Wind EUROPE

Wind energy in Europe

2023 Statistics and the outlook for 2024-2030

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DISCLAIMER

This report summarises new wind farm installations in Europe from 1 January to 31 December 2023.

It also analyses how European markets will develop in the next seven years (2024 to 2030). The outlook is based on WindEurope internal analysis and consultation with its members.

The data represents gross installations per site and country unless otherwise stated. Rounding of figures is at the discretion of the author.

Photo: Shutterstock

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Executive summary

EUROPE NOW HAS

272 GW

OF WIND CAPACITY

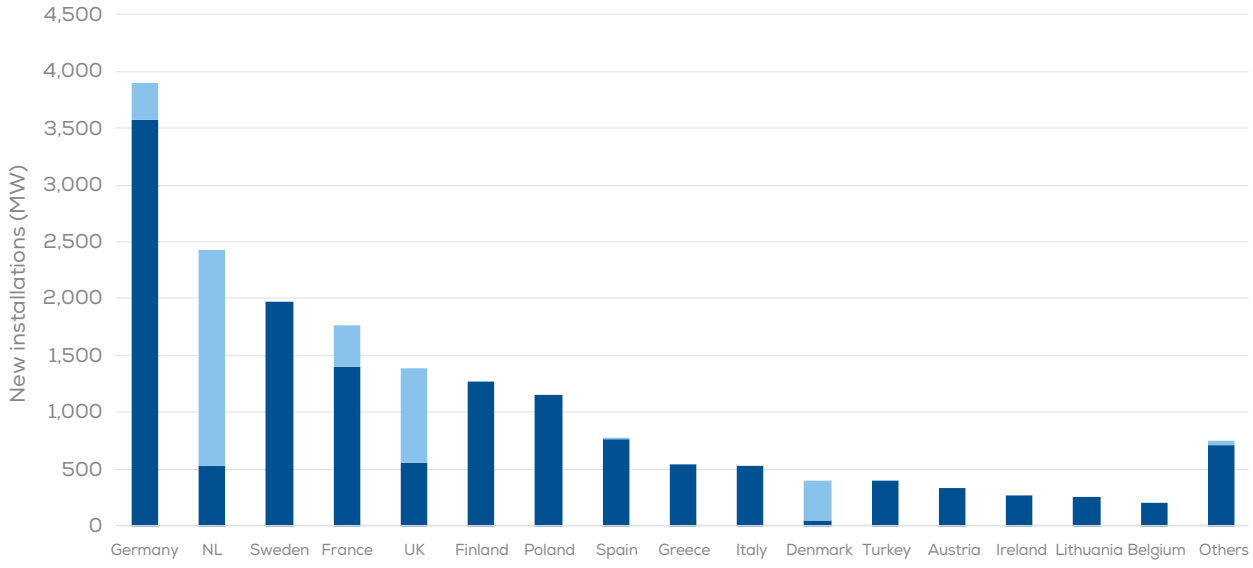
Europe installed 18.3 GW of new wind power capacity in 2023. The EU-27 installed 16.2 GW of this, a record amount but only half of what it should be building to meet its 2030 climate and energy targets.

79% of the new wind capacity built in Europe last year was onshore. The volume of new offshore installations is growing – last year it was a record 3.8 GW in Europe. But 2/3rds of the new wind installations up to 2030 will continue to be onshore.

Germany built the most new capacity last year, thanks to its rapid ongoing onshore wind expansion. After Germany, the Netherlands built the most thanks to their record new offshore wind installations. Sweden was third with 1.9 GW of new capacity installed, all onshore.

Wind energy was 19% of all the electricity consumed in the EU-27 in 2023. It was 56% in Denmark, 36% in Ireland, 31% in Germany, 29% in the UK and 27% in Spain and the Netherlands.

FIGURE A. New onshore and offshore wind installations in Europe in 2023



	Germany	NL	Sweden	France	UK	Finland	Poland	Spain	Greece	Italy	Denmark	Turkey	Austria	Ireland	Lithuania	Belgium	Others
Onshore	3,567	527	1,973	1,400	553	1,278	1,157	762	543	525	54	397	331	275	262	203	717
Offshore	329	1,906	0	360	833	0	0	2	0	0	344	0	0	0	0	0	35

Source: WindEurope

We expect Europe to ramp-up its annual build-out of new wind power capacity over the period 2024-2030.

We expect the EU to build 29 GW of new wind farms a year on average over the period 2024-2030. To meet its 2030 climate and energy targets the EU now needs to build 33 GW a year on average.

The expected increase in annual build-out over 2024-2030 reflects a combination of Government ambition, increased auction volumes, improvements in the permitting of new wind farms and increased investments.

New EU rules on permitting are already delivering an increase in permitting volumes for new wind farms. Germany and Spain both permitted 70% more onshore wind in 2023, with Germany reaching 7.5 GW.

The rising annual build-out that we anticipate for 2024-2030 would take the EU to 393 GW total installed capacity. The EU's 2030 target is 425 GW[1].

The main risk to this build-out is delays in connection to the grid. Governments need to focus on accelerating the development of their electricity grids. Connecting wind farms to the grid is now a key challenge for project developers across Europe.

2023 saw a major increase in investments for new wind farms. Total "Final Investment Decisions" (FIDs) were more than double the figure for 2022. Investments from FIDs in new offshore wind reached a record €30bn, a major rebound from 2022 when there were hardly any.

1. 2030 REPowerEU target reduced from 440 GW after the compromise of a 42.5% renewable energy target for 2030 was reached in 2023

FIGURE B. 2024-30 annual onshore and offshore wind power installations in the EU - WindEurope's Outlook

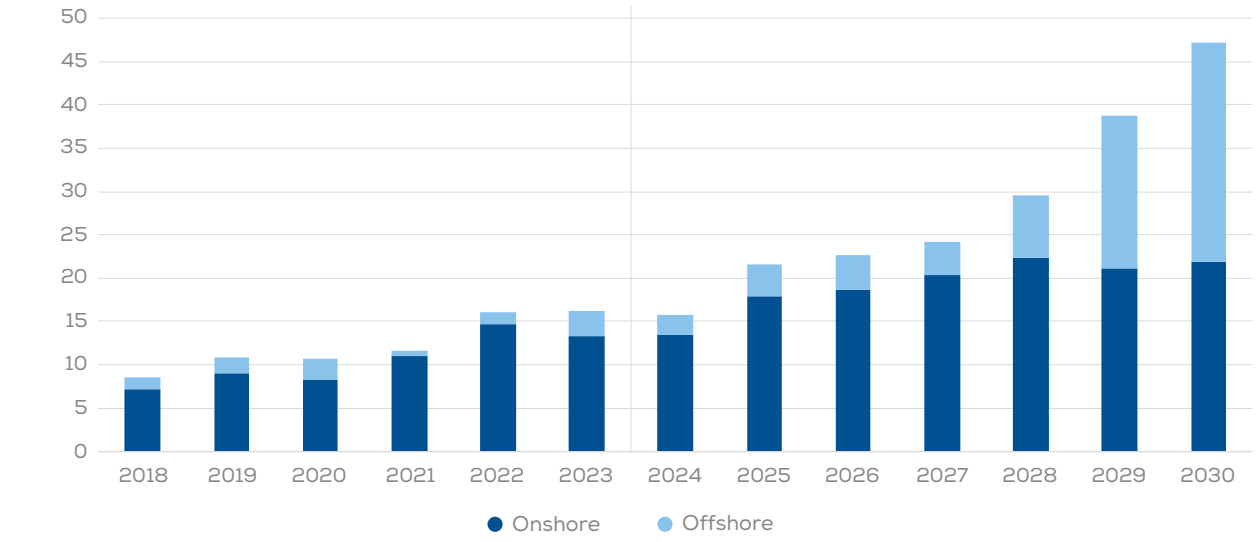
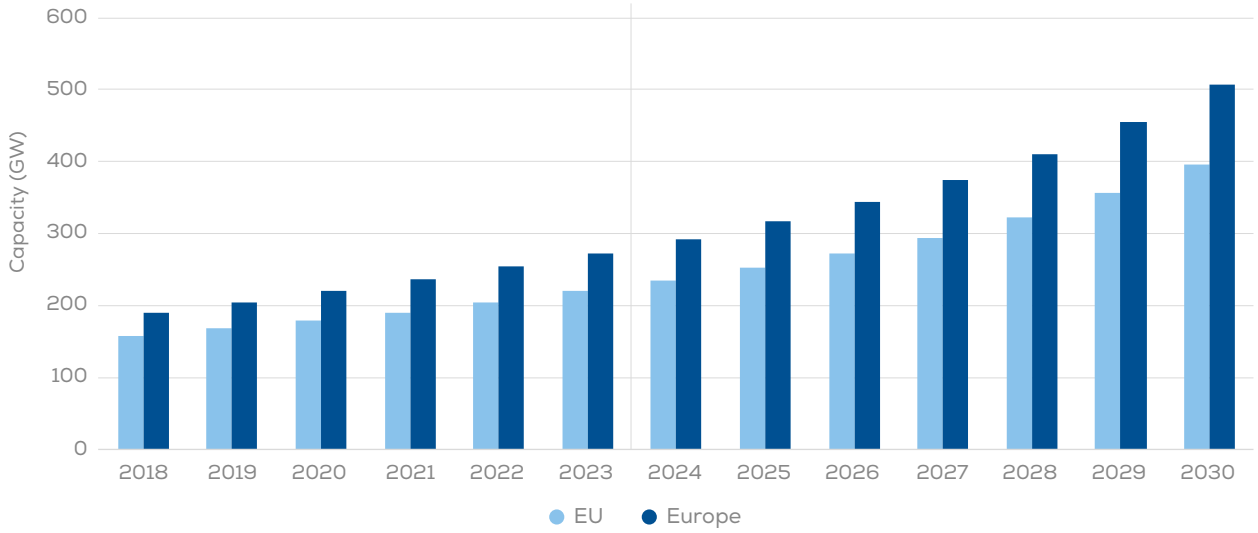


FIGURE C. 2024-30 total wind power capacity in Europe and the EU - WindEurope's Outlook



Source: WindEurope

2023 Annual figures

- Europe installed 18.3 GW of new wind capacity in 2023 (gross installations). Onshore wind made up 79% of new installations for a total of 14.5 GW.
- A record 16.2 GW of new capacity was installed in the EU-27. 82% of this was onshore (13.3 GW).
- New offshore wind installations in Europe were a record 3.8 GW. 2.9 GW of this was in the EU-27, also a new record.
- Wind farms in the EU generated 466 TWh of electricity in 2023. This covered 19% of the EU's electricity demand.
- Total "Final Investment Decisions" (FIDs) were more than double the figure for 2022. Investments from FIDs in new offshore wind farms were a record €30bn, a major bounce back from 2022 when there were hardly any.
- Governments in Europe awarded 26 GW of new capacity in their wind energy auctions in 2023. 13 GW of this was onshore, 13 GW offshore.

Total installed capacity

- Europe now has 272 GW of installed wind power capacity: 238 GW onshore and 34 GW offshore.
- The EU-27 has 220 GW installed wind capacity: 201 GW onshore and 19 GW offshore.

Performance of new wind farms

- Anticipated capacity factors for the new onshore wind farms built in Europe in 2023 range from 30% to 45%. It is around 50% for offshore wind.
- The average power rating of the new onshore turbines installed in 2023 was 4.5 MW, up from 4.1 MW in 2022. For offshore wind it was 9.7 MW, up from 8.0 MW in 2022.

Country highlights

- Germany installed the most wind power capacity in 2023 (3.9 GW). 92% of that was onshore.
- The Netherlands (2.4 GW), Sweden (2 GW), France (1.8 GW), the UK (1.4 GW), Finland (1.3 GW), and Poland (1.2 GW) came next.
- Denmark and Ireland had the highest share of wind in their electricity mix with 56% and 36% respectively.
- Wind met more than 20% of electricity demand in another eight countries: Germany (31%), the UK (29%), the Netherlands (27%), Spain (27%), Sweden (26%), Portugal (26%), Lithuania (21%) and Greece (20%).
- Despite the ongoing war, Ukraine installed 146 MW of new capacity. 71% of its total installed capacity of 1.9 GW is currently out of operation.

2024-2030 Outlook

- We expect Europe to install 262 GW of new wind power capacity over 2024-2030. The EU-27 should install 201 GW of this – 29 GW a year on average.
- We expect 2/3 of new installations over the period 2024-2030 to be onshore.
- The EU needs to build 33 GW a year on average to meet its 2030 climate and energy targets.
- The new EU rules on permitting have already boosted permitting volumes for new wind farms. Germany and Spain both permitted 70% more onshore wind in 2023 than in 2022, with Germany reaching 7.5 GW.
- Grid permitting is fast becoming the biggest bottleneck for deploying wind energy at scale. National Authorities should invest in expanding, reinforcing or optimising their transmission and distribution networks as soon as possible.

Old wind farms and repowering

- Europe decommissioned 736 MW of wind capacity in 2023. At the same time, it commissioned 1.4 GW of repowered capacity. The overall net new capacity additions, when youn add on all the greenfield installations, were 17.6 GW.
- About 27 GW should be decommissioned over the 2024-2030 period. We expect 17 GW of that to be repowered (eventually leading to 28 GW of repowered capacity). The remaining 10 GW will be fully decommissioned and removed from the system.
- Repowering trebles wind farm output on average while cutting the number of turbines by 25%.

TABLE 1. New additions, total wind capacity and the share of wind in the electricity demand in 2023 [2]

	New installations in 2023 (MW)			Cumulative capacity (MW)			Share of wind in power mix in 2023		
EU-27	**Onshore**	**Offshore**	**Total**	**Onshore**	**Offshore**	**Total**	**Onshore**	**Offshore**	**Total**
Austria	331	-	**331**	3,885	-	**3,885**	14%	-	**14%**
Belgium	203	-	**203**	3,231	2,261	**5,492**	8%	10%	**18%**
Bulgaria	-	-	**-**	706	-	**706**	4%	-	**4%**
Croatia	156	-	**156**	1,256	-	**1,256**	14%	-	**14%**
Cyprus	-	-	**-**	158	-	**158**	4%	-	**4%**
Czechia	-	-	**-**	337	-	**337**	1%	-	**1%**
Denmark	54	344	**398**	4,910	2,652	**7,562**	32%	24%	**56%**
Estonia	58	-	**58**	376	-	**376**	10%	-	**10%**
Finland	1,278	-	**1,278**	6,872	71	**6,943**	18%	-	**18%**
France	1,400	360	**1,760**	21,950	842	**22,792**	11%	0%	**11%**
Germany	3,567	329	**3,896**	61,139	8,536	**69,675**	26%	5%	**31%**
Greece	543	-	**543**	5,226	-	**5,226**	20%	-	**20%**
Hungary	-	-	**-**	329	-	**329**	1%	-	**1%**
Ireland	275	-	**275**	4,777	25	**4,802**	36%	-	**36%**
Italy	525	-	**525**	12,306	30	**12,336**	8%	0%	**8%**
Latvia	-	-	**-**	137	-	**137**	4%	-	**4%**
Lithuania	262	-	**262**	1,208	-	**1,208**	21%	-	**21%**
Luxembourg	42	-	**42**	208	-	**208**	-	-	**-**
Malta	-	-	**-**	-	-	**-**	-	-	**-**
Netherlands	527	1,906	**2,433**	6,754	4,739	**11,493**	16%	11%	**27%**
Poland	1,157	-	**1,157**	9,383	-	**9,383**	13%	-	**13%**
Portugal	79	-	**79**	5,809	25	**5,834**	25%	0%	**26%**
Romania	72	-	**72**	3,100	-	**3,100**	14%	-	**14%**
Slovakia	-	-	**-**	3	-	**3**	0%	-	**0%**
Slovenia	-	-	**-**	3	-	**3**	0%	-	**0%**
Spain	762	2	**764**	30,562	7	**30,569**	27%	-	**27%**
Sweden	1,973	-	**1,973**	16,249	192	**16,441**	26%	-	**26%**
Total EU-27	**13,263**	**2,941**	**16,204**	**200,873**	**19,380**	**220,253**	**17%**	**2%**	**19%**

2. All numbers are rounded and therefore may not sum to totals.

	New installations in 2023 (MW)			Cumulative capacity (MW)			Share of wind in power mix in 2023		
Others	Onshore	Offshore	Total	Onshore	Offshore	Total	Onshore	Offshore	Total
Albania	-	-	-	-	-	-	-	-	-
Belarus	-	-	-	3	-	3	-	-	-
Bosnia & Herzegovina	-	-	-	135	-	135	-	-	-
Faroe Islands	-	-	-	68	-	68	-	-	-
Iceland	-	-	-	3	-	3	-	-	-
Kosovo	-	-	-	137	-	137	-	-	-
Liechtenstein	-	-	-	-	-	-	-	-	-
Montenegro	-	-	-	118	-	118	-	-	-
North Macedonia	36	-	36	73	-	73	-	-	-
Norway	-	35	35	5,083	101	5,184	10%	-	10%
Russia	-	-	-	2,043	-	2,043	-	-	-
Serbia	114	-	114	512	-	512	-	-	-
Switzerland	14	-	14	101	-	101	0%	-	0%
Turkey	397	-	397	12,342	-	12,342	11%	-	11%
UK	553	833	1,386	14,866	14,756	29,622	12%	17%	29%
Ukraine	146	-	146	1,902	-	1,902	-	-	-
Total others	1,260	868	2,128	37,387	14,857	52,244	-	-	-
Total Europe	14,523	3,809	18,332	238,260	34,237	272,497	16%	4%	20%

1.

