguarding distances, radar (civil & military) safeguarding distances, average tip height restrictions and so on. Stakeholders' expectations are increasing with a requirement for well-planned projects, developed in harmony with Europe's landscape and societal interest, projects opened to local ownership models and extensive stakeholder consultation.

Despite the fact that renewables are well-regarded in opinion polls[3] [4] (people prefer renewables to fossil fuels), project acceptance at the local level is down.

The main impacts of permitting delays are:

- An increase in the cost of project development. If construction is delayed because of a legal dispute, for example, the total project cost will increase since the construction schedule is on a tight timeline (e.g. contracts for renting equipment are already signed and are awaiting execution);
- Limited use of the latest available technology: the application file submitted to the permitting authority includes the wind turbine model(s). If the proposed project is blocked in permitting limbo for years, developers will miss out on the latest features and designs, losing competitive advantage. In conclusion the project developer may need to file an application for a new permit in order to be able to use the latest wind turbine technology (additional costs and time). In many countries the permits are issued for a determined period of time and may expire before getting the consent to start building;
- Banks are more likely to lend money for projects if the consenting risks are lower, or if there are financial mechanisms in place e.g. insurance to cover the risk of being denied consent, or longer consenting periods than initially envisaged.

2. https://windeurope.org/members-area/market-intelligence/ business-intelligence-reports/
3. https://www.cleanenergywire.org/factsheets/polls-reveal-citizens-support-energiewende
4. http://www.climateaction.org/news/85-of-the-uk-supports-renewable-energy-in-record-high-poll

## Undersubscribed auctions and tenders

Auctions provide the necessary long-term visibility for developers, as an increasing number of countries offer 2-3 years' visibility in the auction schedule. However, developers are struggling to fulfil the offered capacity for new onshore wind farms as a result of the challenging environment to obtain construction consent and permits.

The latest German onshore wind auction in September was the fifth consecutive undersubscribed German auction, with only 176 MW being awarded out of the 500 MW that were offered. Similarly, the last Greek auctions were undersubscribed. France had an undersubscribed auction in September that prompted government officials to open the next onshore wind auction to projects without the necessary permits. This practice is unhelpful, as it only delays the problem; projects without permits do not get built.

**TABLE 1**
**List of recently undersubscribed auctions in Europe**

| LIST OF RECENTLY UNDERSUBSCRIBED AUCTIONS IN EUROPE | | |
|---|---|---|
| | **Capacity auctioned by the government** | **Awarded capacity** |
| **Germany September, 2019** | 500 MW | 176 MW |
| **Germany August, 2019** | 650 MW | 208 MW |
| **Germany May, 2019** | 650 MW | 270 MW |
| **Germany February, 2019** | 700 MW | 476 MW |
| **Germany October, 2018** | 670 MW | 363 MW |
| **Germany May, 2018** | 670 MW | 604 MW |
| **France September, 2018** | 500 MW | 118 MW |
| **Greece, July, 2019** | 300 MW | 180 MW |
| **Greece July, 2018** | 300 MW | 171 MW |

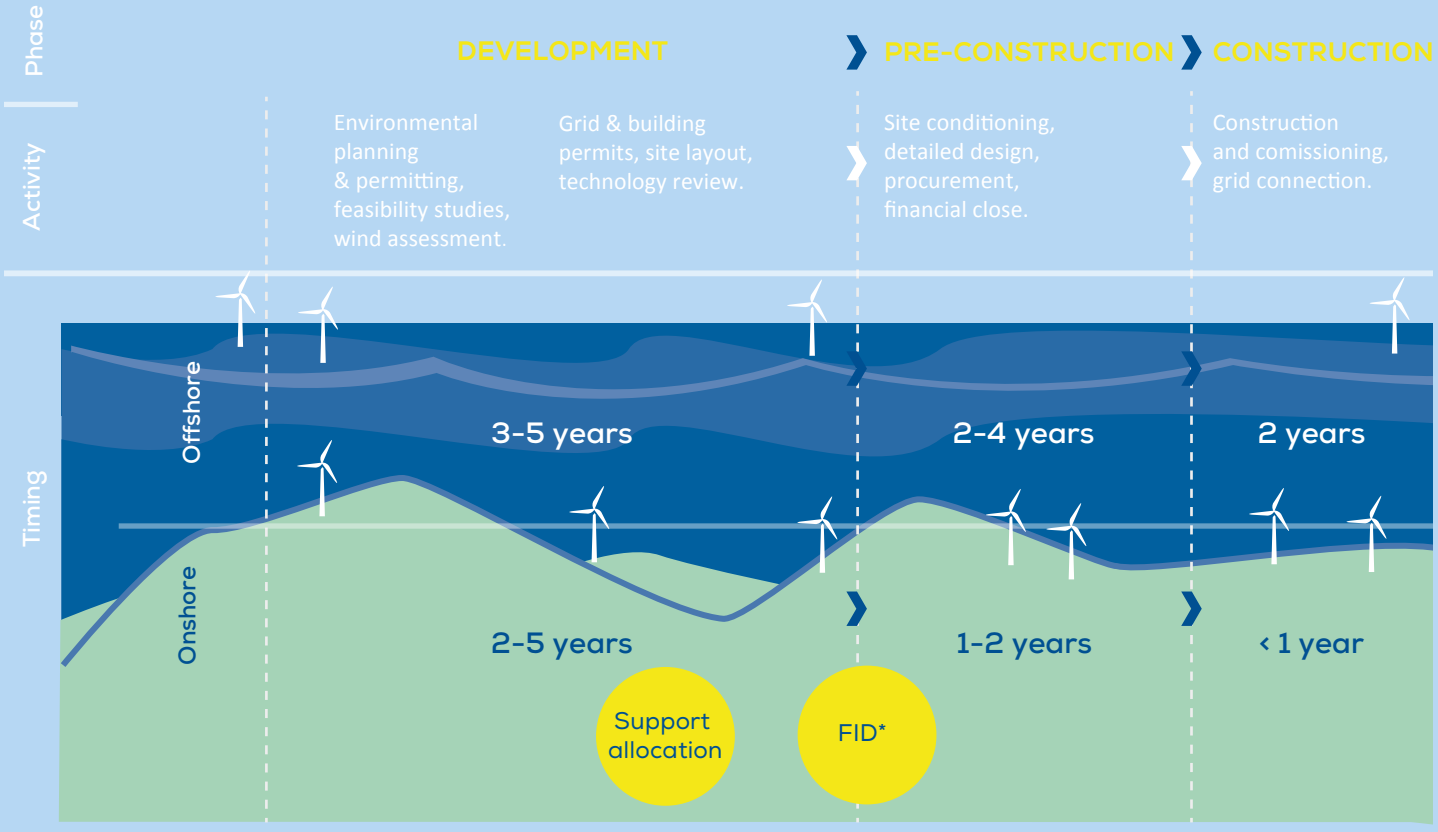
## Projects' development timeline

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 good visibility on upcoming tenders and the regulatory framework.

Once a support mechanism 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 2019 and 2023) 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 2019 to 2021/2022 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 2022 and 2023, which could be affected by upcoming planned tenders (e.g. in 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 2019 and 2023, up to 65 GW of auction capacity has already been set in the plans of nine countries. Of this, 32 GW are specific to wind energy and approximately 33 GW[5] are technology-neutral, allowing for the participation of wind.

**65 GW**

OF AUCTIONS PLANNED IN 2019-2023

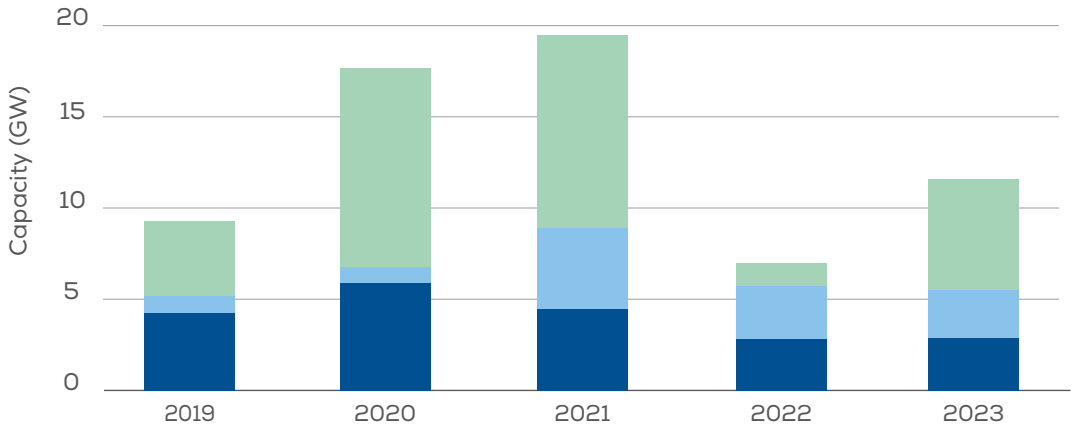
Out of the planned 65 GW of auctioned capacity, 36% (approximately 24 GW) are planned for offshore wind[6] and onshore wind on remote islands. Most of it comes from the UK, which plans up to 6 GW of offshore wind to be auctioned once every two years. Denmark, France, Germany and the Netherlands also provide a clear and significant plan for future offshore auctions.

A large part of the planned 65 GW (approximately 20 GW) will be auctioned in 2021 due to the additional onshore wind volumes in Germany and offshore wind auctions in the Netherlands, Germany and France. We expect other countries to make additional announcements for the next 5-year period as they are in the process of updating their respective National Energy and Climate Plans.

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. In addition the German government agreed last November for an additional 4 GW of onshore wind to be distributed in 2019, 2020 and 2021. The next offshore tender will take place in 2021.

The latest CfD auction round in the UK was dominated by offshore wind and onshore wind farms on remote islands that claimed the most of the 6 GW that was offered. The UK government plans to hold CfD auctions every two years.

**FIGURE 1**
**Planned wind auctions and tenders in Europe**




| | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|
| Technology-neutral | 4.1 | 10.9 | 10.5 | 1.2 | 6.0 |
| Offshore | 0.8 | 1.0 | 4.4 | 2.9 | 2.7 |
| Onshore | 4.3 | 5.9 | 4.5 | 2.9 | 2.9 |

Onshore Offshore Technology-neutral

Source: WindEurope

In Poland the draft amendments to the country's Renewable Energy Act in June confirmed that the government plans to support the construction of 2.5 GW of onshore wind, with a scheduled tender towards the end of this year. That follows the 2018 auction in November, which awarded 1 GW of onshore wind projects.