Wind power in 2023

1.1 Overview

New wind installations in Europe totalled 18.3 GW in 2023, with 14.5 GW of wind capacity installed onshore and 3.8 GW offshore. Total installations in Europe fell short of our outlook (central scenario) from 2022 by 6%.

New installations in the EU-27 reached record levels in 2023 with 16.2 GW of new wind power capacity added representing 88% of all installations in Europe. For the EU to reach its 42.5% renewable energy target by 2030, wind energy installations need to average 33 GW a year between 2024 and 2030. This is based on an installed wind power capacity target of 425 GW[3].

Wind farm installations in Germany were the highest in Europe last year, accounting for 25% of installed capacity onshore. The total installation figure came to 3.9 GW – including 329 MW of offshore wind. Seven countries installed more than 1 GW of new capacity in 2023.

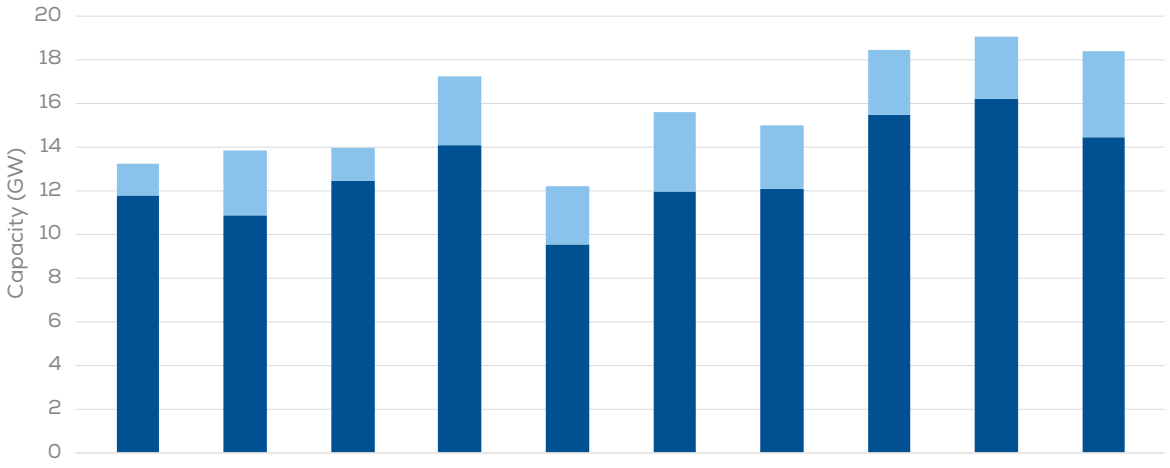
Offshore wind accounted for 21% of installations in Europe with 3.8 GW of wind farm capacity connected to the grid. Nearly half of the newly connected capacity was in the Netherlands (1.9 GW) with the remainder coming from the UK (833 MW), France (360 MW), Denmark (344 MW), Germany (329 MW) and Norway (35 MW).

Outside the EU, the 2.1 GW installed were attributable to the UK (1.4 GW), Turkey (397 MW), Serbia (114 MW), North Macedonia (36 MW), Norway (35 MW) and Switzerland (14 MW). Despite the ongoing conflict Ukraine installed 146 MW.

736 MW of wind capacity was decommissioned in 2023, so net installations in Europe (installed minus decommissioned capacity) totalled 17.6 GW.

For the second year in a row Ukraine managed to build new wind capacity despite the ongoing war. 146 MW was added to the grid. At the same time however 71% of the country's 1.9 GW capacity was out of operation – but not destroyed – as of the end of 2023. Given the uncertainty of the situation, estimates for future build-out in the region have not been included in the 2024-2030 outlook for Europe.

FIGURE 1. Annual onshore and offshore wind power capacity installed in Europe



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Onshore	11.8	10.8	12.5	14.1	9.5	12.0	12.1	15.5	16.3	14.5
Offshore	1.5	3.0	1.5	3.2	2.7	3.7	2.9	2.9	2.6	3.8

Source: WindEurope

3. Reduced from 440 GW in 2023 after the compromise of a 42.5% renewable energy target was agreed.

1.2 Installations

Germany installed the most wind power capacity in 2023 with 3.9 GW. 3.6 GW of this was onshore – the most in a single year since 2017 – and 1.1 GW came from repowered wind farms, a record figure. Germany also connected 257 MW of offshore wind capacity in the Baltic Sea, all from the Arcadis Ost 1 wind farm. With an extra 72 MW from capacity modifications at existing turbines, the installed offshore wind power capacity grew by 329 MW over the year. 0.5 GW of old wind farm capacity was decommissioned.

The Netherlands set a new national record for installations in a single year with 2.4 GW, 78% of which was offshore. Offshore wind installations in the Netherlands represented half of all the offshore wind power capacity installed in Europe in 2023.

Sweden installed almost 2 GW, all onshore. Over the past three years Sweden has installed almost 6.5 GW – only Germany has installed more over the same period. Its total onshore wind power capacity has risen by 65% to 16.4 GW during the same period.

France installed 1.8 GW – 1.4 GW of which was onshore. This is the second highest amount for a single year after the record 2.1 GW installed in 2022.

The UK installed 1.4 GW of wind power capacity, mostly offshore (833 MW). 553 MW were installed onshore, almost exclusively in Scotland.

Finland installed 1.3 GW of onshore wind, after installing a record 2.4 GW in the previous year.

Poland installed a record 1.2 GW of onshore wind, 20 MW more than in 2022.

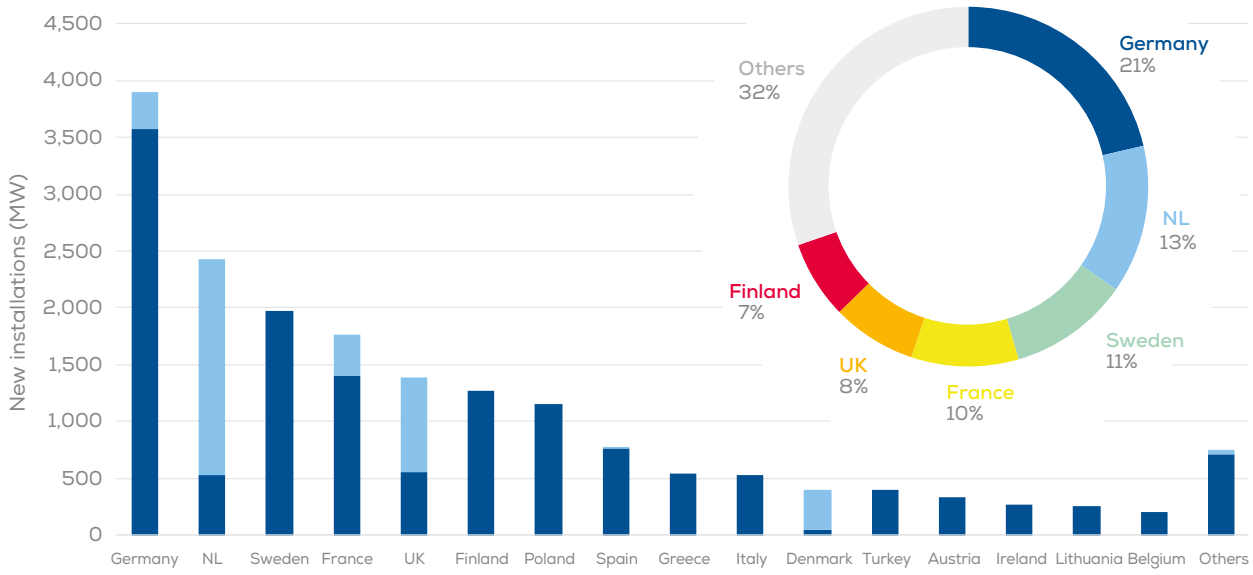
Spain installed a total of 764 MW, all of which was onshore except for a 2 MW floating wind turbine, part of a pilot project. This was less than half the installed capacity in 2022 (1.7 GW).

Greece installed 543 MW of onshore wind capacity in 2023, more than double the previous year and second only to 2019 for the amount of capacity installed in a year.

79%

OF WIND INSTALLATIONS IN 2023 CAME FROM ONSHORE WIND

FIGURE 2. New onshore and offshore wind installations in Europe in 2023



	Germany	NL	Sweden	France	UK	Finland	Poland	Spain	Greece	Italy	Denmark	Turkey	Austria	Ireland	Lithuania	Belgium	Others
Onshore	3,567	527	1,973	1,400	553	1,278	1,157	762	543	525	54	397	331	275	262	203	717
Offshore	329	1,906	0	360	833	0	0	2	0	0	344	0	0	0	0	0	35

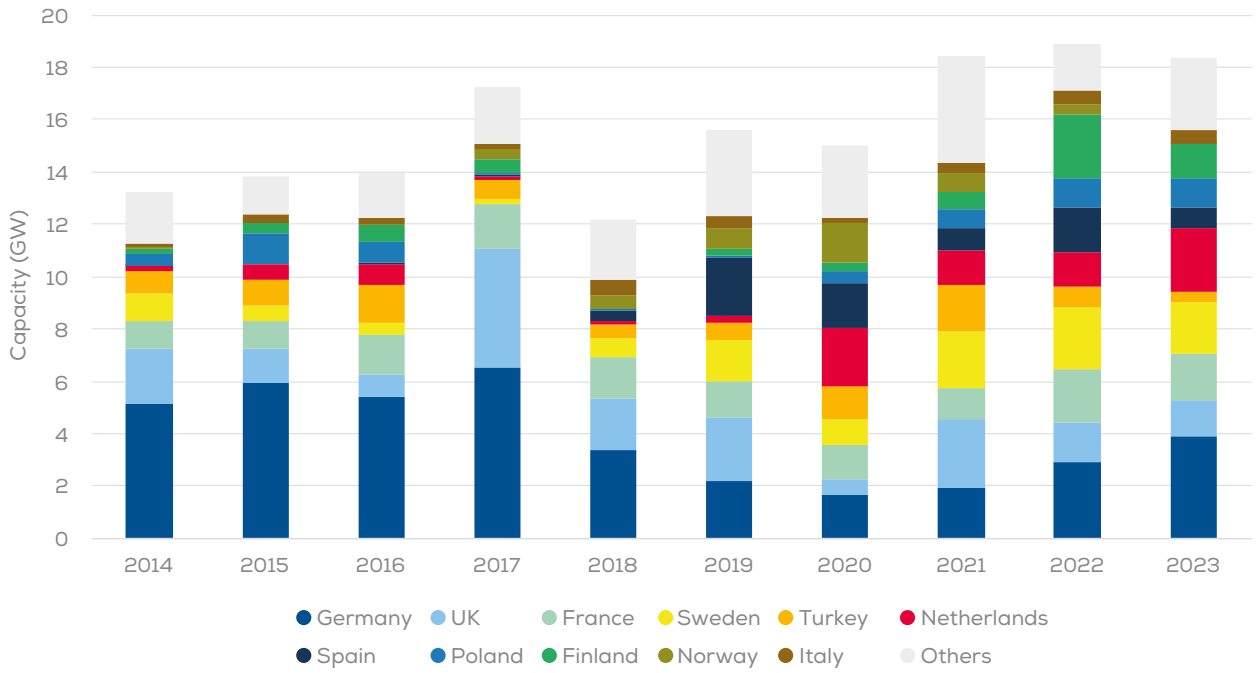
Source: WindEurope

Italy installed 525 MW of onshore wind power capacity in 2023.

In **Denmark**, Vesterhav Nord and Vesterhav Syd were commissioned adding 344 MW of new offshore wind capacity. With 54 MW of onshore wind, total capacity additions amounted to 396 MW.

14 countries did not install any wind power capacity in 2023. Eight of these were EU Member States.

FIGURE 3. Distribution of new wind installations by country in 2014-23



Source: WindEurope

A total of 3.8 GW of offshore capacity was connected to the grid in Europe. There were 11 wind farms across six countries connecting turbines to the grid in 2023, as well as a demo project in Spain.

The Netherlands connected 1.9 GW of offshore wind turbines across the Hollandse Kust Noord wind farm (759 MW) as well as the remaining turbines that had to be connected at the Hollandse Kust Zuid 1-4 (1.5 GW). The latter is now the largest operating offshore wind farm in the world.

The UK installed 833 MW of capacity offshore, finalising the connection of the Seagreen offshore wind farm. One turbine was also connected at the Dogger Bank (phase A) offshore wind farm.

France connected 360 MW of offshore wind in 2023. This includes turbines from the Fécamp wind farm (250 MW) and the Saint-Brieuc wind farm (496 MW). Both are already partially online and the remaining turbines will be connected in 2024.

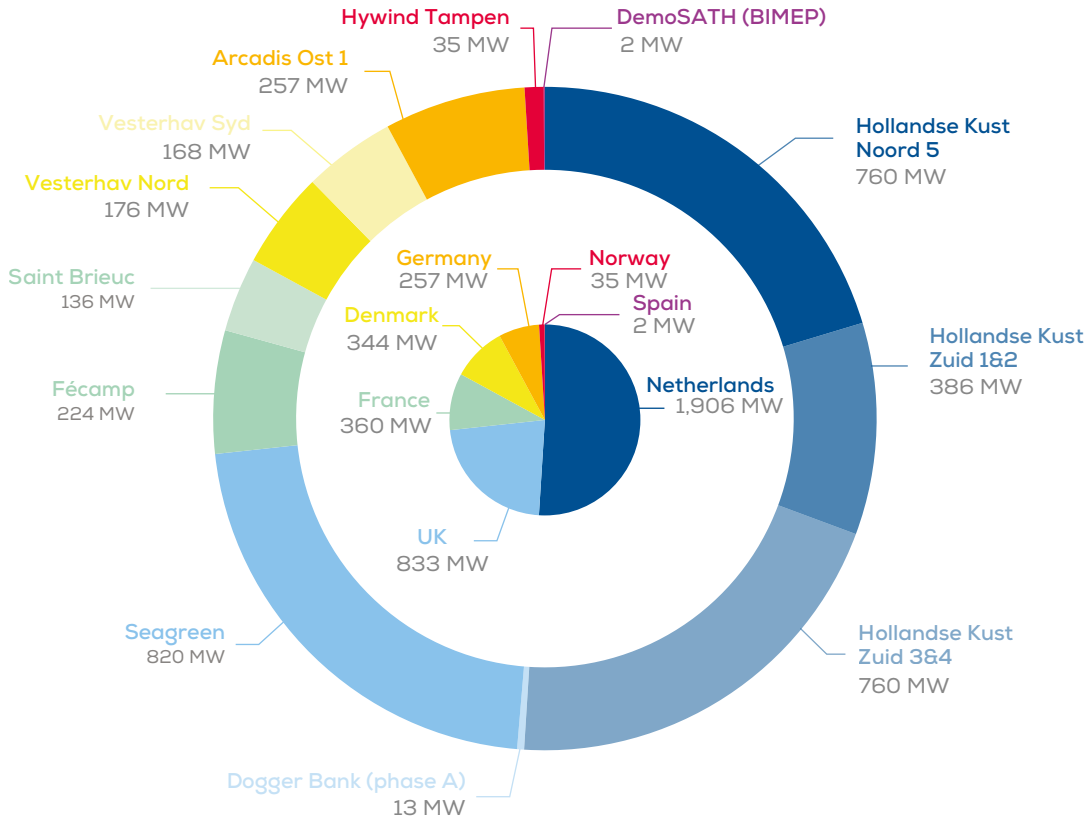
Denmark commissioned two offshore wind farms in 2023, Vesterhav Syd (168 MW) and Nord (176 MW).