In France, as a consequence of the lower prices resulting from the Dunkirk offshore tender earlier this year, the government has boosted its installation target for tendered offshore wind capacity from 750 MW to 1 GW per year by 2024[7].

The current EU State Aid guidelines set specific conditions for governments to use technology-specific auctions. These conditions have been enshrined in legislation under the recently agreed EU Renewable Energy Directive. This important development confirms Member States' right to put technology-specific auctions in place.

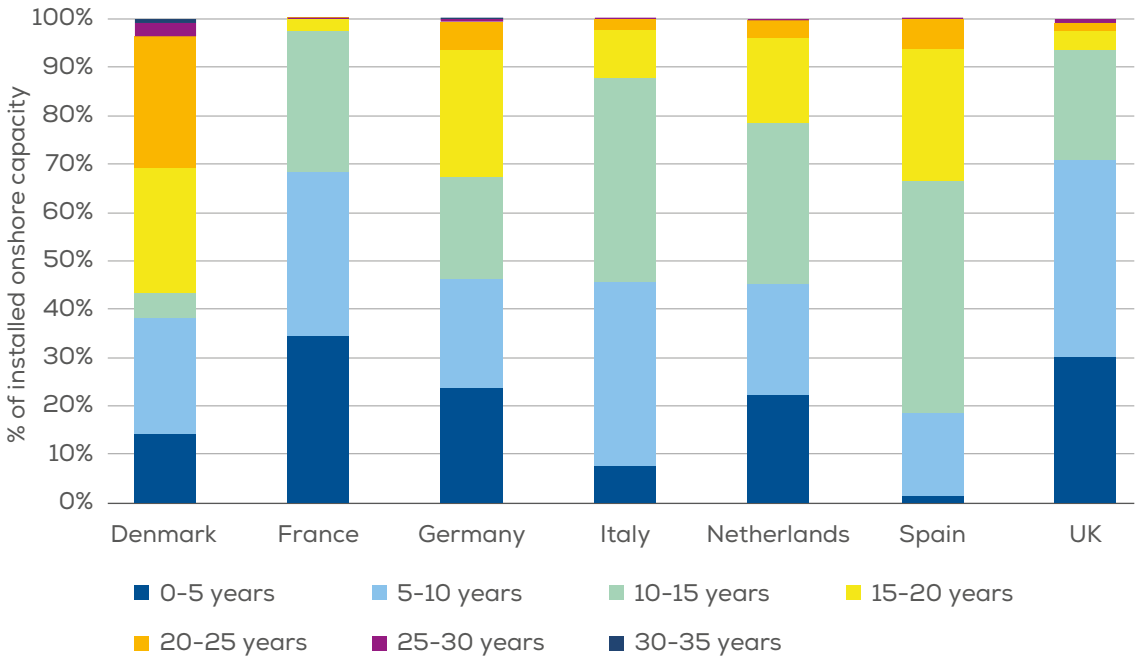
## An ageing wind fleet

In 2018, 421 MW of wind power were decommissioned, following a similar trend to previous years. This took place in Germany (249 MW), the Netherlands (72 MW), Austria (29 MW), Greece (15.4 MW), Portugal (13.7 MW), Sweden (13.3 MW), Denmark (12.7 MW), France (12.6 MW) and Finland (3 MW). Most of this (407 MW) was in onshore wind.

Since most of those wind farms have been deployed in the areas with the best wind energy resource, 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), the length of the support frameworks (generally 20 years) and the evolution of the wholesale electricity market prices. We consider that, generally, the lifetime of wind farms can be as much as 30 years when lifetime extension strategies are in place. Most of the repowering decisions will be taken after 15 years of wind farm operation.

**FIGURE 2**
**Distribution of age of the onshore wind fleet, as of August 2019**




Source: WindEurope

5. Some auctions volumes are defined by budget and not by capacity (e.g. the Netherlands, the UK)
6. For more info on future auctions and tenders visit www.windeurope.org/tenders
7. For a detailed overview of past and future auctions visit http://www.windeurope.org/tenders

In Germany, about 33% of the installed onshore fleet is over 15 years old; the same applies for 33% in Spain and 57% in Denmark. To put this into perspective, more than 16 GW of wind farms in Germany are over 15 years old, 3.2 GW of which are more than 20 years old. In Denmark, more than half of the wind fleet (around 2.4 GW) is more than 15 years old, while 31% of the fleet is over 20 years old.

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

## 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 houses have also changed in recent 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. That means that those sites will either have to opt for life-time extension measures or fully decommission the wind farm.

According to the EU Renewable Energy Directive, permitting procedures for repowered installations will be simplified, with shorter deadlines for swifter build-out. Under the new European legislation, the permitting process for repowering projects should be completed within 2 years. As of today, Member States have not yet put forward clear actions in their National Energy and Climate Plans to simplify the process for repowering projects.

**FIGURE 3**
Repowering terminology

| REPOWERING TERMINOLOGY<br>Example - Tauerwindpark (Austria) | | | |
|---|---|---|---|
| **Old project** | | **New project** | |
| Number of turbines | 13 | Number of turbines | 9 |
| Turbine power rating | 1.8 | Turbine power rating | 3.5 |
| Capacity under repowering | 23 | Repowered capacity | 31 |
| **Decommissioned capacity = Capacity under repowering + fully decommissioned capacity** | | | |

## Repowering trends

The analysis of more than 60 repowering projects in Europe has shown a number of interesting trends. Projects are repowered at very different points in their lifetime, ranging from just 9 to 27 years. The late repowering projects were mostly in Spain where, on average, projects operate for 22 years before being repowered. In Germany the repowering of projects took place (on average) after 16 years because of the repowering bonus of 5 EUR/MWh that was in place until 2014, incentivising wind farm operators to repower their projects earlier.

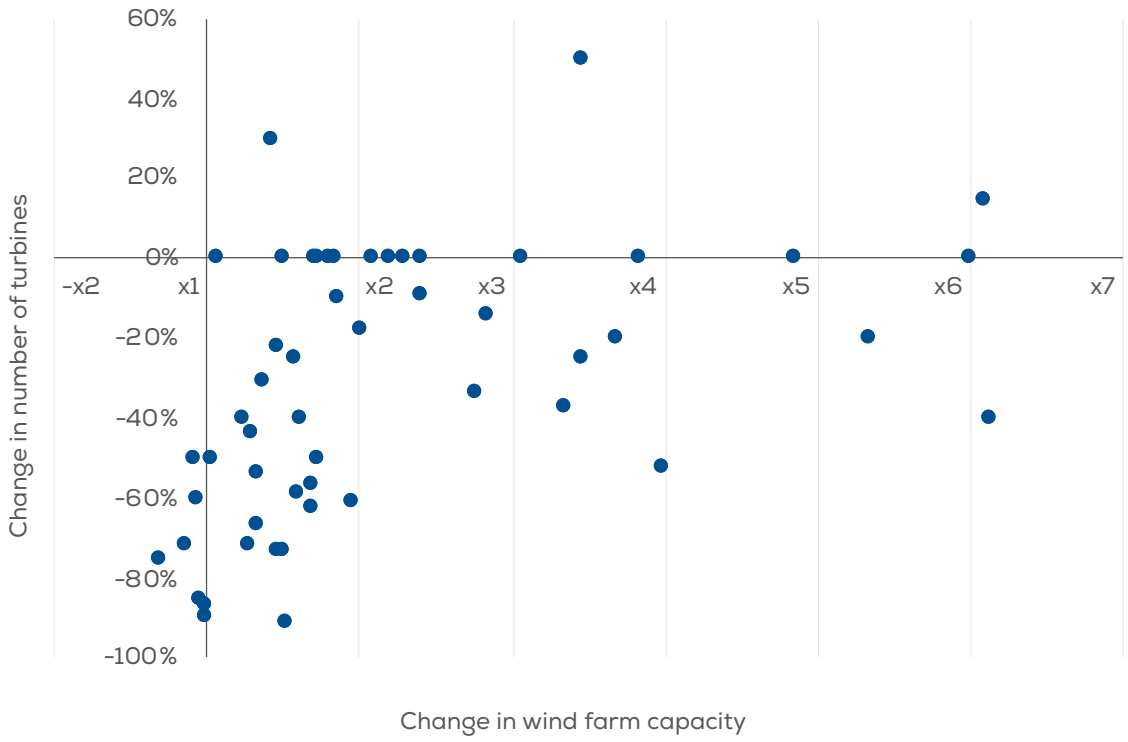
THE NUMBER OF TURBINES DECREASES BY A **THIRD**, BUT THE WIND FARM CAPACITY INCREASES BY A FACTOR OF **2.23**

Other observations of repowering projects were that, on average:

- The number of turbines decreases by a third;
- The wind farm capacity more than doubles (by a factor of 2.23).
- The power rating of the newer turbines is four times larger than the decommissioned turbines.

There was a decrease in wind farm capacity in only five such projects.

**FIGURE 4**
**Change in number of turbines and wind farm capacity of repowering projects**




Source: WindEurope

# 2. MID-TERM OUTLOOK

## 2.1. 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 277 GW cumulative installed capacity in Europe, with an average annual gross market of 18 GW.
- Our ***Low Scenario***, in which European governments propose no positive improvements from current legislation, leading to 254 GW cumulative installed capacity.
- Our ***High Scenario***, in which European countries improve their legislative framework, leading to 299 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.