In Germany the Arcadis Ost 1 wind farm was commissioned adding 257 MW. Additionally, some existing offshore wind turbines were upgraded, boosting existing wind power capacity by 72 MW.

Norway connected the remaining 35 MW from Hywind Tampen (95 MW), now the largest floating offshore wind farm in the world.

And finally, Spain installed the DemoSATH, a floating barge equipped with a 2 MW wind turbine located off the coast of Bilbao.

FIGURE 4. New offshore wind farms in Europe in 2023



Source: WindEurope

Decommissioning, capacity under repowering and repowered capacity

Wind farms have a finite operational lifetime. For the oldest wind farms this is typically in the region of 15 – 25 years. Newer wind farms, constructed with more modern turbines will likely have longer lifetimes.

When the wind farm reaches the end of its operational lifetime – assuming its lifetime is not extended by replacing components or blades – the turbines will be shut off, taken down and removed. This is known as decommissioning.

It often makes sense to repower the wind farm since this means replacing all the turbines, cables and grid connections with modern turbines and accessories which are more powerful and efficient. The original capacity being replaced is known as capacity under repowering.

Wind farm capacity that is decommissioned but not repowered is fully decommissioned.

Finally, because of the enormous technological advances made since early turbines were installed, the new repowered wind farms often have increased capacity even with fewer new turbines. This increased capacity is known as repowered capacity.

Decommissioned capacity = Capacity under repowering + Fully decommissioned capacity

Repowered capacity = Capacity of new wind farm

1.3 Decommissioning and repowering

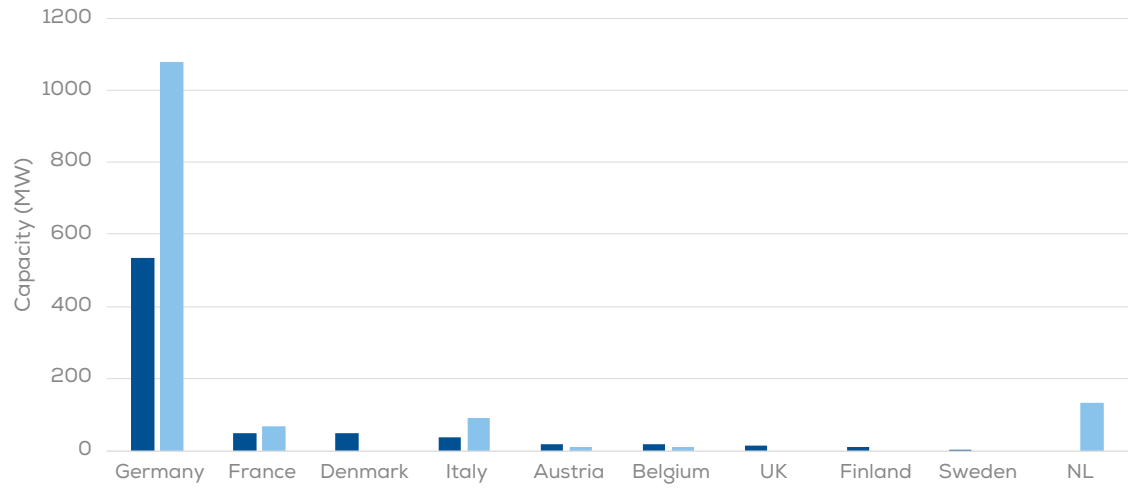
736 MW of wind power across seven countries was decommissioned in 2023. The decommissioning took place in Germany (534 MW), France (50 MW), Denmark (49 MW), Italy (37 MW), Austria (19 MW), Belgium (17 MW), the UK (16 MW), Finland (12 MW) and Sweden (2 MW).

Out of the 18.3 GW of wind power capacity added in Europe in 2023, 1.4 GW came from repowering projects. Most repowering took place in Germany (1.1 GW) with some also taking place in the Netherlands, France, Italy, Austria and Belgium.

Repowering represents a major opportunity to quickly boost wind energy installations in Europe. Not only do older projects tend to be located in the best wind locations, but asset owners should be very familiar with site conditions, with many years of operational data. Much of the infrastructure is already in place (roads, substations) and there is generally less opposition from local communities (although it is still important to engage communities given the likely increase in the size of the turbines).

Obtaining new permits should therefore be quicker and more efficient than for greenfield projects.

FIGURE 5. Decommissioned and repowered capacity in 2023



	Germany	France	Denmark	Italy	Austria	Belgium	UK	Finland	Sweden	NL
Decommissioned	534	50	49	37	19	17	16	12	2	0
Repowered	1,076	69	0	92	12	11	0	0	0	132

Source: WindEurope

736 MW

DECOMMISSIONED IN 2023

The EU has recognised the potential of repowering projects through dedicated measures in the Renewable Energy Directive, revised in 2023. The legislation calls on Member States to ensure that all permitting procedures for renewable projects should be completed within two years – or one year in the case of repowering projects (except in Renewable Acceleration Areas where the deadline is six months for new and repowered projects).

There are still hurdles at the national level though, and they continue to hinder wind farm repowering. In Italy for instance, repowering projects can take part in auctions. But they need to discount their bids because the legislator considers the development costs for repowered projects to be lower than those for greenfield projects. In fact, this is not always the case. Unlike greenfield projects, for example, repowering projects will often involve decommissioning costs. For now, permitting timelines for repowering projects are roughly similar to those for new projects.

1.4 Power generation

Wind energy met a record 19% of demand across the EU-27 last year, up 3% from 2022.

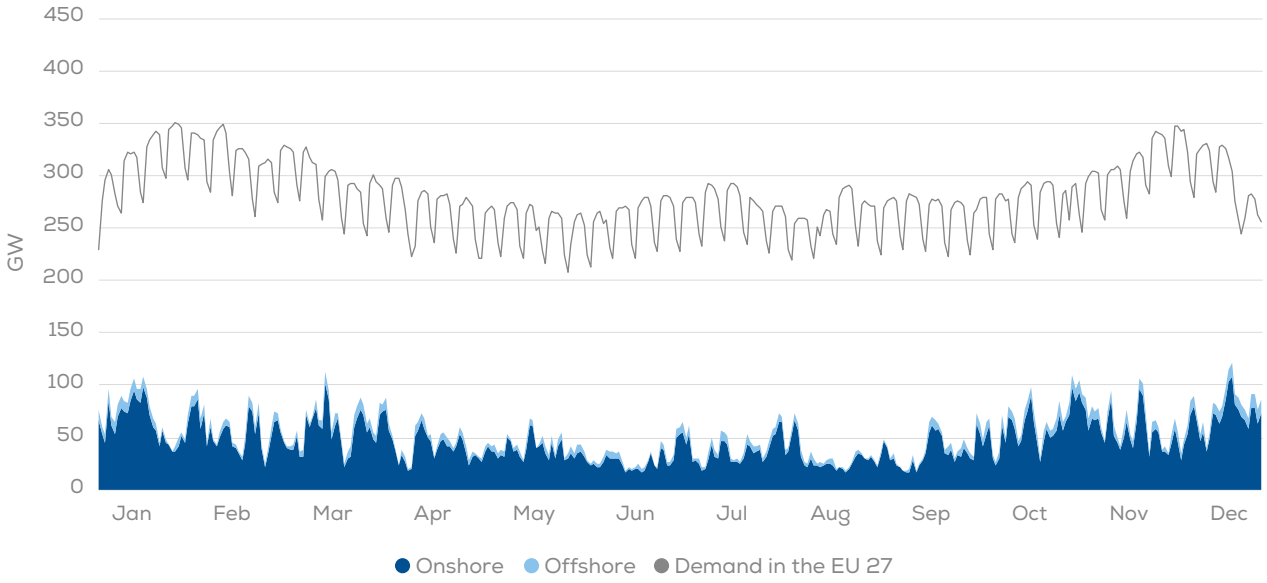
The EU is still dealing with the economic aftermath of the global energy crisis and despite strong growth in electrification, electricity demand in the EU was almost 4% lower in 2023 than in the previous year.

The growing share of demand met by wind power was also bolstered by record levels of generation across the EU. Wind conditions were actually less favourable than in previous years, particularly across northern Europe. But record onshore wind build-out more than compensated for this lower relative generation.

Wind power plants in the EU produced 466 TWh of electricity, covering 19% of electricity demand (16.8% from onshore and 2.2% from offshore wind). Wind power achieved record daily production on 22 December (2,906 GWh) corresponding to an average output of 122 GW or about 60% of the fleet producing at maximum output for the entire day.

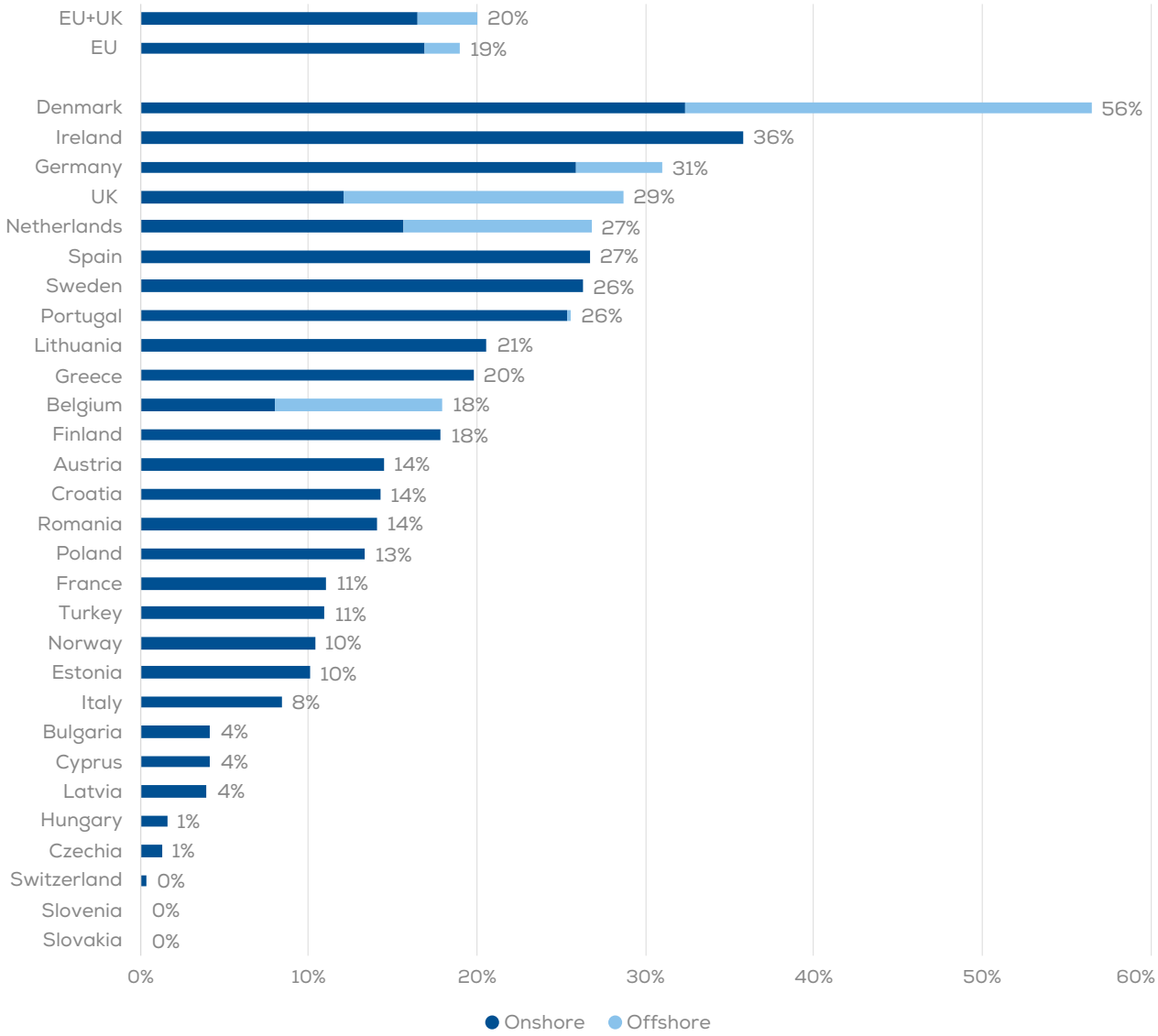
The day with the lowest generated electricity output was on 23 August when total generation was 433 GWh, covering 6% of demand in the EU that day.

FIGURE 6. Power demand and wind energy generation in the EU-27 in 2023 (GW)



Source: WindEurope

FIGURE 7. Percentage of electricity demand covererd by wind in 2023



Source: WindEurope

WIND ENERGY MET

19%

OF THE ELECTRICITY DEMAND IN THE EU AND UK IN 2023

Denmark had the highest share of wind with 56%, followed by Ireland with 36%. A combination of a 4% drop in load and a 14% increase in Germany's wind power generation saw its share of demand jump from 26% in 2022, to 31% in 2023, overtaking the UK to end up with the third highest share in Europe.

The UK was the non-EU country with the highest share of wind at 29%, placing it fourth in Europe. They were followed by the Netherlands (27%), Spain (27%), Sweden (27%), and Portugal (26%).

Almost every country in Europe met a greater share of its demand with wind power in 2023. 20 countries had wind energy shares above 10%, 17 in the EU plus the UK, Turkey and Norway.

TABLE 2. Electricity production in 2023 from wind power in the EU-27 and in the EU+UK

	Electricity consumption in EU+UK (TWh)	Onshore wind energy production (TWh)	Offshore wind energy production (TWh)	Total wind energy production (TWh)	Share of consumption met by wind energy
EU-27	2,449	412	53	466	19%
EU+UK	2,726	446	99	545	20%

Wind energy generation in the EU in 2023 reached new records in terms of absolute production (466 TWh), and for the share of consumption met by onshore (16.8%) and offshore wind (2.2%).

Wind energy generation in the EU+UK also reached record levels (545 TWh), meeting 20% of electricity demand in the region. The UK's offshore fleet generated 46 TWh, almost matching the entire electricity demand of Greece (47 TWh).

It is not surprising that the general trend is of increased generation and share of demand given the new installations of ever more powerful turbines. But wind conditions also play a role here.

In Norway, Sweden and Finland, less favourable wind conditions saw power generated by turbines installed at the start of the year generate less than in 2022. In Sweden and Finland, new build-out of wind power capacity counteracted the lower generation of the installed turbines and total generation was actually higher than in 2022 (from the turbines already installed at the start of the year and those installed during the year).

In Norway however, there were no new installations during the year and so total generation in 2023 fell compared with 2022.

The less favourable conditions also affected offshore wind generation in Denmark, the Netherlands, the UK and Germany. A large growth in offshore wind power capacity in the Netherlands and the UK compensated for lower relative generation and both countries saw rising generation from their offshore fleets in 2023. In Germany and Denmark, new wind power capacity offset the less favourable conditions to some extent, but total offshore generation in 2023 was lower than in 2022.

Capacity factors for the entire EU wind fleet were 25% on average. For onshore they were 24% (equal to 2022), while for offshore they were 34% - down from 35% in 2022.

The fleet-wide capacity factor numbers are relatively low compared with new wind farms, as they represent the performance of the entire wind fleet, including very old installations. These old installations typically feature turbines with large generators and relatively small rotors (short blades). These are best suited for very windy locations. Modern turbines can be built in locations with a lower high-speed wind resource, and thus need to take advantage of lower-wind speeds.

They use larger blades and relatively lower generators, boosting their capacity factors.

Capacity factors for new onshore wind farms are estimated to be between 30 and 35%. For new offshore wind farms, this figure ranges between 42% and 55%.

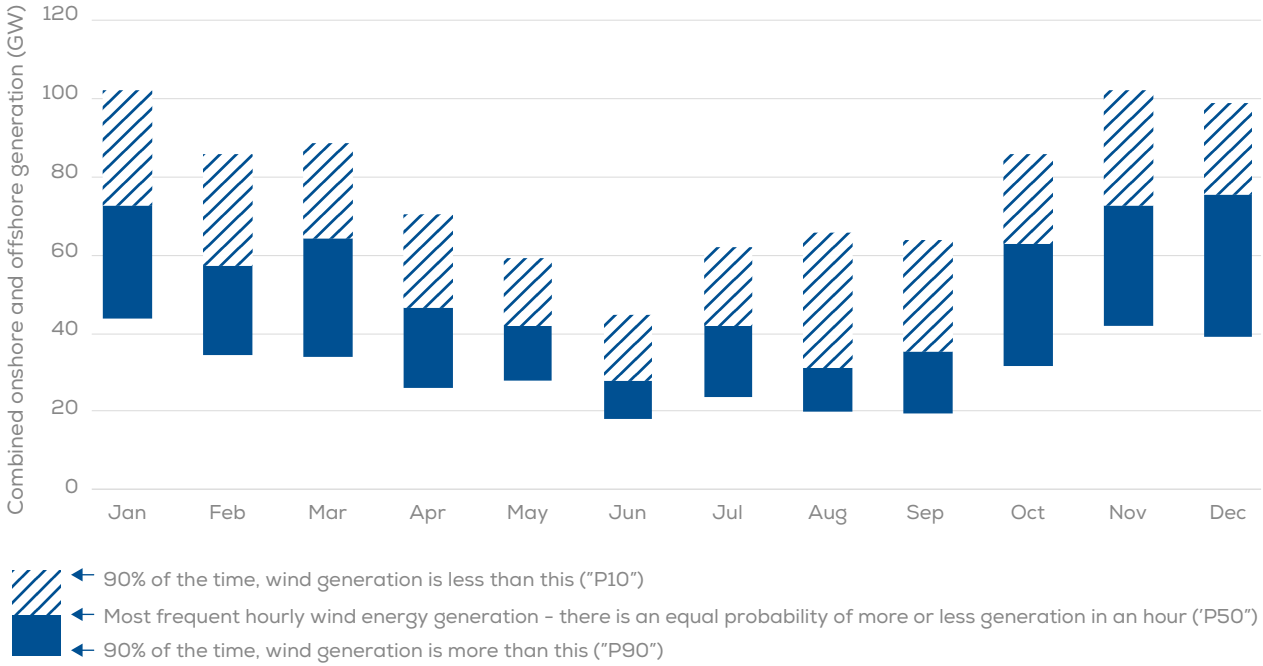
Figure 8 shows the range of hourly electricity generation from wind energy during each month of 2023. In January for instance, the average (median) power output of the wind fleet was 74 GW, while we could rely on at least 44 GW most of the time (90% of total hours). There were a few instances (10% of all hours) where output exceeded 101 GW. Unlike over the period 2020-2022 where February saw the highest average output, in 2023 December was the month with the highest average (mean) output with 74 GW. And for 90% of the time EU wind output was more than 39 GW, enough to cover the average demand of Spain.

Over the summer period from June to September, the variation in electricity produced per hour by wind fell (shown by the size of the boxes) and the average amount was also lower (shown by the lower position of the boxes).

June saw the lowest average generation figure. Output for 90% of all hours exceeded 18 GW, and for 10% of the hours, it was 45 GW or more.

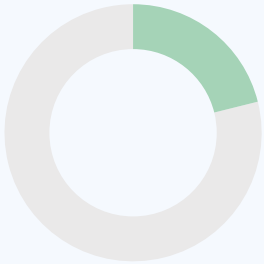
Wind energy production is variable, and the hourly variability generally follows a set pattern of more wind generation and greater variability of generation in the winter months. Over the summer when stable high-pressure systems are more common over Europe, wind energy generation tends to be lower and less variable.

FIGURE 8. Spread of hourly wind energy generation in EU in 2023



Source: WindEurope

The EU's wind energy generation 2023



19%
of the EU's electricity demand

466 TW/h
EU wind energy generation

Highest wind energy shares

- 56%
- 36%
- 31%
- 27%
- 27%
- 26%
- 26%

201 GW
onshore wind capacity

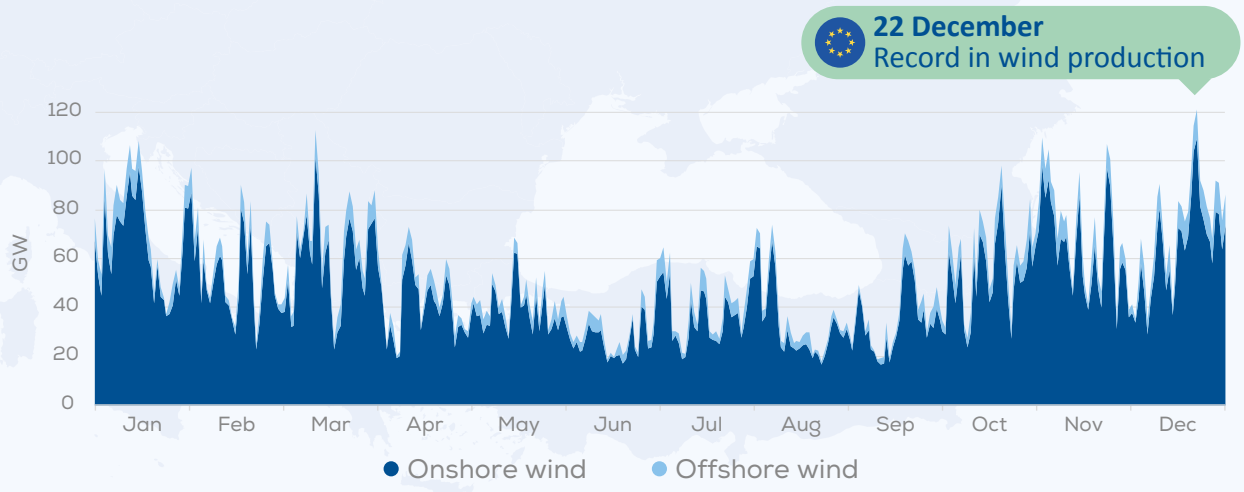
17%
of EU electricity demand met by onshore wind

24%
average onshore wind capacity factor*

19 GW
offshore wind capacity

2%
of EU electricity demand met by offshore wind

34%
average offshore wind capacity factor*



*Capacity factors of entire fleet including old turbines

1.5 Turbine sizes

The size and type of wind turbine installed in Europe varies between countries. The average power rating of onshore turbines installed across Europe in 2023 was 4.5 MW, up from 4.1 MW in 2022.

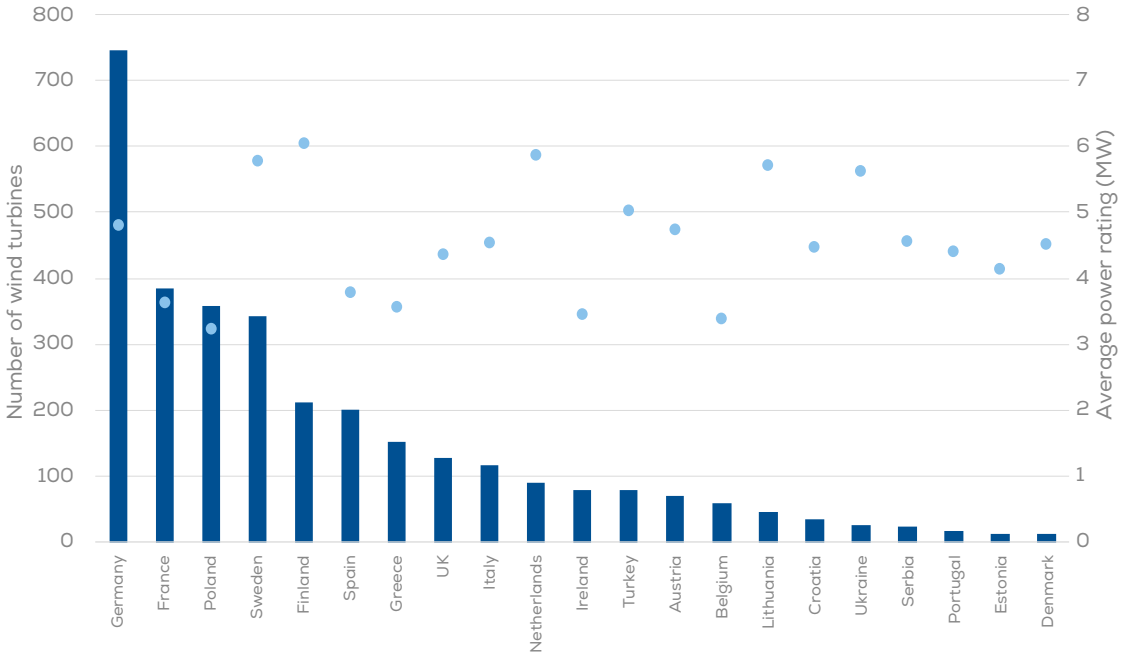
The most powerful onshore wind turbines were installed in Finland and Romania, with an average power rating of 6 MW, followed by the Netherlands (5.9 MW), Sweden (5.8 MW) and Ukraine (5.6 MW). Switzerland had the lowest average power rating with 2.3 MW, albeit based on only 14 installed turbines.

Poland installed the second lowest average turbine rating of 3.2 MW. Power ratings correlate closely with the size of the turbines, and in Poland the sizes have been largely constrained by the so-called 10H rule – limiting the minimum distance between a turbine and nearby housing to ten times the tip height of a turbine. The 10H rule has now been amended to a less restrictive minimum setback distance of 700 m.

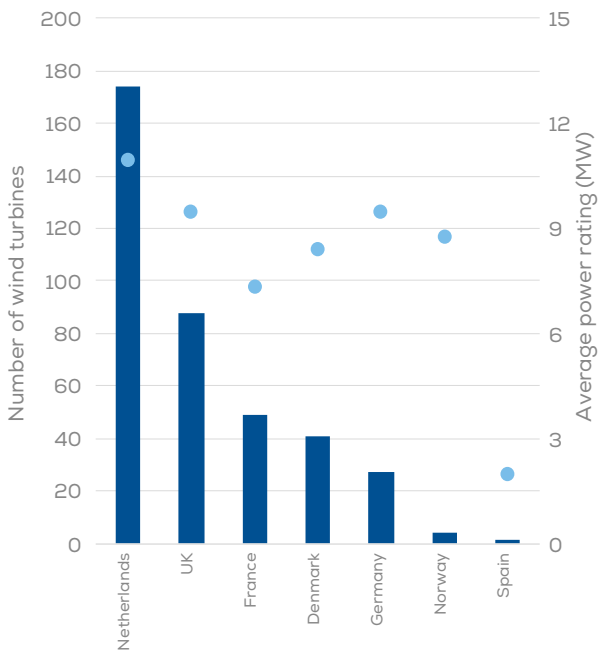
In 2023 the average rated capacity of grid connected offshore wind turbines was 9.7 MW, up from 8 MW in 2022. Although at wind farm level the UK installed the largest and first of the GE Haliade 13 MW turbine (Dogger Bank phase A), at a country level the Netherlands connected the largest offshore turbines with an average power rating of 11 MW.

Apart from Spain's demo project, France had the lowest average offshore turbine power rating connected to the grid in 2023 (7.3 MW). This is because the projects were awarded more than 10 years ago and their permits were based on older turbine models.

FIGURE 9. Number of turbines installed in 2023 and their average power rating



	Germany	France	Poland	Sweden	Finland	Spain	Greece	UK	Italy	Netherlands	Ireland	Turkey	Austria	Belgium	Lithuania	Croatia	Ukraine	Serbia	Portugal	Estonia	Denmark
Average power rating	4.8	3.6	3.2	5.8	6.0	3.8	3.5	4.4	4.5	5.9	3.4	5.0	4.7	3.4	5.6	4.5	5.6	4.6	4.3	4.1	4.5
Number of wind turbines	745	385	359	342	212	202	153	127	116	90	80	79	70	60	46	35	26	25	18	14	12



	Netherlands	UK	France	Denmark	Germany	Norway	Spain
	11	9.5	7.3	8.4	9.5	8.8	2
	174	88	49	41	27	4	1

Source: WindEurope

Based on disclosed wind turbine orders, the average power rating of onshore turbines ordered in 2023 was 5.5 MW (5.1 MW in 2022). For offshore turbines, this figure reached 14.9 MW (12.2 MW in 2022). These turbines will be installed over the next few years and this is likely to continue the trend of growing power ratings for installed turbines.

1.6 Auction and tenders

In 2023, 27.3 GW of new wind power capacity was awarded in auctions across 13 countries in Europe, surpassing the figure of 16.9 GW that was allocated in 2022. 13.6 GW was awarded to offshore wind in Germany (8.8 GW), Ireland (3.1 GW), France (1 GW) and Lithuania (0.7 GW). For onshore wind, 12.7 GW was awarded in 12 countries.

Germany awarded the most capacity via auctions. 15.2 GW was awarded in total – 6.4 GW of onshore wind and 8.8 GW offshore. France awarded the second highest amount with 4.2 GW – 3.2 GW onshore and 1 GW offshore. And Ireland awarded 3.2 GW in total – 3.1 GW of which was for offshore wind.

Onshore

Germany awarded 6.4 GW of onshore wind capacity, out of 12.8 GW available. This was double the awarded volume in 2022. The average-weighted strike price was €73.3/MWh (€58.1/MWh in 2022), just below the maximum permissible value of €73.5/MWh. In 2024 Germany will auction 10 GW of onshore wind support in the form of a 20-year floating Feed-in-Premium.

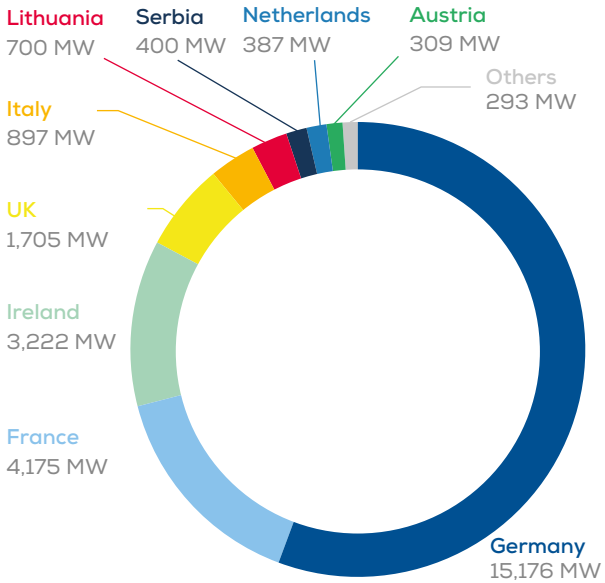
The Federal Network Agency (BNetzA) has kept the maximum bidding price at €73.5 MW.

France held three technology-specific onshore wind energy auctions in 2023, awarding 3.1 GW (the results of the last round were announced in 2024), and one technology-neutral renewable energy auction which awarded 78 MW to onshore wind. In 2022, just 643 MW were awarded in total.