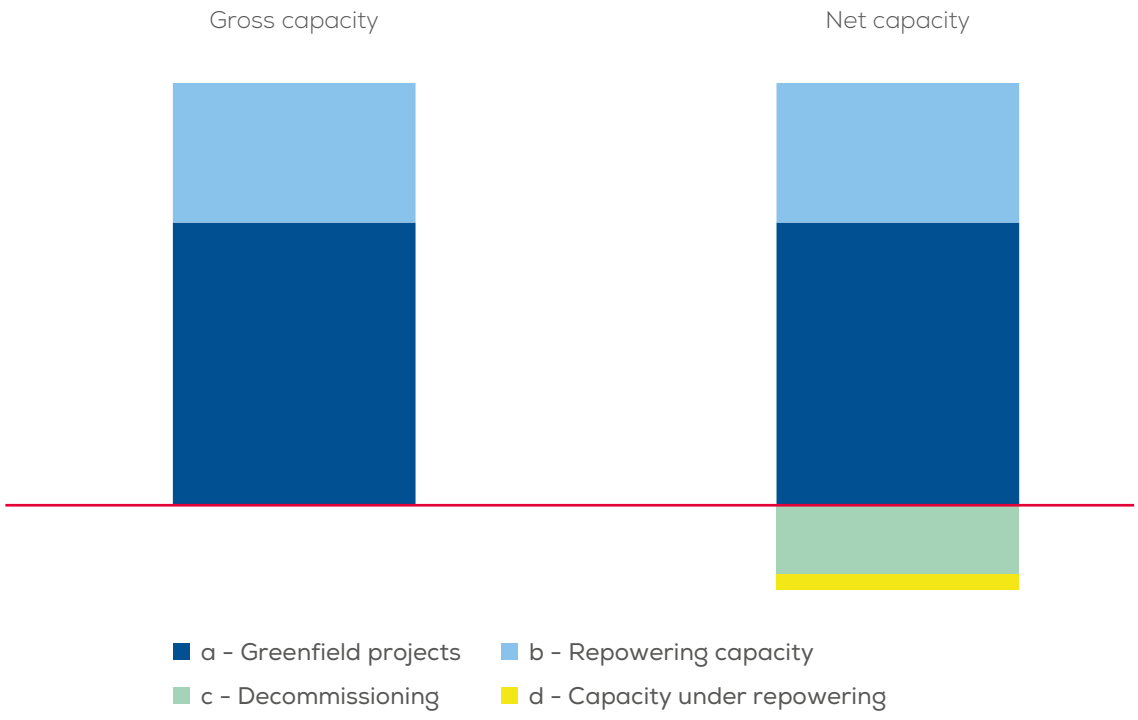
EUROPE COULD REACH
**299 GW**
BY 2023
IF GOVERNMENTS IMPROVE THEIR LEGISLATION

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 5 for more details.

**FIGURE 5**
**Gross vs. net added capacity accounting for decommissioning and repowering**




Source: WindEurope

## 2019, a record year?

2019 may be a record year in installations, both for onshore and offshore wind. However, there are still uncertainties related to the capability of the German onshore market to deliver volumes above 1 GW in 2019 and the capability of some countries to deliver large volumes in the second half of the year.

Spain, Sweden and Norway are expecting very high volumes by the end of 2019, particularly in comparison to the activity of previous years. By the end of June, the installation volumes in those markets were significantly lower than expected[8]. Spain had installed only 148 MW while we are expecting around 1.8 GW; So far, Sweden has installed 459 MW. We are expecting over 2 GW there. And Norway hasn't installed a single turbine, while we are expecting close to 1 GW there by the end of the year.

It is typical to see significantly higher installations in the second half of the year, in particular because summer months offer better weather conditions for the commissioning of wind turbines. Turbine orders and activity on the ground suggest this trend will be even more pronounced than normal this year.

Installations were particularly poor in Germany, which had its worst H1 of any year since 2000. In 2019 Germany will face its worst year for onshore wind installations this millennium, due to permitting issues and poorly designed auctions.

In combination with the difficulties in Germany, delays in Spain, Sweden and Norway could lead to significantly lower onshore volumes at the end of the year.

**OFFSHORE WILL REPRESENT 20% OF INSTALLATIONS IN THE NEXT 5 YEARS**

Regarding the offshore market, we expect installations to peak in 2019 given the large number of projects under construction in the UK and Germany. 1.9 GW of new offshore wind was installed in the first half of the year, up from the 1.1 GW added in the same period in 2018. The UK (931 MW), Denmark (374 MW), Belgium (370 MW) and Germany (252 MW) accounted for these installations. This includes Hornsea 1 in the UK which, when completed, will be the world's largest wind farm with 1.2 GW.

## Post-2020 outlook

Overall, installations in 2020 should slightly decrease but remain relatively high compared to historical levels. Due to strong increases in expected installations in Italy and Germany, 2022 could be another record year, followed by an even stronger 2023. In 2023 we expect to see strong activity in the offshore sector in the Netherlands, Ireland, Norway and France.

However, uncertainty towards the end of the 5-year period is quite high, particularly in onshore, and we could witness a stagnation of installations if national authorities do not tackle spatial planning and permitting issues in an efficient and comprehensive manner.

## Cumulative capacity by 2023

With between 254 and 299 GW of cumulative capacity across Europe by 2023, Germany will remain the country with the most capacity installed (between 68-77 GW). Spain will come second, with 30-35 GW.

We expect a significant amount of capacity to be decommissioned in the coming years (between 3.9 and 4.8 GW over the next 5 years). Some of it will be repowered and some will be fully decommissioned. This will mostly occur in Denmark, Germany, the Netherlands, Spain and Italy.

By 2023, offshore would represent around 13% of the total installed capacity.

8. Onshore wind installations in the first half of the year are typically around a third of all the onshore capacity installed within a year.

## 2.2. 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 to their currently-projected timeline.

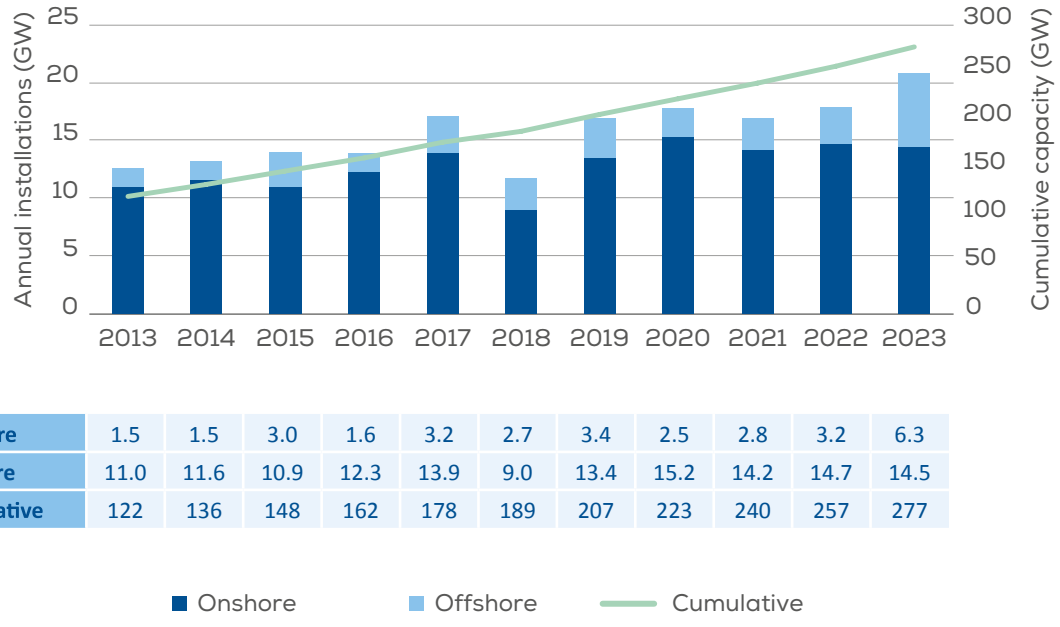
**2019 A STRONG YEAR WITH 16.8 GW OF WIND INSTALLATIONS**

In Spain, Norway and Sweden, the latest information on financed capacity and ordered capacity of wind turbines are providing a clear outlook in the short term.

Developers in Spain had a tight deadline to meet (2019) for those projects awarded in the 2016 and 2017 auctions (4.5 GW). Less than half of it will happen in 2019 as the government extended the deadline until 2020. The government set those deadlines to help Spain meet its 2020 renewable energy target.

In Sweden, with an additional 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 for installations in Sweden.

**FIGURE 6**
**Gross annual and cumulative installations in Europe - WindEurope's Central Scenario**




| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Offshore | 1.5 | 1.5 | 3.0 | 1.6 | 3.2 | 2.7 | 3.4 | 2.5 | 2.8 | 3.2 | 6.3 |
| Onshore | 11.0 | 11.6 | 10.9 | 12.3 | 13.9 | 9.0 | 13.4 | 15.2 | 14.2 | 14.7 | 14.5 |
| Cumulative | 122 | 136 | 148 | 162 | 178 | 189 | 207 | 223 | 240 | 257 | 277 |

Source: WindEurope

The planned tenders and the results of previous auctions and tenders in Germany, France and the Netherlands provide good visibility on post-2020 market development.

In Germany permitting and public acceptance are one the main reasons for slower market activity. The poorly-designed auctions that favoured citizens' projects (projects without construction permits could bid) also have a negative effect on installations in 2019. In spite of the German Climate Cabinet decision to increase tendering volumes for wind, the conclusions on setback distances – in principle 1000m – will present a further challenge for the recovery of the German market.

In France the government is setting up a new permitting authority to overcome the uncertainty that has caused challenges in the country's consenting system.

In Turkey the depreciation of the Turkish Lira is still a problem but, judging from the last YEKA auction results, confidence in the Turkish market is still strong.

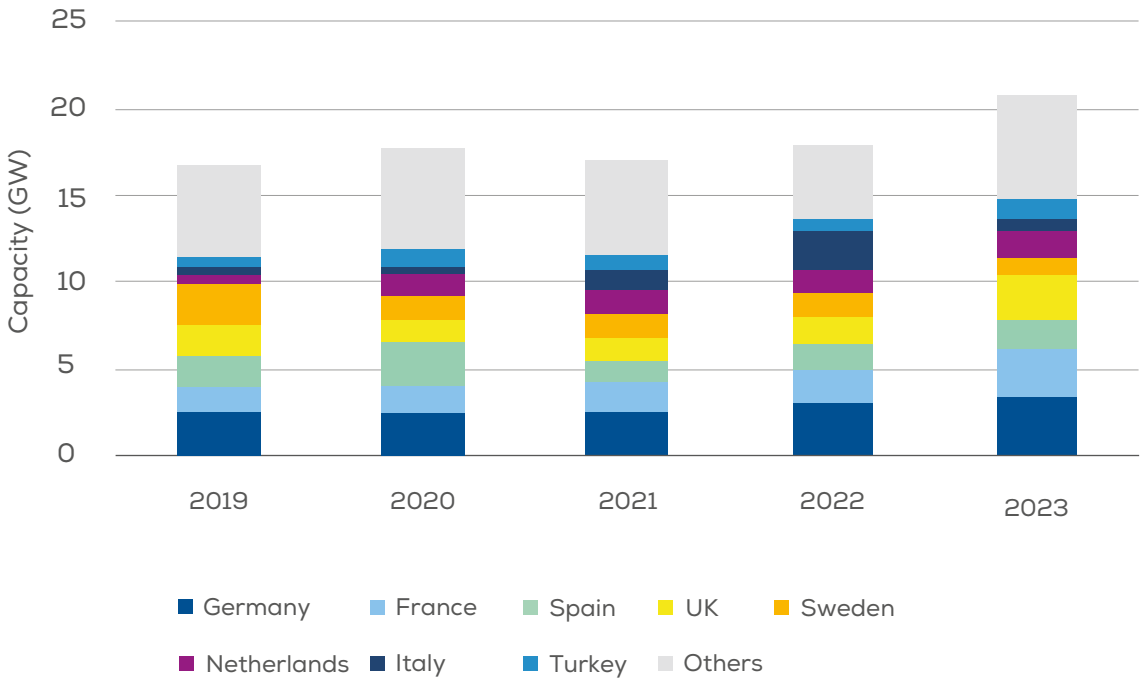
In Norway more than 2 GW of onshore wind is currently under construction but the onshore market will experience a significant slowdown post 2020.