The weighted average strike price in the technology-specific auction rounds was €86.2/MWh (up from €68.9/MWh in 2022), while the technology-neutral round was €87.2/MWh (up from €78.8/MWh in 2022).

The strike price is indexed to inflation to reflect changes in both CAPEX and OPEX, and support is in the form of a 2-sided Contract-for-Difference, awarded for a period of 20 years.

FIGURE 10. Share of awarded support in wind energy auctions in 2023



Source: WindEurope

The UK awarded 1.7 GW of onshore wind as part of the Contract-for-Difference (CfD) Allocation Round 5 (AR 5). All successful projects were in Scotland, except for 35 MW awarded to a project in Wales. Unlike in the CfD AR4 of 2022, onshore wind competed together with remote island onshore wind in the CfD AR5 of 2023.

The CfD AR 6 will take place in 2024. The strike price ceiling of onshore wind and remote island wind has been increased by £11 to £64/MWh (€73.6/MWh). All prices mentioned for the UK's CfD ARs refer to 2012 prices. The support is for 15 years.

Italy awarded 897 MW of onshore wind across three rounds of its technology-neutral renewable energy auction scheme, up from 213 MW in 2022. The bid price ceiling was increased by 12% to €77.6 MWh and this led to a much more successful auction. The average weighted strike price of the successful bids was €72.2/MWh. Support is in the form of a 20-year 2-sided Contract-for-Difference.

Serbia awarded all 400 MW offered in its first onshore wind auction. The average strike price achieved by the four winning projects was €68.4/MWh.

The Netherlands awarded 387 MW of onshore wind under the 2023 edition of the SDE++ scheme. Most projects were awarded a strike price of around €60/MWh. The support is in the form of a floating Feed-in-Premium and is awarded for a period of 15 years.

Austria awarded 309 MW of onshore wind, out of 390 MW available. Following the lack of bidders in the previous round, the maximum bidding price was raised from €82.2/MWh to €92.8/MWh. The average winning strike price was €87.4/MWh. Support was provided in the form of a 20-year floating Feed-in-Premium.

Albania awarded 223 MW of onshore wind in its first wind energy auction. The average strike price was €64.5/MWh against a ceiling bidding price set at €75/MWh. The support is in the form of a 15-year 2-sided Contract-for-Difference.

Ireland awarded 148 MW of onshore wind capacity in 2023. The weighted average price of successful bids – including onshore wind, solar PV and community projects – was €100.5/MWh (€97.9/MWh in 2022). The strike price is indexed to reflect changes in OPEX. The support is in the form of a 2-sided Contract-for-Difference awarded for 16.5 years.

Czechia held two technology-neutral auctions in 2023 where it awarded 45 MW out of 90 MW offered. The average strike price was of €139.8/MWh. The support is in the form of a 2-sided Contract-for-Difference and lasts for the lifetime of the asset.

Poland awarded 25 MW of onshore wind in its 2023 technology-neutral auction. The minimum strike price for onshore wind was PLN119/MWh (€27.4/MWh). Support is awarded via a 15-year 2-sided Contract-for-Difference.

Estonia tendered support for 650 GWh of renewable electricity as part of its first technology-neutral auction. A total of 1,201 GWh of bids were submitted, of which 220 GWh was successful from a hybrid onshore wind-solar PV facility. The support is unique in that bidders can bid a strike price of up to €45/MWh maximum. However, the winners only receive a premium of up to €20/MWh, even if the spread between the strike price and the electricity market price is higher than that.

Croatia, Greece, and Spain were expected to run onshore wind auctions but did not do so in the end. Bulgaria, Kosovo, Moldova, and Romania are expected to run their first onshore auctions in 2024.

Offshore

Germany awarded 8.8 GW of offshore wind via a zero-subsidy tender. 7 GW across four sites (three in the North Sea, one in the Baltic Sea) were centrally pre-surveyed and featured the "dynamic bidding" system, where if two or more €0/MWh bids are received, the bidders enter a second bidding round to decide how much they would be willing to pay per MW installed. The winning bidders committed to a payment of €12.4 billion.

The remaining 1.8 GW was awarded across four sites (all in the North Sea) that were not centrally pre-surveyed. The auction only featured a negative bidding component which yielded €748 million. In 2024, Germany will auction 5.5 GW of centrally pre-surveyed capacity and 2.5 GW of non-centrally pre-surveyed capacity.

Ireland awarded 3.1 GW under its first offshore wind energy auction, ORESS 1. The average strike price reached by the four winning projects was €86.1/MWh while the maximum bidding price was set at €150/MWh. The strike price is indexed to reflect changes in both CAPEX and OPEX. The support takes the form of a 2-sided Contract-for-Difference with a time span of 20 years. Under the ORESS 2.1, 900 MW of offshore wind is expected to be auctioned in 2024.

France awarded 1 GW of offshore wind for the Centre Manche 1 site, at a strike price of €44.9/MWh. The strike price is indexed to reflect changes in both CAPEX and OPEX. The support comes in the form of a 2-sided Contract-for-Difference and lasts for 20 years. In 2024 France will award the 250 MW Brittany floating wind farm and the 2 x 250 MW Mediterranean wind farms.

Lithuania held its first offshore wind energy auction using a negative bidding system. It awarded 700 MW for a development fee of €20 million. The country will hold a second 700 MW offshore auction in 2024. However, the negative bidding mechanism will be replaced by a 2-sided Contract for Difference with a bidding floor and ceiling of €64.3/MWh and 107.2/MWh respectively.

In **the UK**, no offshore wind projects submitted bids in the CfD AR 5 because the bid price ceiling was too low - £44/MWh (€50.6/MWh) for bottom-fixed offshore wind and £116/MWh (€133.4/MWh) for floating offshore wind. In response, the bid price ceilings under the CfD AR 6 have been increased to £73/MWh (€83.9/MWh) for bottom-fixed offshore wind and to £176/MWh (€202.3/MWh) for floating offshore wind.

Portugal, Norway and Italy are set to launch their first offshore wind energy auctions in 2024. Portugal is looking to auction 3.5 GW of floating offshore wind over three sites. Norway will be auctioning 1.5 GW of bottom-fixed offshore wind at the Sørlige Nordsjø II site and 1.5 GW of floating offshore wind at the Utsira Nord site.

Italy is expected to finally launch its offshore renewable energy auction scheme, set to offer 3.8 GW over the period 2024-2028.

TABLE 3. Auctions and tenders for wind energy support schemes in 2023

Onshore	Auction	MW awarded	Type of auction	Support mechanism	Price in €/MWh
Albania	2023 onshore wind auction	223	Technology specific	Contract for Difference	65
Austria	EAG - 2023 March round	101	Technology specific	Feed-in-premium (floating)	82
	EAG - 2023 June round	53	Technology specific	Feed-in-premium (floating)	82
	EAG - 2023 September round	-	Technology specific	Feed-in-premium (floating)	-
	EAG - 2023 December round	155	Technology specific	Feed-in-premium (floating)	93
Czechia	2nd call	20	Technology neutral	Contract for Difference	140
	3rd call	25	Technology neutral	Contract for Difference	140
Estonia	Technology neutral 2023	Undisclosed	Technology neutral	Feed-in-premium (floating)	21.9-39.8
France	AO PPE2 Neutre	78	Technology neutral	Contract for Difference	87
	AO PPE2 Eolien terrestre 4th round	1,160	Technology specific	Contract for Difference	85
	AO PPE2 Eolien terrestre 5th round	930	Technology specific	Contract for Difference	87
	AO PPE2 Eolien terrestre 6th round	1,007	Technology specific	Contract for Difference	87
Germany	EEG - February round	1,441	Technology specific	Feed-in-premium (floating)	73
	EEG - May round	1,535	Technology specific	Feed-in-premium (floating)	73
	EEG - August round	1,433	Technology specific	Feed-in-premium (floating)	73
	EEG - November round	1,967	Technology specific	Feed-in-premium (floating)	73
Ireland	RESS 3	148	Technology neutral	Contract for Difference	101
Italy	FER 1 bidding round 11	214	Technology neutral	Contract for Difference	65
	FER 1 bidding round 12	10	Technology neutral	Contract for Difference	65
	FER 1 bidding round 13	673	Technology neutral	Contract for Difference	75
Poland	2023 round for systems above 1 MW	25	Technology neutral	Contract for Difference	27.4-71.4
Serbia	2023 round	400	Technology specific	Contract for Difference	68
Netherlands	SDE++ 2023	387	Technology specific	Feed-in-premium (floating)	60
UK	Allocation Round 5 Onshore wind	1,481	Technology specific	Contract for Difference	60
	Allocation Round 5 Remote Island wind	224	Technology specific	Contract for Difference	60

Offshore	Auction	MW awarded	Type of auction	Support mechanism	Price in €/MWh
France	Centre Manche 1	1,000	Technology specific	Contract for Difference	45
Germany	N-11.1 (site not pre-surveyed)	2,000	Technology specific	Zero-subsidy bid	n.a.
	N-12.1 (site not pre-surveyed)	2,000	Technology specific	Zero-subsidy bid	n.a.
	N-12.2 (site not pre-surveyed)	2,000	Technology specific	Zero-subsidy bid	n.a.
	0-2.2 (site not pre-surveyed)	1,000	Technology specific	Zero-subsidy bid	n.a.
	N-3.5 (pre-surveyed site)	420	Technology specific	Zero-subsidy bid	n.a.
	N-3.6 (pre-surveyed site)	480	Technology specific	Zero-subsidy bid	n.a.
	N-6.6 (pre-surveyed site)	630	Technology specific	Zero-subsidy bid	n.a.
	N-6.7 (pre-surveyed site)	270	Technology specific	Zero-subsidy bid	n.a.
Ireland	ORESS 1	3,074	Technology specific	Contract for Difference	86
Lithuania	1st offshore auction	700	Technology specific	Zero-subsidy bid	n.a.
UK	CfD Allocation Round 5 - Offshore wind	-	Technology specific	Contract for Difference	-
	CfD Allocation Round 5 - Floating offshore	-	Technology specific	Contract for Difference	-

2.

Wind power in Europe: The full picture

2.1 Europe's total wind power capacity

A total of 272 GW of wind power capacity is now installed in Europe. 87% of this (238 GW) is installed onshore and 13% (34 GW) is offshore.

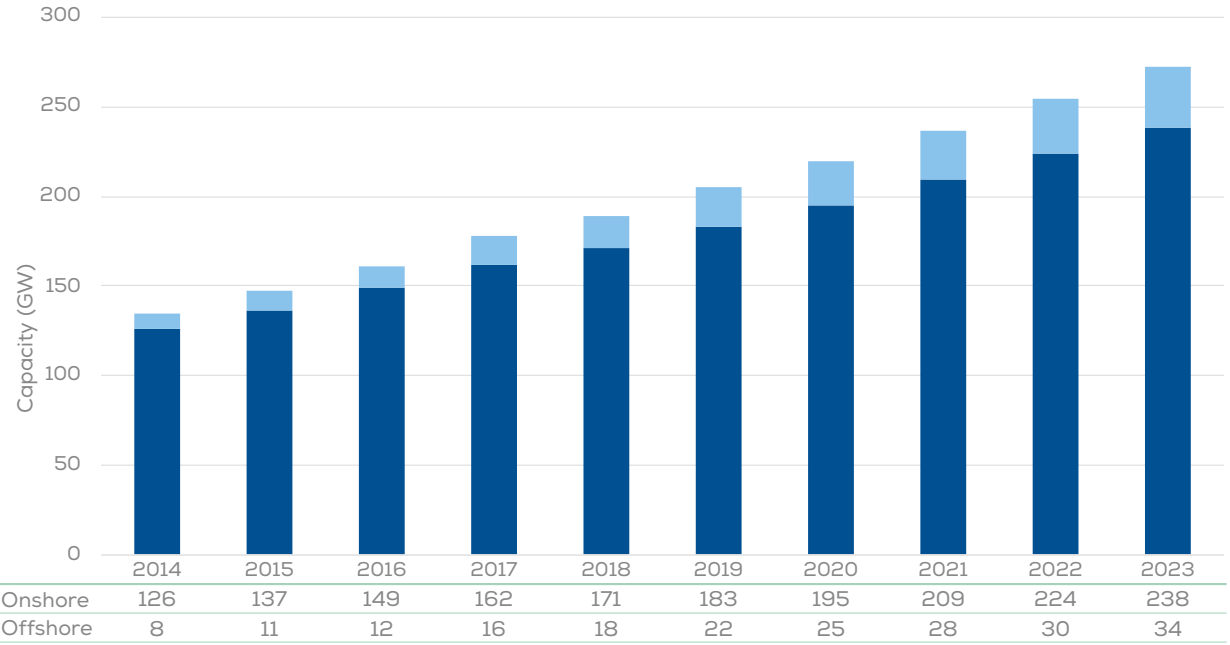
In the EU-27 the total installed wind power capacity has reached 220 GW, with 201 GW (91%) onshore and 19 GW (8%) offshore.

EUROPE NOW HAS

272 GW

OF WIND POWER CAPACITY

FIGURE 11. The growth of wind power capacity in Europe, 2014-23



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Onshore	126	137	149	162	171	183	195	209	224	238
Offshore	8	11	12	16	18	22	25	28	30	34

Source: WindEurope

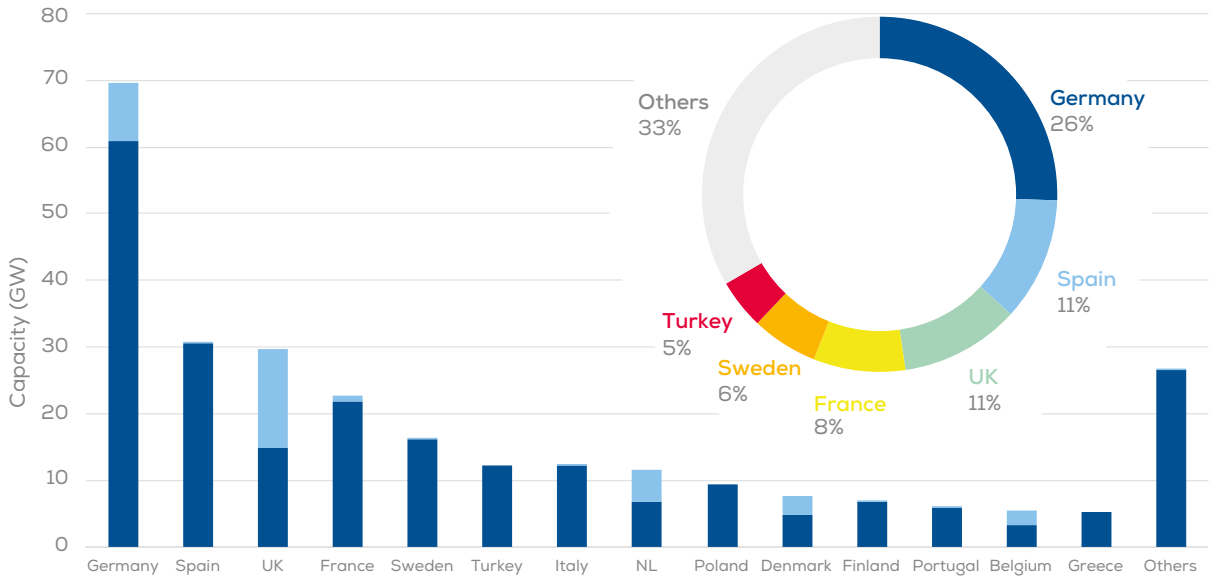
2/3 OF EUROPE'S WIND POWER IS INSTALLED IN JUST SIX COUNTRIES

Germany continues to have the largest installed wind power fleet in Europe, with just under 70 GW of installed capacity. With Spain (30.6 GW), the UK (29.6 GW), France (22.8 GW), Sweden (16.4 GW), and Turkey (12.3 GW), the top six countries account for two-thirds of total installed capacity in Europe. Italy (12.3 GW) and the Netherlands (11.5 GW) are the other two countries in Europe that have installed wind power capacities greater than 10 GW.