Under the Central Scenario, 2019 will be a strong year: 16.8 GW of gross installations, with record installations in offshore wind.

After 2020 (17.7 GW), we expect 2021 and 2022 to be at 17 and 17.9 GW respectively, while 2023 is expected to be the best year (20.8 GW) over the next 5-year period due to a strong contribution of offshore wind (6.3 GW).

In total, the Central Scenario would register about 90 GW of additional gross capacity in the next 5 years.

**FIGURE 7**
**Annual gross installations per country - WindEurope's Central Scenario**



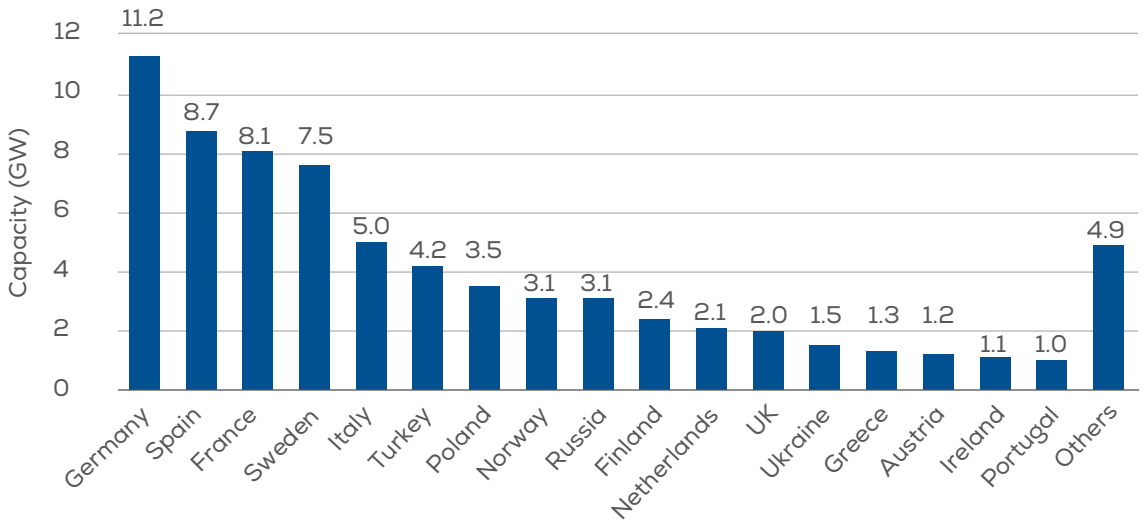

Source: WindEurope

## Onshore

Between 2019 and 2023 onshore installations would reach 72 GW, at an average rate of 14.4 GW/year. Germany would be the leader in onshore wind with 11.2 GW of gross additions over the 5 years (16% of the total onshore market), followed by Spain (8.7 GW), France (8.1 GW) and Sweden (7.5 GW). From non-EU countries, Norway, Russia and Turkey will be within the nine largest markets in Europe. Eight more countries are expected to install over 1 GW in the 2019-2023 period.

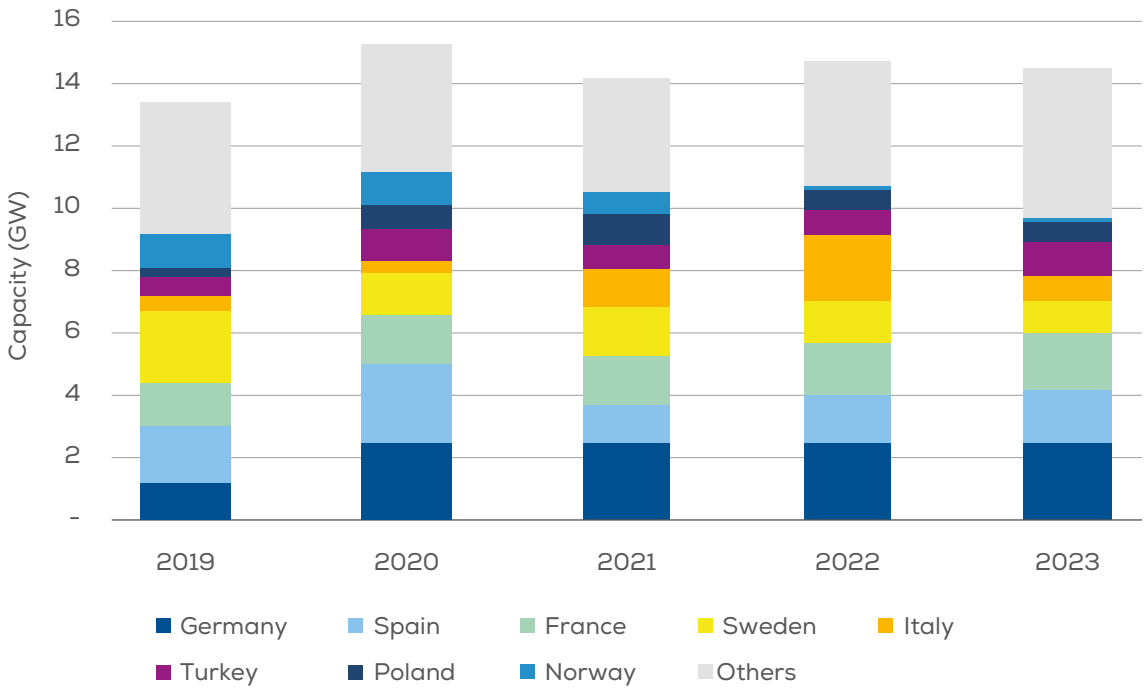
**GERMANY**
WILL CONTINUE TO BE
**THE LARGEST**
MARKET FOR
**ONSHORE WIND**

**FIGURE 8**
**2019-2023 gross installations of onshore wind per country**




Source: WindEurope

**FIGURE 9**
**Annual gross onshore installations per country - WindEurope's Central Scenario**




Source: WindEurope

## Offshore

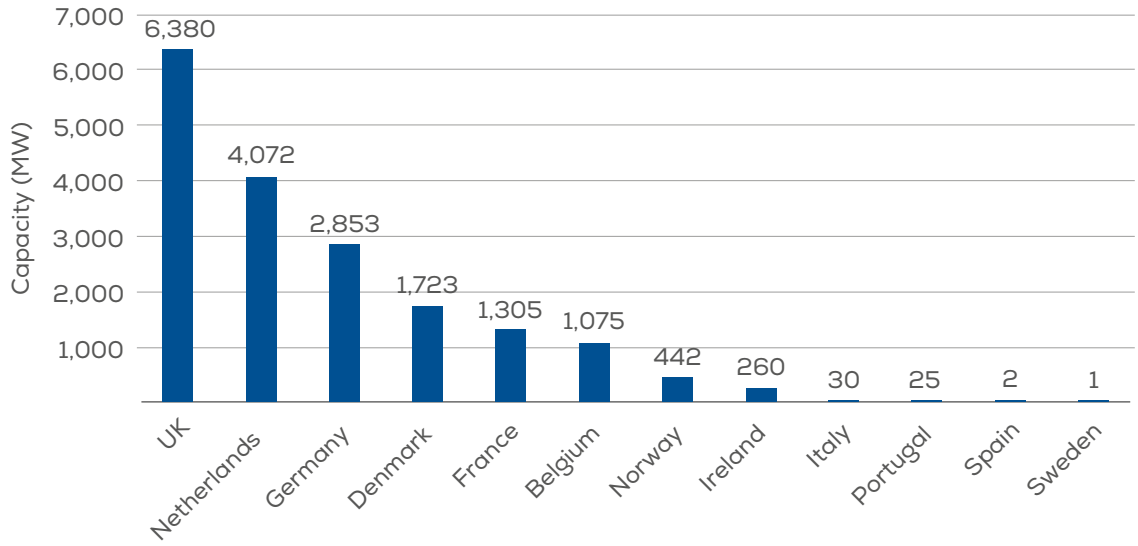
According to our Central Scenario, between 2019 and 2023 offshore installations would represent 18.2 GW. With an average 3.6 GW/year, offshore wind will represent about 20% of the total market of the 5-year period (compared to a 17% share in the last 5-year period).

Installations will concentrate mainly in the UK, with 6.4 GW or 35% of all the new grid-connected capacity. Another 5 countries will see large offshore installations: the Netherlands (4 GW), Germany (2.9 GW), Denmark (1.7 GW), France (1.3 GW) and Belgium (1.1 GW). Norway and Ireland are expected to enter the offshore market with large commercial projects but still below the 1 GW mark in the 2019-2023 timeframe. Italy, Portugal, Spain and Sweden will have small projects.