Poland (9.4 GW), Denmark (7.6 GW), Finland (6.9 GW), Portugal (5.8 GW), Belgium (5.5 GW), Greece (5.2 GW) and Norway (5.2 GW) have all installed wind power capacity in excess of 5 GW.

The next three countries each have more than 3 GW of installed capacity. They are Ireland (4.8 GW), Austria (3.9 GW), and Romania (3.1 GW).

FIGURE 12. Total wind power installations by country



	Germany	Spain	UK	France	Sweden	Turkey	Italy	NL	Poland	Denmark	Finland	Portugal	Belgium	Greece	Others
Onshore	61	31	15	22	16	12	12	7	9	5	7	6	3	5	27
Offshore	9	0	15	1	0	0	0	5	0	3	0	0	2	0	0

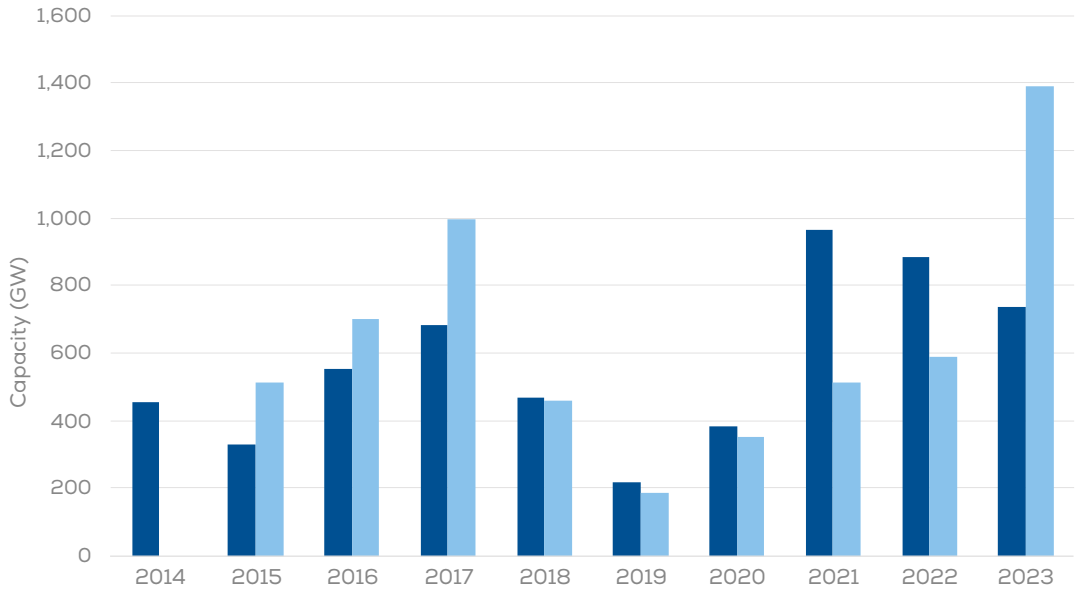
Source: WindEurope

2.2 Decommissioning and repowering trends

736 MW of wind power capacity was decommissioned in Europe in 2023. Germany accounted for almost three-quarters of this figure (534 MW).

Of the 18.3 GW installed in 2023, 1.4 GW were repowered projects. The total capacity repowered rose for the fifth year in a row, and was the highest of the last ten years.

FIGURE 13. Decommissioned and repowered capacity in Europe, 2014-23



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Decommissioned capacity	455	329	555	684	466	217	383	964	883	736
Repowered capacity	-	513	700	996	461	185	351	515	591	1,392

Source: WindEurope

As the European wind turbine fleet ages, we expect repowering volumes to increase. Some Governments are setting out new rules to facilitate repowering. But as long as power prices are higher than expected, the economic situation will continue to favour turbine lifetime extension.

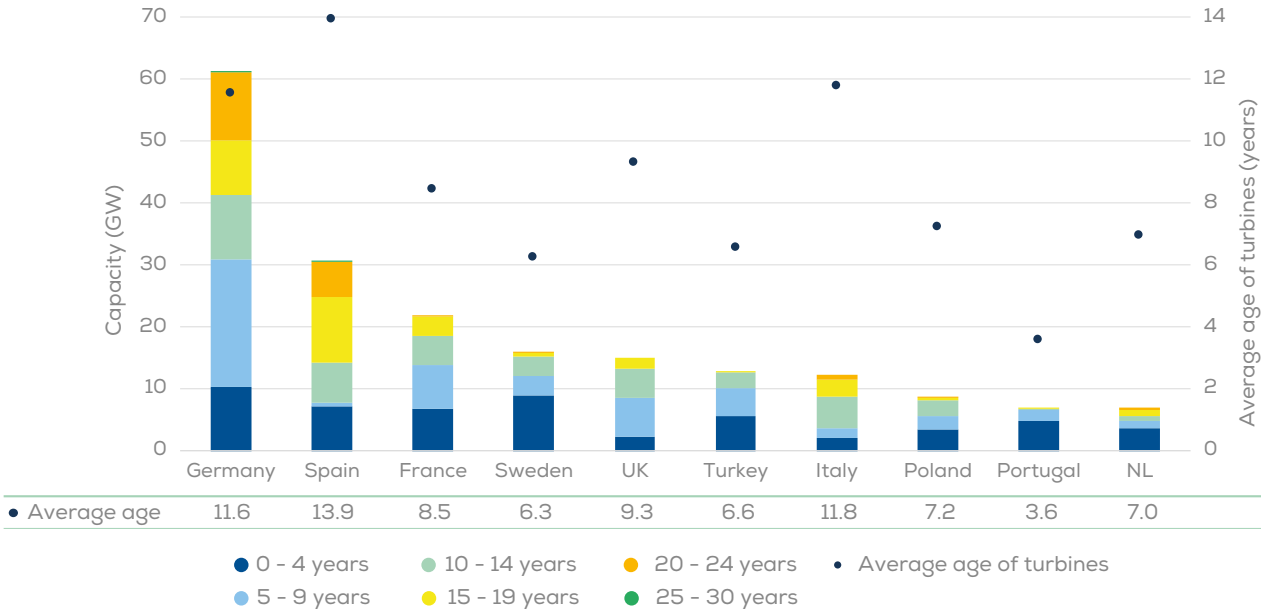
Many of Europe's onshore wind farms are approaching the end of their planned operational lifetime. Currently, 14 GW of Europe's existing wind farms have already been running for more than 20 years. By 2030, 78 GW of capacity will be more than 20 years old. Denmark, Spain and Portugal have the oldest wind fleets on average. Germany has the largest installed capacity which could potentially be repowered, with 20 GW older than 15 years.

Most wind farms reaching the end-of-life stage currently opt for some form of lifetime extension, not only because of the current economic situation, but often because legislative frameworks for repowering are not yet in place.

Wind farm repowering trebles its output on average, while also cutting down on the number of turbines. For this reason it presents a unique opportunity to quickly ramp-up wind energy production in Europe.

Almost all repowered capacity by 2030 will come from onshore wind.

FIGURE 14. Average age of onshore wind farms in Europe



Source: WindEurope

2.3 Turbine trends

Onshore

The average power rating of turbines installed onshore in 2023 was 4.5 MW, up from 4.1 MW in 2022. Before this, the average power rating grew from a value of 2.5 GW in 2014, an increase of more than 80% over the last decade.

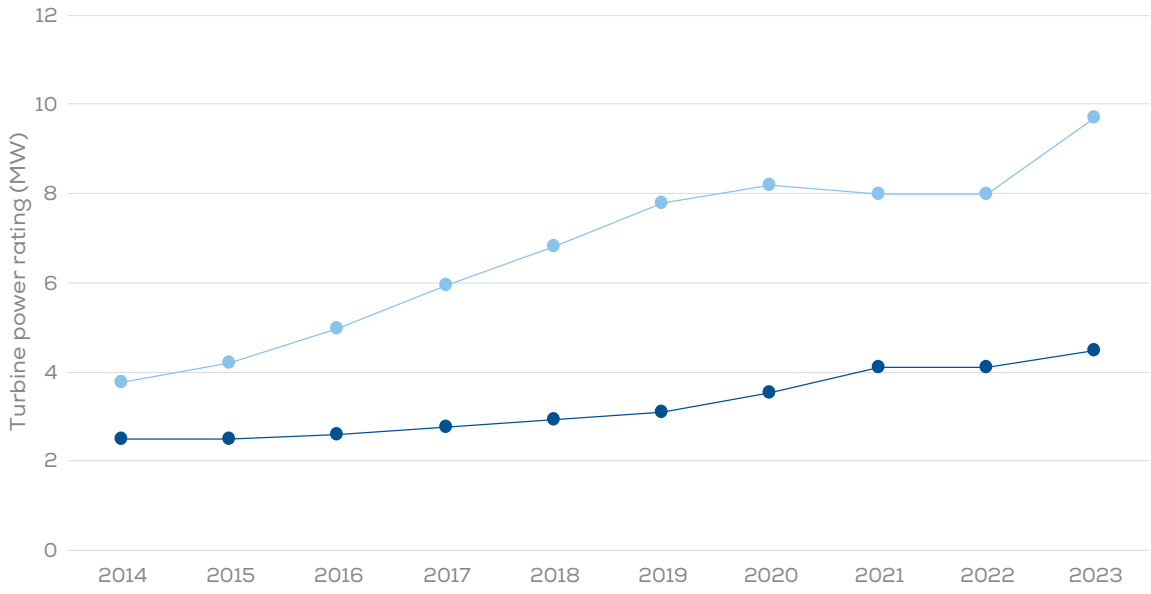
As well as newer, more powerful machines, turbines with relatively larger rotor diameters and lower power ratings were unveiled in 2022. These are designed for sites characterised by lower wind speeds. The average power rating of onshore turbines ordered over the year grew to a record 5.5 MW (up from 5.1 MW in 2022). Their deployment on the ground in the years to come is likely to boost the average power rating of installed onshore wind turbines even further.

Offshore

The average power rating of offshore wind turbines installed in Europe grew by almost 20% compared with 2022, reaching 9.7 MW.

Orders for offshore turbines in 2023 also reached a record high, averaging 14.9 MW (12.2 MW in 2022). With new, more powerful turbines about to enter the market, the average power rating of installed offshore wind turbines is expected to increase over the next few years.

FIGURE 15. Average power rating of installed turbines in Europe, 2014-23



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Onshore	2.5	2.5	2.6	2.8	2.9	3.1	3.5	4.1	4.1	4.5
Offshore	3.8	4.2	5.0	6.0	6.8	7.8	8.2	8.0	8.0	9.7

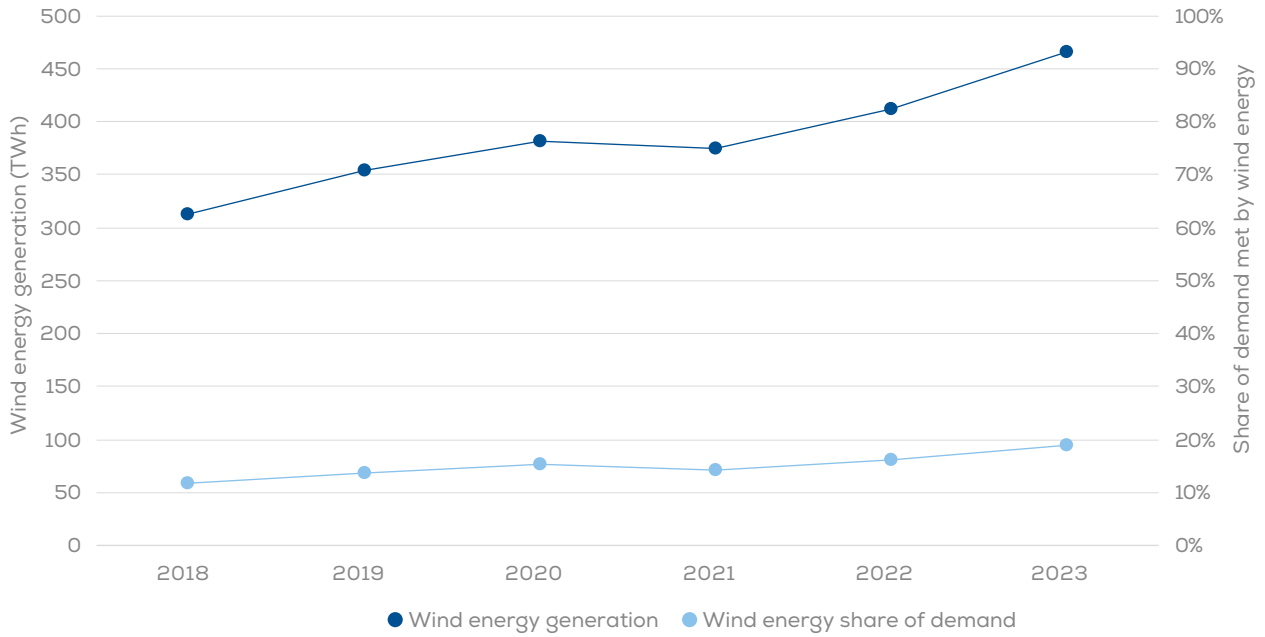
Source: WindEurope

2.4 Power generation trends

Wind energy generation in the EU has been growing steadily from 313 TWh in 2018 to 466 TWh in 2023, with one anomalous year in 2021 when generation was lower than in 2020. Over the same period, electricity demand has fallen from 2,652 TWh in 2018 to 2,449 TWh in 2023. In part this has been a result of the COVID-19 pandemic in 2020 and the energy crisis following Russia's invasion of Ukraine in 2022.

Wind energy met 12% of total demand in the EU in 2018, and in 2023 it covered 19%, up from 16% in 2022. In general, capacity factors for wind turbines grow over time as turbine technology improves. Many countries have seen rising fleet-wide capacity factors over the past few years as they install more modern turbines.

FIGURE 16. Wind energy generation and share of demand in the EU, 2018-23



Source: WindEurope

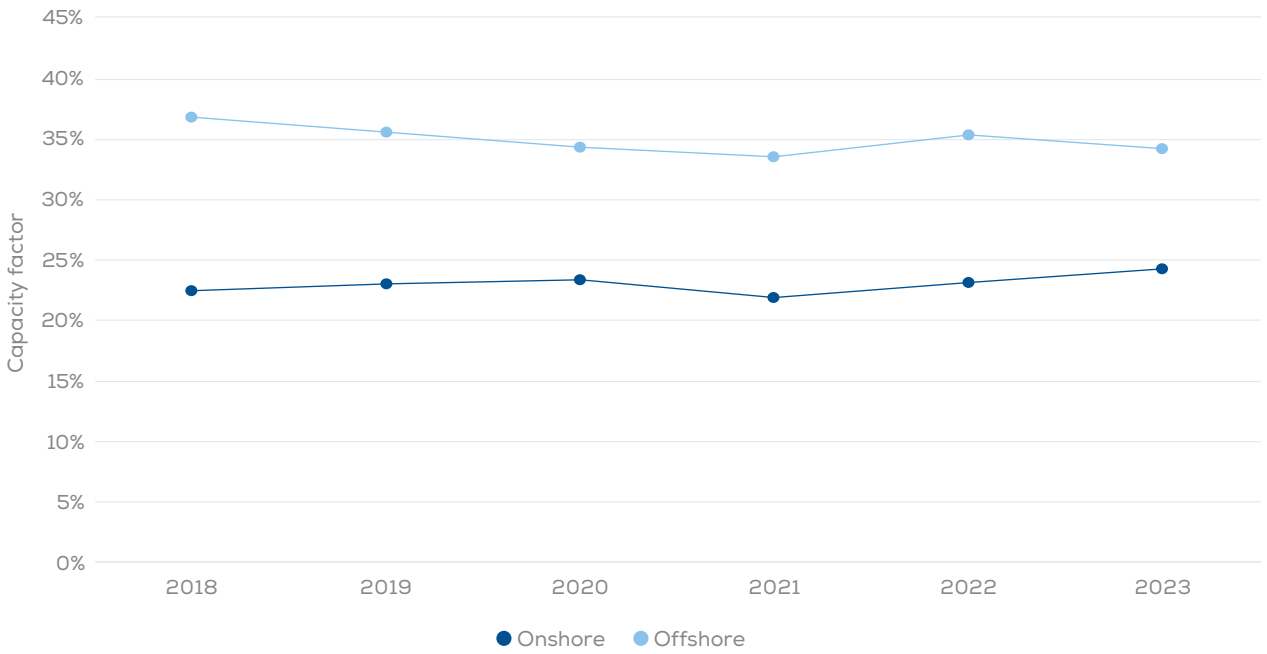
When looking at Europe as a whole, other factors become important. The size of turbines installed in each country has a major impact. If there are more turbines installed in countries which typically install smaller turbines (because of more restrictive rules, for example), this would boost the proportion of turbines with lower capacity factors in Europe. The European fleet's capacity factors could fall as a result.