**UK TO REMAIN THE LARGEST OFFSHORE MARKET**

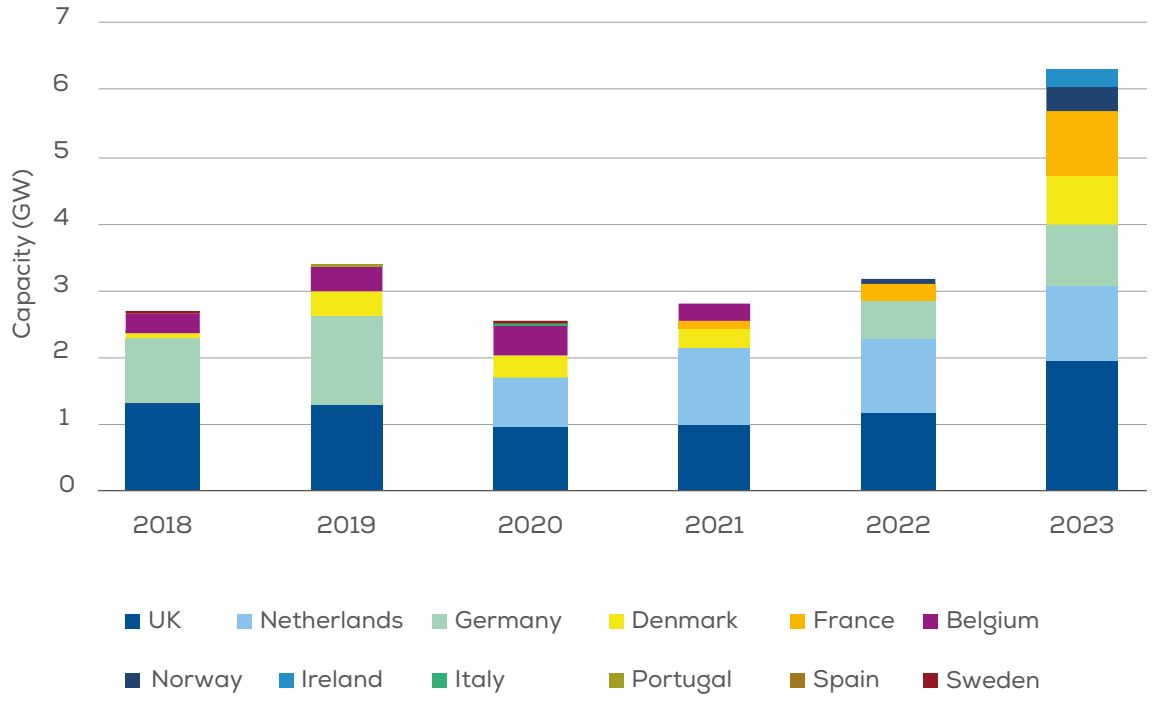
2019 will be a record year for offshore wind (3.4 GW) due to strong installations in the UK (Beatrice 2, Hornsea 1 and East Anglia 1) and Germany (Merkur Offshore, EnBW Hohe See, EnBW Albatros and Deutsche Bucht). After that, there will be no installations in German waters until 2022 but the Dutch offshore wind projects (Borssele Sites I, II, III and IV) will prevent a significant decrease in new offshore installations. In 2023, we expect another record year of 6.3 GW due to strong installations in almost all North Sea countries (the UK, the Netherlands, Germany, France and Denmark).

**FIGURE 10**
2019-2023 gross installations of offshore wind per country




Source: WindEurope

**FIGURE 11**
Annual gross offshore installations per country - WindEurope's Central Scenario




Source: WindEurope

## Repowering

Repowering decisions are driven by many factors. Some of the most relevant are the following:

- Existing incentives for repowering or lifetime extension,
- current and future wholesale electricity prices,
- regulation around the Environmental Impact Assessment and other environmental restrictions that have changed the most over recent years.

Based on these drivers, together with the analysis of historical trends, WindEurope has developed 4 main types of repowering scenarios where a 'type' reflects the local specificities of national markets.

The types vary on how much of the wind fleet is repowered and decommissioned after 20 or 25 years. We assume that repowering projects follow the previously analysed trend of an increased power factor in new wind farms of 2.23, and that wind farms that reach 30 years of age would be fully decommissioned.

The four different types are explained in the following box. And an illustration of Type 1 is provided in Figure 12.

**REPOWERING SCENARIOS AFTER EACH DECOMMISSIONING**

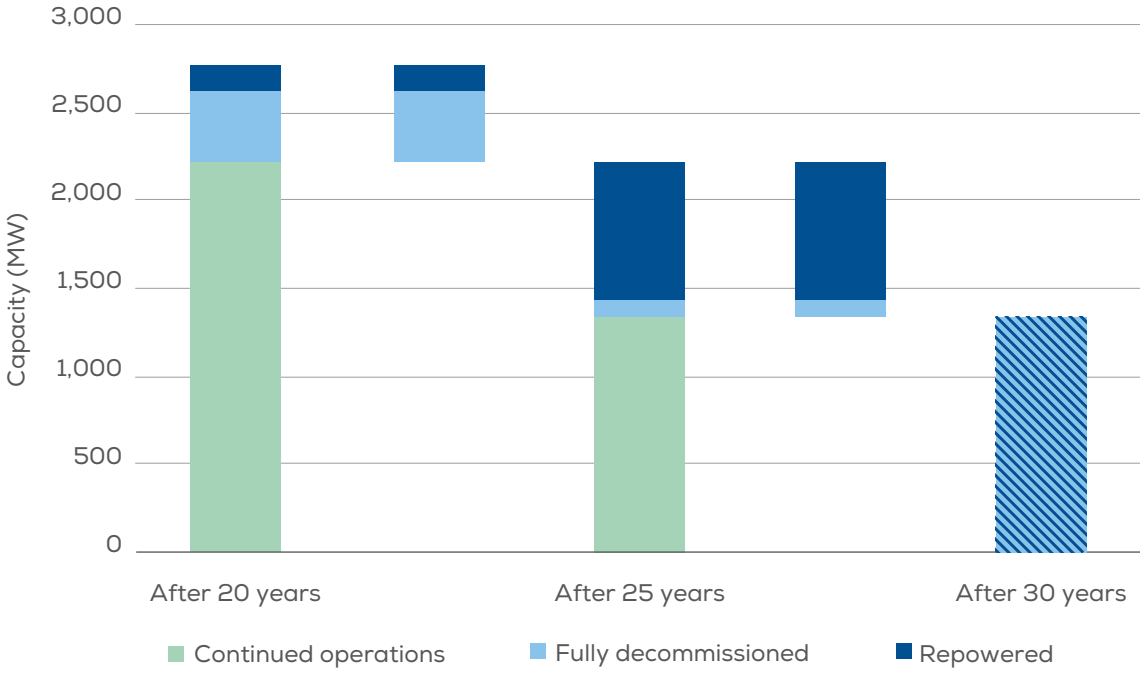
Type 1 - CONSTRAINED REPOWERING
**Repowering:**
5% repowering after 20 years
35% repowering after 25 years
**Decommissioning**
20% removed after 20 years
40% removed after 25 years

Type 2 - LATE REPOWERING
**Repowering:**
0% repowering after 20 years
40% repowering after 25 years
**Decommissioning**
0% removed after 20 years
40% removed after 25 years

Type 3 - LIFETIME EXTENSION & REPOWERING MARKET
**Repowering:**
50% repowering after 20 years
50% repowering after 25 years
**Decommissioning**
55% removed after 20 years
60% removed after 25 years

Type 4 - INCENTIVIZED REPOWERING
**Repowering:**
75% repowering after 20 years
65% repowering after 25 years
**Decommissioning:**
80% removed after 20 years
70% removed after 25 years

**FIGURE 12**
**Overview of type 1 - Illustrative**




Source: WindEurope

According to WindEurope's estimates for repowering, between 4.3 and 5.2 GW of new installations would come from repowering projects. In 2019 the repowering volume would be around 400 MW but by 2023 it could reach up to 1.5 GW.

We expect that Germany would be the largest repowering market: 1.4 GW over the next five years. This would be followed by Italy (0.9 GW), Spain (0.6 GW), Denmark (0.5 GW) and the Netherlands (0.5 GW).

## Decommissioning and lifetime extension

As wholesale electricity prices are on the rise due to increased Emissions Trading System (ETS) prices and the continuous phase-out of coal power around Europe, we have downgraded our assumptions on fully decommissioned capacity over the next five years. We expect between 3.9 and 4.8 GW to be decommissioned over the next five years. This could lead to more than 14,000 blades needing to be reused or recycled.

Between 1.9 and 2.3 GW of the decommissioning power will be repowered (with an increase factor of 2.23), while between 2 and 2.4 GW would be fully decommissioned over the next five years.

As we expect 22 GW to reach their initially forecasted end of life over the next five years, we expect that up to 18 GW will continue running their operations (with partial replacement of certain elements such as gearbox or blades).

## Cumulative capacity

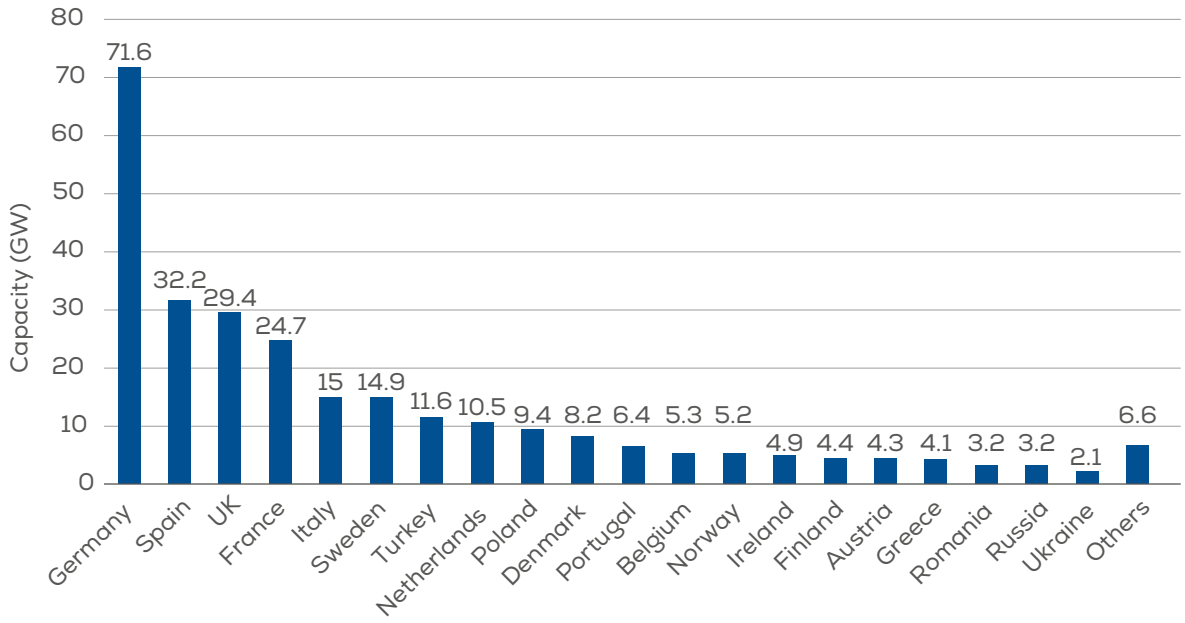
In cumulative terms, Europe would reach 277 GW of installed capacity by the end of 2023. Germany will remain the country with the largest wind fleet (71.6 GW), followed by Spain (32.2 GW), the UK (29.4 GW) and France (24.7 GW). Four other countries will be above the 10 GW threshold (Italy, Sweden, Turkey and the Netherlands).

**57%**

ALL THE WIND FLEET WILL BE IN JUST 4 COUNTRIES

**FIGURE 13**

Cumulative capacity in 2023 per country - WindEurope's Central Scenario




Source: WindEurope

# 2.3. LOW SCENARIO

In our Low Scenario, we assume that European governments propose no positive improvements from current legislation, and delays in the completion of projects are widespread. According to this scenario, permitting issues continue to be a problem and there is limited grid development. Consequently, all countries with no incentives for wind energy remain with no new installations. 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 Low Scenario also assumes bad weather conditions in 2019 that cause delays in markets such as Sweden and Norway.

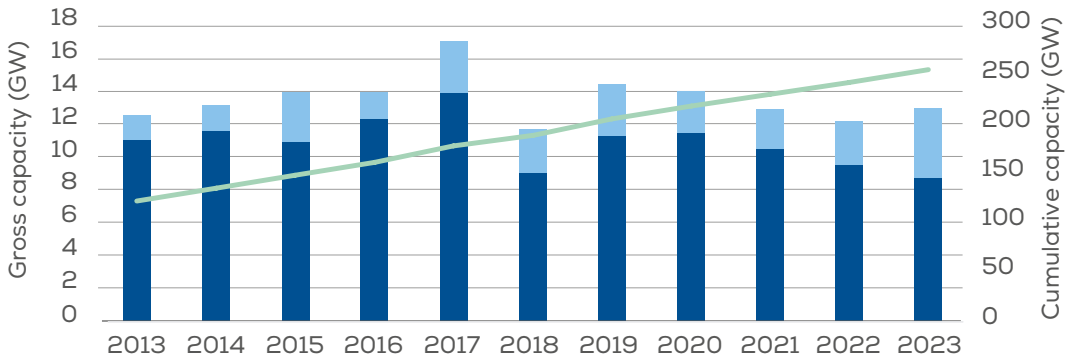
Under the Low Scenario, 2019 is not a record year for new installations due to lower installations in Germany, Sweden and Spain, summing a total of 14.5 GW.

Overall, there is a potential 24 GW drop from the Central to the Low Scenario in 2019-2023 installations, at an annual installation rate of 13.3 GW/year. This would lead to a cumulative capacity of 254 GW by 2023.

The Low Scenario assumes that in Germany the citizens' projects awarded in 2017 onshore auctions (without permits) are causing a lower realisation rate and that the permitting troubles and court issues remain a problem. Those problems, together with offshore delays, result in a 3.6 GW drop compared to the Central Scenario.

With regards to offshore, the Low Scenario foresees a slower installation rate mainly due to delays. This would result in a 3.1 GW drop over the next 5 years compared to the Central Scenario.

**FIGURE 14**
**Annual Gross installations - WindEurope's Low Scenario**




| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Offshore | 1.5 | 1.5 | 3.0 | 1.6 | 3.2 | 2.7 | 3.1 | 2.5 | 2.5 | 2.7 | 4.3 |
| Onshore | 11.0 | 11.6 | 10.9 | 12.3 | 13.9 | 9.0 | 11.3 | 11.5 | 10.4 | 9.5 | 8.7 |
| Cumulative | 122 | 135 | 148 | 162 | 178 | 189 | 203 | 217 | 229 | 241 | 254 |

Onshore Offshore Cumulative

Source: WindEurope

# 2.4. HIGH SCENARIO

In the High Scenario, the legislative framework in European countries is improved. Those changes 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.

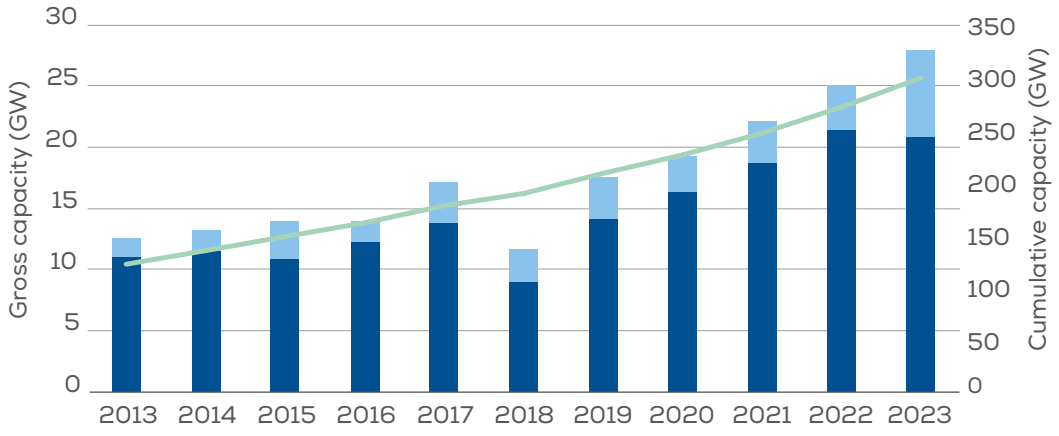
After a record year in 2019 with 17.7 GW (900 MW more than in the Central Scenario), 2020 would be an even stronger year with 19.4 GW, continuing the trend of consecutive record years for installations. In 2023 the installations could reach 28 GW and result in a total 299 GW of cumulative capacity.

About 22 GW of additional capacity is installed in the High Scenario compared to the Central Scenario, with an annual installation rate of 22.4 GW/year.

In Germany the new auctions for wind energy enjoy a healthy level of competition due to solved issues of permitting. Combined with a higher build-out rate of citizens' projects, the High Scenario means 5 GW more for Germany compared to the Central Scenario.

For offshore wind the High Scenario anticipates a faster build-out that would bring the offshore capacity to 39 GW in 2023. The faster build-outs in the UK, Germany, Denmark, the Netherlands, France and Ireland would result in 2.2 GW more capacity being installed over the next five years compared to the Central Scenario.

**FIGURE 15**
**Annual Gross installations - WindEurope's High Scenario**




| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Offshore | 1.5 | 1.5 | 3.0 | 1.6 | 3.2 | 2.7 | 3.4 | 2.9 | 3.4 | 3.7 | 7.1 |
| Onshore | 11.0 | 11.6 | 10.9 | 12.3 | 13.9 | 9.0 | 14.3 | 16.5 | 18.8 | 21.3 | 20.9 |
| Cumulative | 122 | 135 | 148 | 162 | 178 | 189 | 207 | 226 | 247 | 272 | 299 |

Onshore Offshore Cumulative

Source: WindEurope

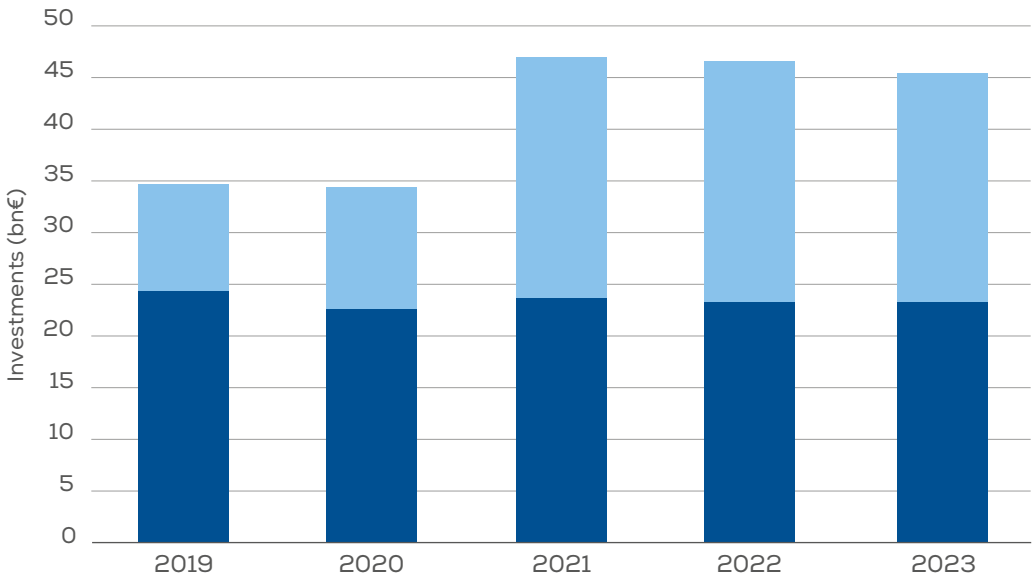
# 2.5. INVESTMENT OUTLOOK

According to WindEurope's Central Scenario, €208 bn of investments in new assets will be needed in new assets moving forward to 2023.

Onshore investments are expected to remain around €23 bn per year due to a flat installations forecast for 2020 and after. We could experience a record year of investments in 2021 (assuming a 2-year delay between FID and commissioning), as we expect record installations in 2023. In 2021, offshore investments in new assets might equal and even overtake investments in new onshore wind assets.

For the 5-year investment outlook we assume a consistent CAPEX for both onshore and offshore installations.

**FIGURE 16**
**Investment outlook in new assets for the period 2019-2023 - WindEurope's Central Scenario**




| | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|
| Offshore | 10.3 | 11.7 | 23.3 | 23.3 | 22.2 |
| Onshore | 24.4 | 22.7 | 23.6 | 23.1 | 23.1 |

Source: WindEurope

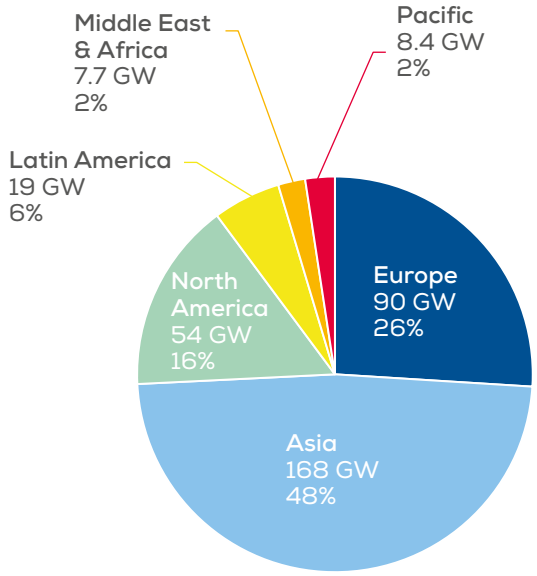
# 2.6. GLOBAL WIND ENERGY MARKET OUTLOOK

With more than 90 GW of new installations in the 2019-2023 period under the Central Scenario Europe could represent 26% of global gross installations. Asia will be leading the race in bringing additional capacity, with an expected 168 GW representing almost half of all global installations in the next 5 years.