Wind conditions across the continent also impact fleet-wide capacity factor trends. In 2021, wind conditions were lower than average in northern Europe. Even though they were higher than usual in southern Europe, the larger part of installed wind capacity is located in the north. The impact is visible in the capacity factor statistics for that year.

In 2023, despite less favourable conditions in northern Europe leading to lower offshore capacity factors, record build-out of onshore wind in the EU counteracted the impact and it was a record year for generation.

Offshore wind capacity factors across the entire EU fleet tend to be more variable than onshore wind since the fleet is concentrated in a smaller region (albeit over generally larger farms with a stronger and steadier wind resource). Onshore wind capacity factors rose across the EU in 2023. This points to the benefits of diversifying resources; the wind is always blowing somewhere in Europe.

FIGURE 17. Average capacity factor of installed wind turbines in the EU, 2018-23



Source: WindEurope

3.

Outlook 2024-2030

3.1 WindEurope's Outlook

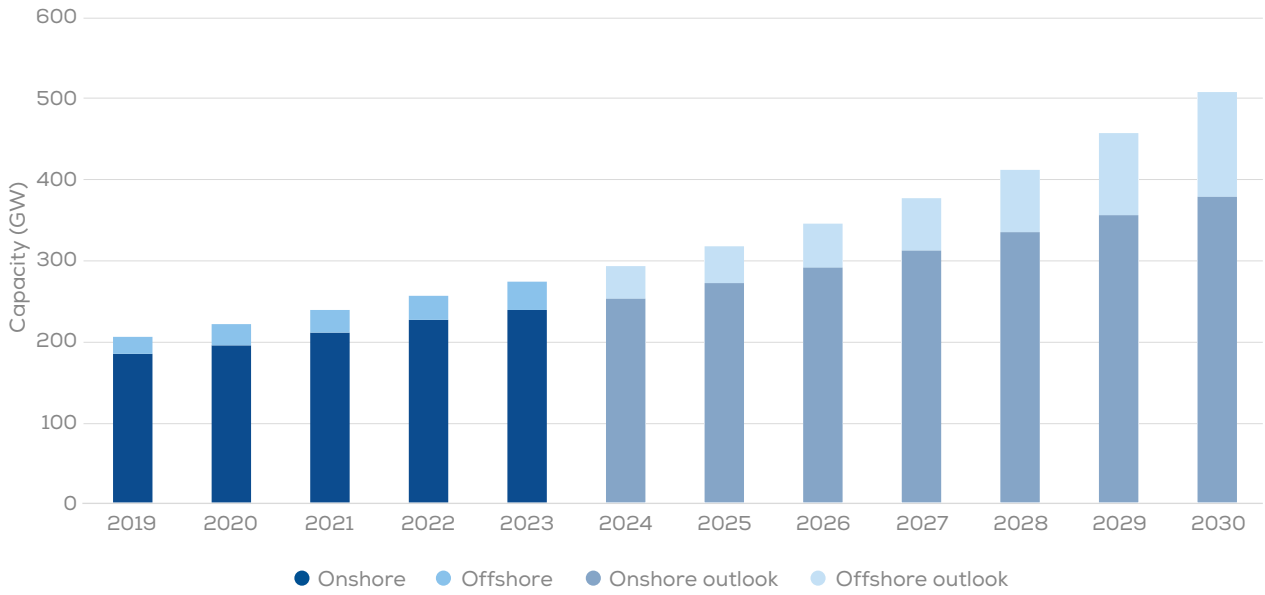
WindEurope's **Outlook** for wind installations looks at the likely development of wind power capacity in Europe up to 2030.

The **Outlook** lays out the best estimate for installed capacity in Europe over the next seven years, including any likely political or economic developments which could affect installations. We consider the latest developments in EU regulation, national policies, announcements of signed power purchase agreements (PPAs), project development timelines and the ability of wind to secure further capacity in upcoming auctions and tenders. Under this scenario, Europe will install 262 GW, with an average installation rate of 37.5 GW per year. In the EU, we expect installations of 201 GW between 2024 and 2030 at an average rate of 28.6 GW a year. This is lower than the average installation rate of 33 GW per year between 2024 and 2030 which we need to see to meet our energy and climate targets.

In Europe, we expect 21 GW of new capacity installations in 2024, up from 18.3 GW in 2023. Both onshore and offshore wind power installations are expected to be higher in 2024 than in the previous year.

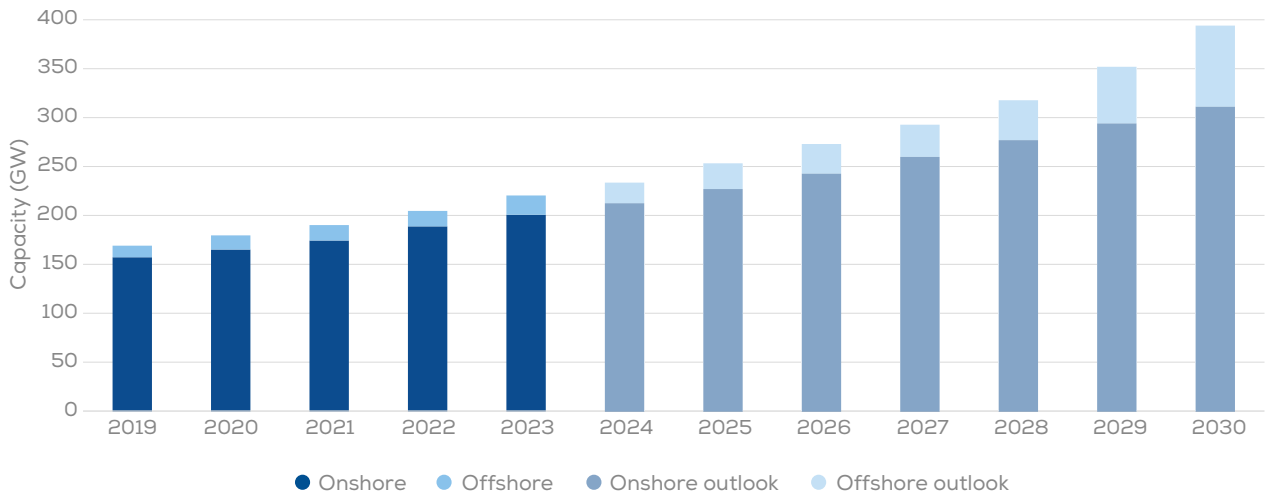
Annual build-out of offshore wind should ramp-up significantly towards the end of the decade. We expect offshore wind installations to surpass onshore figures for the first time in Europe and in the EU by 2030. We also see Europe's installed wind power capacity exceeding 500 GW over the same timeframe.

FIGURE 18. New wind power capacity in Europe - WindEurope's Outlook



Source: WindEurope

FIGURE 19. New wind power capacity in the EU - WindEurope's Outlook



Source: WindEurope

The rise in annual build-out that we anticipate for 2024-2030 will take the EU to 393 GW by the end of the decade. The EU 2030 target is 425 GW.

Installations in the EU are expected to total 15.8 GW in 2024, slightly less than the 16.2 GW which was installed in 2023. Although we expect marginally more onshore wind installations in 2024 compared with 2023, offshore wind installations are expected to be lower. This is mostly due to a lack of wind energy auctions in EU countries in recent times. Denmark for example didn't tender any capacity between 2017 and 2020, and in Germany nothing was awarded in 2019 and 2020. Since wind farms are typically commissioned 5-7 years after the auction, the lack of regular auctions affects the construction cycle.

In our outlook for the EU, 50% of new installations over the next seven years should come from projects which have already been awarded in auctions. This means that the other 50% will depend on Member States carrying out their planned auctions on time. Any delays would also hold up the construction of new projects and lead to lower installed capacity than originally forecasted for 2030.

In 2030 we expect the installed wind power capacity to reach 393 GW - 310 GW of onshore wind capacity with an additional 83 GW offshore. The outlook therefore sees the EU falling around 30 GW short of its 425 GW ambition needed to meet their 42.5% renewable energy target.

3.2 EU Member States

Germany

Germany will continue to be Europe's largest market, with 44 GW of new onshore wind capacity expected, along with 20 GW offshore.

In 2022 the German Parliament adopted the Onshore Wind Law (WindLandG) setting an installation target of 10 GW a year from 2025. It also enshrined the principle that the expansion of renewables is a matter of "overriding public interest" and made improvements to onshore wind permitting. The benefits of these changes are already being felt with 7.5 GW of projects permitted in 2023, up from 4.3 GW in 2022.

However, permits for transportation have become a separate bottleneck. Transportation companies require 150 permits on average to transport just one wind turbine and there is a backlog of 15,000 applications which could stall installations[4].

The onshore wind auction schedules have been revised as well. In 2023, 6.4 GW of onshore wind was awarded, and this will be followed with the auctioning of 10 GW a year in the period 2024-2028. Although originally 12.8 GW was scheduled to be auctioned in 2023, there wasn't a sufficient pipeline of permitted projects and there likely won't be enough permitted projects to reach the minimum 10 GW ambition in 2024 either.

These onshore capacity additions would bring Germany's total installed onshore wind power up to approximately 90 GW by 2030, making it by some margin the largest onshore wind market in Europe, more than twice the installed capacity of the next largest onshore market, Spain. But the expected installed onshore capacity total of 90 GW by 2030 would fall short of the ambitious 115 GW target by 25 GW.

Germany also awarded 8.8 GW of offshore wind capacity in 2023. 1.8 GW was awarded for centrally pre-examined areas (where the Federal Maritime and Hydrographic Agency (BSH) carries out an initial examination of the area's conditions). 7 GW was also awarded for non-centrally pre-examined areas. Over the next five years to 2028, Germany has a clear offshore auctions schedule which will offer 24 GW – in both centrally and non-centrally pre-examined areas.

We anticipate a build-out of more than 20 GW over the period from 2024-2030 – mostly from projects awarded in auctions by 2025. This build-out would deliver 29 GW, falling slightly short of the target of 30 GW. As of February 2024, some of the upcoming offshore wind auctions have confirmed grid connection delays. For Germany to reach 29 GW by 2030, the Government would have to carry out all auctions on time as planned and there can be no further delays to the connection of projects to the grid.

As well as this auction schedule, Germany's PPA market has seen strong growth in the last few years, providing other means for developers to secure fixed prices for electricity production.

Spain

In Spain new onshore wind capacity is expected to climb to more than 16 GW by 2030. With the addition of a possible 1 GW of new offshore wind by the end of the decade, Spain will be the second largest wind energy market in the EU after Germany. The PPA and merchant markets remain strong, despite an unsuccessful auction in 2023. We expect the annual onshore build-out to reach 2 GW by 2025 and reach 2.5 GW thereafter up to 2030.

But we need to see improvements in the permitting process. As it stands, there are sharp regional differences. For example, it has become impossible to develop wind farms in Galicia where local judges have put all construction on hold.

At the national level, permitting processes are relatively inefficient and can be held up by long appeal procedures. Another challenge for Spain will be the grid where there is a high risk of congestion and a lack of new access points and connections.

Spain has set an ambitious target of 59 GW of onshore wind by 2030. But given the current challenges, we see total onshore installations reaching just 40 GW by that date. The final years of the decade would need to see much higher build-out rates if the installed power capacity is to reach a level closer to the target.

The Government has also scheduled the first offshore wind energy auctions for 2024 and 2025. In 2024 an auction will be held for a floating wind farm in the Canary Islands, with an indicative volume of approximately 300 MW. Additional auctions may follow in 2025, mostly for floating wind. Should these auctions go ahead as planned, we see Spain potentially having up to 1 GW of installed offshore wind by 2030.

France

In France the country's first national law on renewable energy came into force in March 2023. The Renewable Acceleration Law improved auctioned conditions for wind and solar from December 2023 and makes local elected officials jointly responsible for the implementation of the energy transition.

The current auction framework gives good visibility and support. There are 3.7 GW of onshore wind capacity auctions currently scheduled (with an additional 1.5 GW available in technology-neutral auctions) over the next four years. But the elections in 2027 may pose significant risks to the stable wind energy agenda going forward.

4. https://www.reuters.com/business/energy/germanys-wind-power-expansion-stalls-roads-2023-09-07/

France has also seen regional differences in the build-out of wind energy which may limit some areas for future expansion. Some regions in the north of the country for example have become resistant to new developments after more wind farms were built there than in other parts of the country. And there are some regions which face a total blockage due to physical grid constraints.

Despite these challenges, we expect onshore build-out to exceed 11.5 GW over the next seven years. With a total onshore wind power capacity of 33.5 GW this would bring France close to meeting its 2030 onshore target of 35 GW. Additional auctions scheduled in or soon after 2026 would support the additional build-out needed to meet the target by 2030.

Offshore, up to 7.8 GW could be auctioned by 2027, including 2 GW of floating offshore. However, these projects are only likely to come online after 2030. Over the next seven years we expect 3.4 GW of new wind power capacity to be installed, all of it awarded in previous auctions.

The Netherlands

The Netherlands' wind capacity growth over the 2024-2030 period is expected to mostly come from the offshore sector, with almost 11 GW of new capacity expected. In 2024 the Ministry of Economic Affairs and Climate Policy will auction up to 4.6 GW of offshore wind capacity for the Ijmuiden Ver Alpha and Beta sites, originally scheduled to be tendered over the 2023-26 period. At least another 11 GW across seven sites will be tendered and these should be commissioned by 2031 at the latest.

The commissioning of these projects would bring the Netherlands up to 15.6 GW of total offshore power capacity by 2030, just shy of the target of 15.8 GW.

There is still some uncertainty around expected onshore wind build-out in the Netherlands. The scale of future installations depends on the outcome of the unresolved Nevele judgment case. This centres around the standards which are currently used to licence onshore wind farms. We have forecasted 2.6 GW of new onshore capacity by 2030 – giving a total installed power capacity of 9 GW by then. We expect their target of 7.4 GW to be met by 2025.

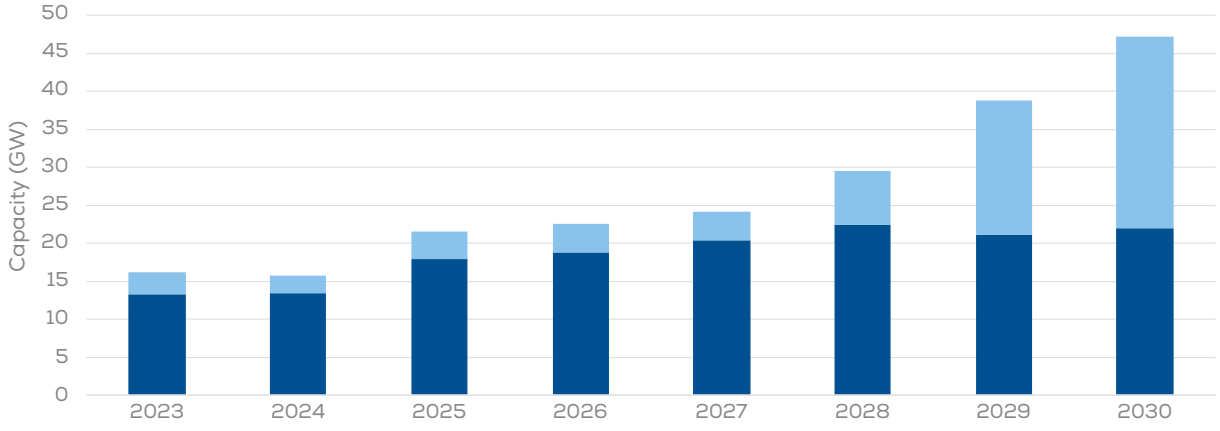
Poland

In 2023 the general election finally brought an end to the ruling Law and Justice (PiS) Government who had been opposed to onshore wind developments. They were also responsible for the infamous 10H rule – forbidding the construction of wind turbines at a distance from buildings equal to at least ten times their tip height. This rule blocked onshore wind development in 98% of Polish territory since 2016.