In offshore wind Europe would contribute 41% of new installations, while Asia would lead the way with 25 GW over the next five years (57% of global offshore installations).

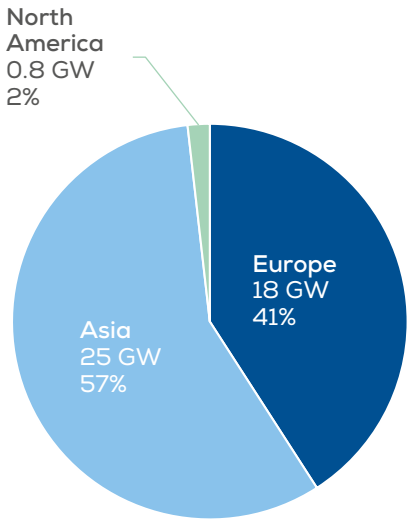
NEW INSTALLATIONS IN EUROPE WILL REPRESENT **26%** OF GLOBAL MARKET

**FIGURE 17**
Global gross installations in 2019-2023




Source: WindEurope, GWEC Global Wind Market Outlook Q3 2019

**FIGURE 18**
Global gross offshore installations in 2019-2023




Source: WindEurope, GWEC Global Wind Market Outlook Q3 2019

# 3. TECHNOLOGY TRENDS

## 3.1 ONSHORE 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.

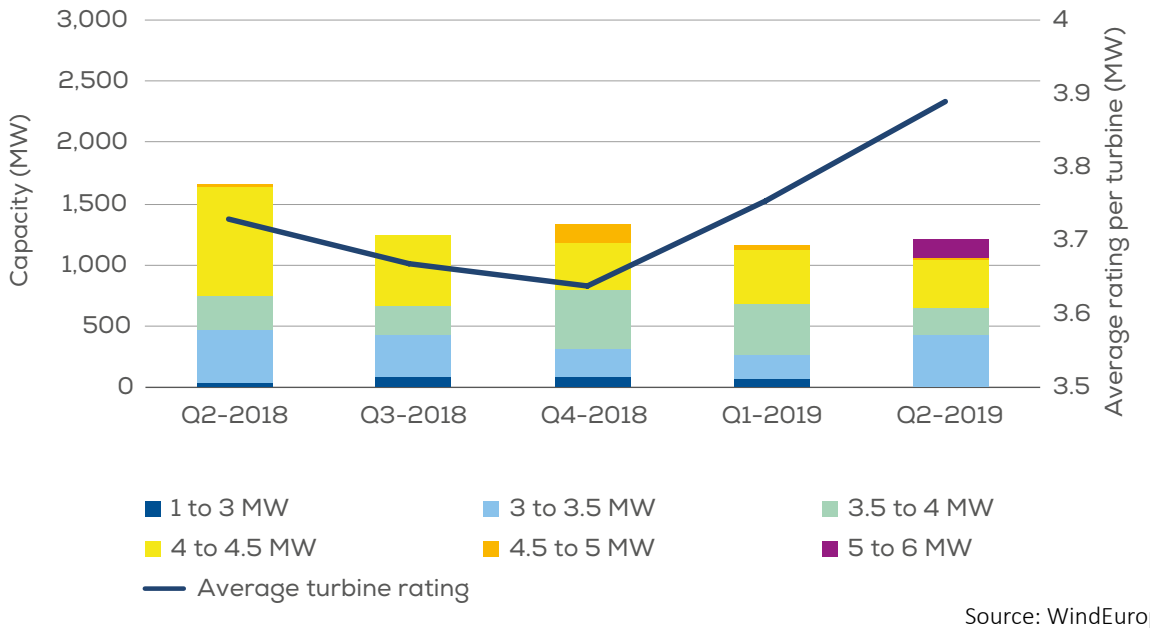
### Beyond 5 MW onshore wind platforms – a new normal?

In Q2 2019, 12% of ordered onshore wind capacity was for turbines above 5 MW, while 47% of ordered capacity came from turbines of 4 MW and above[9]. We expect those turbines to be installed between we expect those turbines to be installed between 2019 and 2023 – a trend that is set to continue towards larger and more powerful turbines. The average power rating is thus growing quickly.

HALF OF THE ONSHORE TURBINES ORDERED IN Q2 2019 WERE **4 MW** OR ABOVE

9. See WindEurope's quarterly turbine orders monitoring (members only) at https://windeurope.org/members-area/market-intelligence/business-intelligence-reports/.

**FIGURE 19**
**Average power rating of ordered onshore wind turbines**



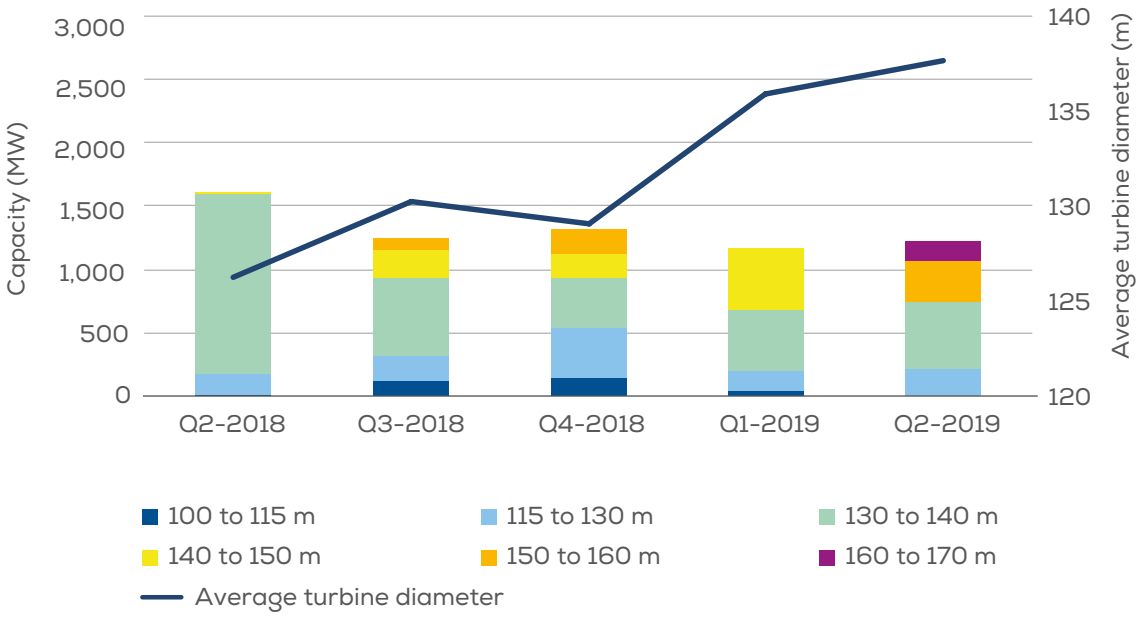

Source: WindEurope

## What is the limit for onshore turbine rotors size?

In Q2 2019 the average diameter of onshore turbine rotors increased to 138m. Turbines of over 160m entered the market as Vestas' V162-5.6 model received an order in Finland.

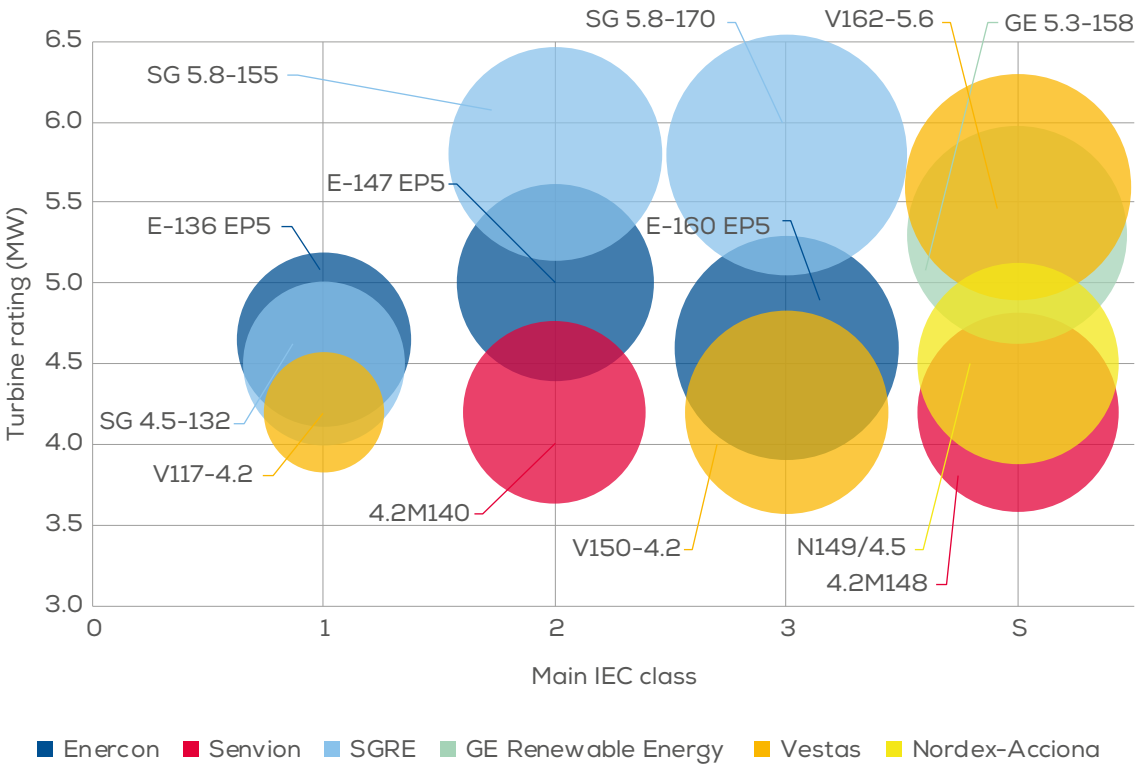
In the meantime several turbine manufacturers announced new onshore turbine models. In August, Nordex-Acciona announced the N163/5.X model, which features a single-piece rotor blade that is nearly 80m long. A couple of months earlier Siemens Gamesa Renewable Energy presented their 5.X platform, which features the SG 5.8-170 turbine model – now the largest onshore rotor diameter (170m). Enercon also launched a new turbine model E-160 EP5 with a 160m rotor diameter. The only 2-piece blade wind turbine in the market – GE's Cypress platform – has already received an order for customers in Germany and Turkey.

**FIGURE 20**
**Average rotor diameter of ordered onshore turbines**




Source: WindEurope

**FIGURE 21**
**Largest onshore turbines currently in Europe (size of bubble represents the rotor diameter)**




Source: WindEurope

# 3.2 OFFSHORE WIND TURBINE SIZE

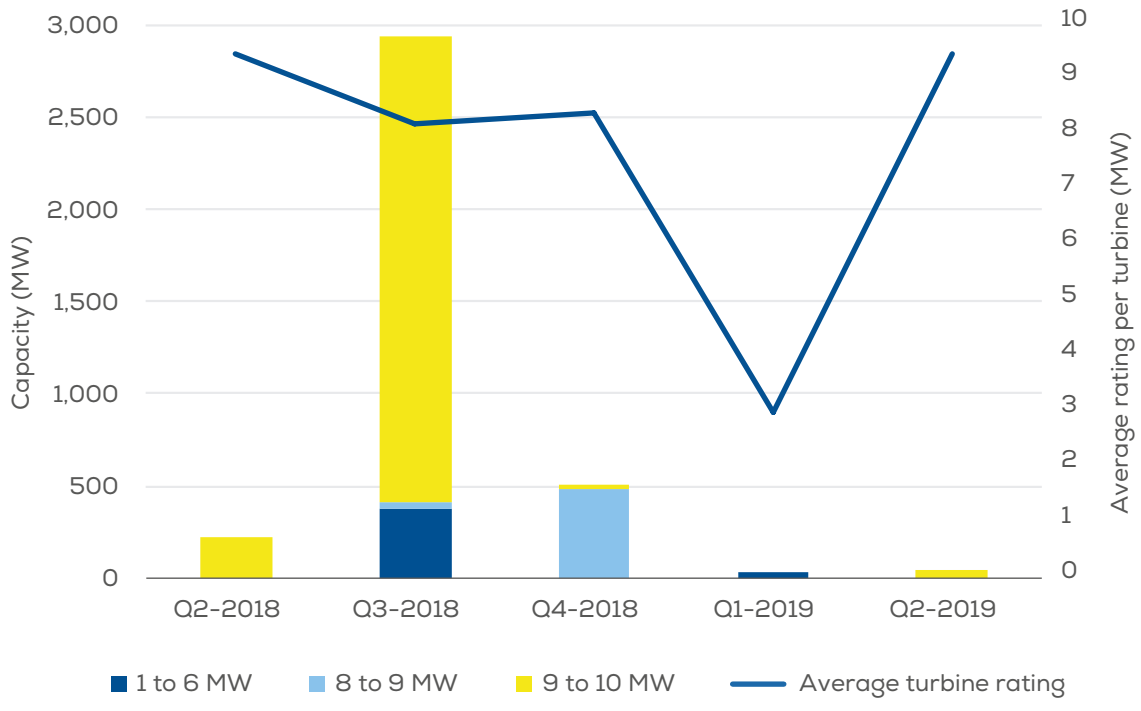
## Beyond 8 MW offshore wind turbines

In the last 12 months, 88% of ordered offshore wind capacity 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 2019-2023 to be 8 MW or above. The period until 2023 will also see the installation of larger turbines (+10 MW) coming from test facilities and the Hollande Kust Zuid wind farm, where SGRE will supply Vattenfall with their SG 10.0-193 DD turbine.

**OFFSHORE TURBINES OF 10 MW ARE EXPECTED TO ENTER THE MARKET BY 2023**

**FIGURE 22**
**Average power rating of ordered offshore wind turbines**



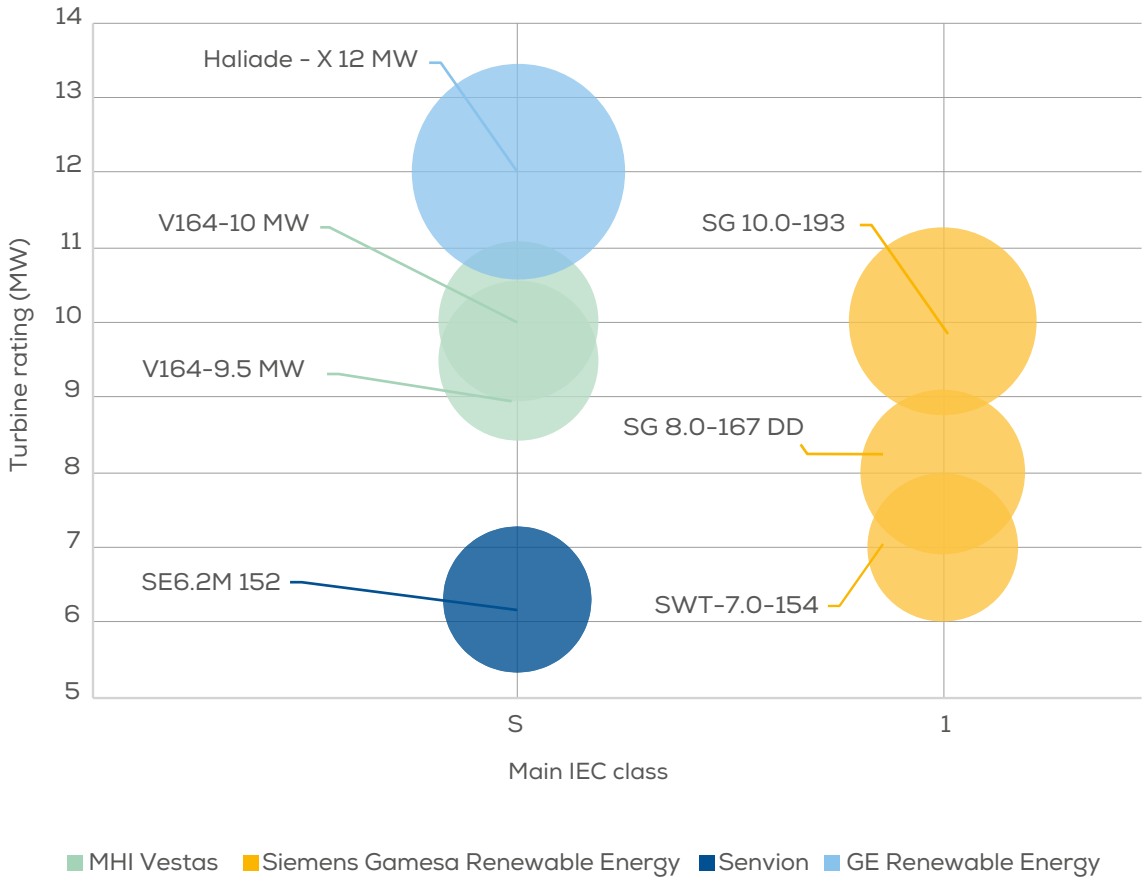

Source: WindEurope

In September 2018 MHI Vestas announced that their V164 platform will be available in a 10 MW version after the success of orders for the V164-9.5 MW model.

In January 2019 Siemens Gamesa Renewable Energy (SGRE) presented their largest turbine model so far – the SG 10.0-193 DD. This 10 MW turbine is expected to see the first prototype erection in 2019.

At the time of writing, GE Renewable Energy was in the process of installing their Haliade-X 12 MW prototype in the port of Rotterdam.

**FIGURE 23**
**Offshore turbines available in Europe above 6 MW (size of the bubble represents the rotor diameter)**




Source: WindEurope

| ANNEX 1 – CENTRAL SCENARIO FIGURES | | | | |
|---|---|---|---|---|
| Country | Gross installations 2019-2023 | | Decommissioned | Cumulative Capacity 2023 |
| | Onshore | Offshore | | |
| Austria | 1,246 | | 156 | 4,277 |
| Belgium | 830 | 1,075 | 0 | 5,265 |
| Bulgaria | - | | 0 | 691 |
| Croatia | 804 | | 0 | 1,387 |
| Cyprus | - | | 0 | 158 |
| Czech Republic | 63 | | 0 | 380 |
| Denmark | 932 | 1,723 | 429 | 8,201 |
| Estonia | 390 | | 0 | 700 |
| Finland | 2,394 | | 0 | 4,435 |
| France | 8,050 | 1,305 | 96 | 24,655 |
| Germany | 11,200 | 2,853 | 2,374 | 71,596 |
| Greece | 1,310 | | 72 | 4,103 |
| Hungary | - | | 0 | 329 |
| Ireland | 1,142 | 260 | 59 | 4,942 |
| Italy | 5,020 | 30 | 450 | 14,959 |
| Latvia | - | | 0 | 66 |
| Lithuania | 545 | | 0 | 984 |
| Luxembourg | 44 | | 0 | 164 |
| Malta | - | | 0 | - |
| Netherlands | 2,020 | 4,072 | 217 | 10,549 |
| Poland | 3,500 | | 0 | 9,364 |
| Portugal | 1,040 | 25 | 139 | 6,432 |
| Romania | 200 | | 0 | 3,229 |
| Slovakia | - | | 0 | 3 |
| Slovenia | - | | 0 | 3 |
| Spain | 8,700 | 2 | 269 | 32,196 |
| Sweden | 7,532 | 1 | 69 | 14,888 |
| UK | 2,083 | 6,380 | 0 | 29,433 |
| Switzerland | 86 | | 0 | 161 |
| Norway | 3,107 | 442 | 0 | 5,224 |
| Turkey | 4,200 | | 0 | 11,569 |
| Ukraine | 1,540 | | 0 | 2,073 |
| Serbia | 471 | | 0 | 845 |
| Bosnia and Herzegovina | 304 | | 0 | 355 |
| Montenegro | 75 | | 0 | 193 |
| Kosovo | 105 | | 0 | 137 |
| North Macedonia | 14 | | 0 | 51 |
| Russia | 3,065 | | 0 | 3,204 |
| Albania | 3 | | 0 | 3 |
| **Total Europe** | **72,014** | **18,167** | **4,329** | **277,206** |
| **Total EU-28** | **59,045** | **17,725** | **4,329** | **253,392** |

WindEurope is the voice of the wind industry, actively promoting wind power in Europe and worldwide. It has over 400 members with headquarters in more than 35 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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