In a major boost for wind energy in Poland, former Prime Minister and European Council President Donald Tusk's party (Civic Coalition) secured enough votes with the support of other opposition parties to oust PiS. The new Government is much more favourable to wind and might look to replace the minimum 700 m set back-distance rule (which replaced the 10H rule in February 2023 but is still restrictive) with a 500 m one.

Last year, we expected Poland to commission 4.2 GW of new onshore wind over the period from 2023-27. Expectations have increased significantly, and we now anticipate 5.3 GW over the same period. Despite challenges for developers looking to secure grid connections, we expect new onshore build-out to exceed 8 GW by 2030, giving us a total onshore wind power capacity of 17.5 GW, much higher than the 14 GW target.

FIGURE 20. New installations in the EU - WindEurope's Outlook



	2023	2024	2025	2026	2027	2028	2029	2030
Onshore	13.3	13.4	17.9	18.7	20.4	22.4	21.2	22.0
Offshore	2.9	2.3	3.7	3.9	3.8	7.1	17.6	25.2

Source: WindEurope

Offshore wind in Poland is set to take off in earnest from 2025 when the projects awarded in the first auction in 2021 could start coming online. In total we expect 5.2 GW to be connected by 2030, coming up just short of the 2030 offshore target of 5.9 GW.

Finland

Finland will continue to expand its installed onshore wind capacity, albeit at a slower pace than the last couple of years. Overall, we expect an onshore build-out of 9.6 GW during the period from 2024-2030 – totalling 16.5 GW of installed onshore capacity nationwide. In general, Finland's low population is favourable for onshore wind development, and it has strong merchant and PPA markets. But some developers may be holding back as demand for renewable hydrogen is not growing as quickly as hoped.

Finland ran its first seabed leasing round in 2022 and they plan to tender an additional 7.5 GW in 2024. We expect the projects to start coming online by the end of the decade and anticipated total offshore power capacity should reach 1.8 GW by 2030. There is no offshore target.

Sweden

We are expecting 8.3 GW of new onshore capacity installations in Sweden during the period from 2024 to 2030. The Government has put less emphasis on renewables and one of the coalition parties is against wind energy developments, but it is still likely to play an important role in the decarbonisation of industry. There is no central support for wind energy but Sweden has one of the most established and well-functioning PPA markets. There is also strong demand from industry – e.g. for green steel, battery factories and wider renewable hydrogen, all of which is supporting the demand for wind energy.

Sweden's offshore wind market is fully merchant and there are many projects under development. Considering the most advanced projects, Sweden could have 1.7 GW of offshore wind capacity installed by 2030.

Italy

Italy has an ambitious onshore wind capacity target of 26 GW by 2030. Permitting of projects can be challenging with project developers needing to secure support from the regions and from the Soprintendenze, the regional representatives of the national Ministry of Culture and Heritage. Additionally penalising tariffs for repowered wind farms and speculative grid connections also hinder the redevelopment of Italy's oldest wind projects – and since Italy's wind fleet is amongst the oldest in Europe, this is a major missed opportunity to quickly ramp-up the build-out of wind.

The Government is however finalising a favourable auction scheme, with support indexed to inflation and a visible schedule. Over the next five years, 5 GW will be auctioned specifically for onshore wind. We expect 5.9 GW to be installed between 2024-2030, taking Italy's total onshore wind power capacity to 18 GW by 2030, 8 GW short of their target.

Italy is aiming for 2 GW of offshore wind by 2030. There are many projects already underway and the Government is planning to run auctions for offshore wind. The decree establishing the auction design detail should be finalised during 2024. It is possible that the projects under development could be commissioned without support from the Government. We expect offshore wind build-out to come to 2 GW by 2030, with the first projects coming online by 2028 at the earliest.

Other EU Markets

Denmark's build-out of wind power capacity from 2024-2030 is expected to include around 2.3 GW of onshore wind and 6.6 GW offshore. Repowering will play an important role for onshore wind given the age of the fleet and the limited space for further development. Build-out is expected to be on a merchant or PPA basis since there is no central support envisaged. The revised National Energy and Climate Plan sets out an ambition to reach 5.9 GW of onshore wind by 2030, and we expect that to be reached by 2028.

Six different offshore areas in the North Sea and Baltic Sea will be auctioned over 2024 and 2025, for a minimum of 9 GW. For each site, there will be an opportunity to build more capacity than the grid connection for power-to-X. We expect the build-out to come to 6.6 GW over the period 2024-2030 giving a total offshore wind power capacity of 9.3 GW by 2030, slightly more than the 9 GW target in the revised National Energy and Climate Plan.

We expect **Ireland** to install 7.4 GW over the next seven years, almost half of which will be onshore (3.4 GW). The onshore auction in 2023 awarded just 148 MW to onshore wind. At least two more technology-neutral onshore auctions are currently planned for 2024 and 2025 with more expected later in the decade. Merchant and PPA-backed projects will likely play a part with demand from data centres leading to onshore wind PPAs being signed in recent years by Amazon, Meta and Microsoft. Ireland has a 2030 onshore wind target of 9 GW and we expect total onshore wind power capacity to climb to 8.7 GW by 2030.

The first commercial-scale offshore wind farms in Ireland which were auctioned in 2023 could start coming online as early as 2028. Another 900 MW is planned to be auctioned in 2024. We expect the build-out to come to 4.0 GW over the period 2024-2030, falling short of the 5 GW 2030 offshore target.

Belgium has had a stable level of onshore wind capacity build-out over the last 10 years, on average installing 220 MW a year. We expect the trend to continue with a total onshore build-out of 2 GW over the next seven years, giving an installed onshore wind capacity figure of 5.1 GW. The 2030 onshore wind targets are set on a regional level but we expect the combined targets for Wallonia and Flanders to come to 5.1 GW.

While Belgium does not run onshore auctions, 3.5 GW of offshore wind will be auctioned between 2024-2027 as part of the Princess Elisabeth Island project. We expect an additional build-out of 2.7 GW by 2030, bringing Belgium's total offshore wind power capacity to 4.9 GW, 0.9 GW short of the 5.8 GW target.

In **Greece**, wind power additions over the period from 2024-30 will be mostly onshore, and are expected to be worth 2.8 GW. In 2024, tenders for at least 500 MW of eligible technologies including wind power are scheduled, but after this, projects will be issued on a merchant or PPA basis. Greece has a 2030 onshore wind power target of 7.6 GW. So with 5.2 GW already installed onshore, we expect the target to be reached.

Greece also wants to have 1.9 GW of offshore wind power capacity installed by 2030. If auctions take place in the next two years it will be possible to deliver some capacity by the end of the decade. We expect around 900 MW to be installed by 2030.

Romania has 3.1 GW of installed onshore wind power capacity. And with a 2030 target of 7.6 GW, it will need to build 4.5 GW over the next seven years to meet it. Much will depend on a draft law for the implementation of a low-carbon technologies Contract-for-Difference (CfD) auction scheme. As things stand, this has yet to be formally presented to Parliament.

Assuming the law is approved and auctions take place in 2024/25, we anticipate 3.6 GW of onshore wind build-out.

For the **EU as a whole**, 200 GW of capacity additions are expected over the next seven years up to 2030. Onshore wind build-out is expected to make up 68% of this, almost 136 GW – with offshore wind capacity additions coming to almost 64 GW. These new capacity additions would bring the EU's installed wind power capacity to 393 GW by 2030 after allowing for the expected decommissioning of older wind farms. We therefore expect, in the current circumstances, that the EU will fall short of its 2030 wind power capacity targets by approximately 32 GW.

3.3 Non-EU-countries

Outside of the EU-27, **the UK** is expected to install the most new wind power capacity over the next seven years, second only to Germany in Europe.

Onshore wind development has faced a de facto ban in England since 2015, severely restricting its build-out in the United Kingdom, although there has been political support for onshore wind in Scotland and Wales during this period. Winning onshore wind projects from the latest auction round (AR5) were almost exclusively in Scotland.

In 2024 however the UK will hold a general election, and a victory for the Labour Party is widely anticipated, bringing an end to 14 years of Conservative Government. Labour want to restart the build-out of onshore wind in England. We expect a new capacity build-out of almost 12 GW over the next seven years, with total installed onshore wind capacity slightly exceeding 26 GW by 2030.

The UK is expected to remain the largest market for offshore wind in Europe. The fifth round of auctions (AR5) failed to deliver any offshore wind project winners as a result of the strike price ceiling being too low. Projects could not deliver at the prices offered given the huge rise in costs seen over the last couple of years. The Government has now increased the strike price ceiling and we anticipate a significant volume of capacity being awarded in the upcoming rounds.

We expect around 29 GW of additional offshore installations between 2024-2030, bringing the expected total offshore wind power capacity to over 43 GW. This would be a significant achievement but would still fall short of the UK's ambitious 2030 offshore wind power target of 50 GW.

In **Turkey** the economic situation in recent years has made it difficult for the private sector to secure funding for projects. But the situation is improving, and the recent high interest rates and high levels of inflation are widely expected to fall back this year. The wider economy is also expected to stabilise as the Government and Central Bank are now pursuing more orthodox policies.

Energy independence is high on the agenda and wind energy has strong political and social support. There is no specific national 2030 target for wind energy. However Turkey's Energy Plan 2020 – 2035 sees 18.1 GW of installed wind power capacity by 2030.

We expect a build-out of almost 14 GW of onshore wind over the period 2024-2030, giving a total installed onshore capacity of 26 GW by 2030.

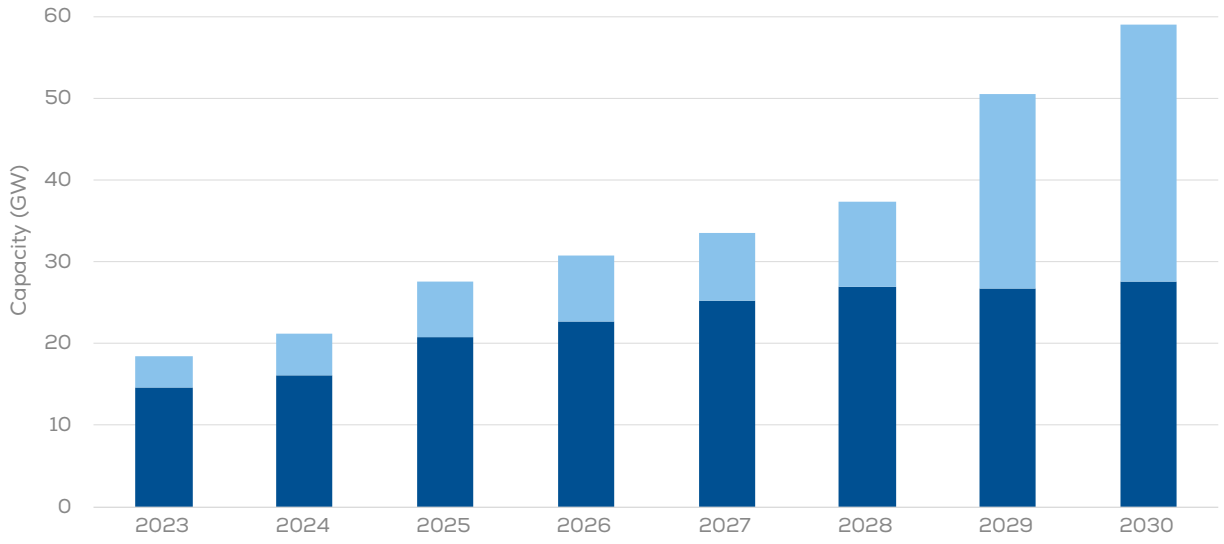
In **Norway**, strong local opposition and laws allowing local communities to block projects have led to a bleak outlook for onshore wind.

The Government plans to auction 3 GW of bottom-fixed and floating offshore wind by 2025. We expect 1.5 GW to come online by 2030.

Total capacity additions across Europe over the next seven years up to 2030 are expected to exceed 260 GW. Onshore wind build-out is expected to reach 167 GW (64%) and 95 GW (36%) of new wind power capacity will be installed offshore.

Europe's total installed wind power capacity could exceed 500 GW by 2030.

FIGURE 21. New installations in Europe - WindEurope's Outlook



	2023	2024	2025	2026	2027	2028	2029	2030
Onshore	14.5	16.1	20.9	22.6	25.1	27.0	26.6	27.6
Offshore	3.8	5.0	6.7	8.2	8.4	10.4	23.8	31.4

Source: WindEurope

TABLE 4. Expected new installations per country, 2024-30 - WindEurope's Outlook

	2024		2025		2026		2027		2028		2029		2030	
EU-27 (MW)	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore
Austria	120	-	450	-	400	-	400	-	410	-	410	-	430	-
Belgium	260	-	280	-	290	-	290	-	290	320	300	950	300	1,410
Croatia	300	-	100	-	100	-	200	-	300	-	190	-	200	-
Czechia	10	-	40	-	30	-	50	-	70	-	70	-	80	-
Denmark	370	-	350	10	220	500	270	680	310	540	350	2,550	380	2,340
Estonia	360	-	500	-	500	-	200	-	200	-	150	230	240	230
Finland	410	-	1,970	-	970	30	1,210	-	2,500	-	1,260	600	1,300	1,200
France	1,140	660	2,000	1,470	2,000	270	2,000	270	2,000	-	1,390	-	1,160	680
Germany	4,500	1,670	5,300	940	5,700	280	6,300	1,500	6,700	2,440	7,180	5,800	7,830	7,800
Greece	330	-	500	-	420	-	400	-	400	-	400	-	400	900
Ireland	570	-	340	-	550	-	480	-	380	400	530	1,800	550	1,800
Italy	400	-	400	-	770	-	1,300	-	1,360	450	1,390	820	1,400	720
Latvia	-	-	220	-	230	-	300	-	200	-	190	280	200	280
Lithuania	190	-	220	-	320	-	390	-	420	-	430	320	440	780
Luxembourg	10	-	80	-	50	-	30	-	50	-	30	-	30	-
Netherlands	400	-	500	760	390	1,520	300	-	330	2,000	350	2,250	380	4,350
Poland	970	-	710	570	1,030	1,250	1,400	1,340	1,400	670	1,400	770	1,400	560
Portugal	120	-	230	-	230	-	380	-	500	-	500	-	600	1,050
Romania	390	-	430	-	560	-	520	-	560	-	570	-	570	-
Slovakia	-	-	60	-	50	-	80	-	100	-	120	-	120	-
Spain	1,800	-	2,000	-	2,500	-	2,500	-	2,500	30	2,500	490	2,500	510
Sweden	770	-	1,060	-	1,260	-	1,260	-	1,300	290	1,320	750	1,330	630
Total EU-27	**13,430**	**2,330**	**17,860**	**3,750**	**18,720**	**3,850**	**20,370**	**3,790**	**22,380**	**7,140**	**21,160**	**17,610**	**21,980**	**25,240**

	2024		2025		2026		2027		2028		2029		2030	
Others (MW)	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore
Albania	-	-	20	-	40	-	40	-	40	-	40	-	40	-
Bosnia & Herzegovina	80	-	-	-	70	-	70	-	70	-	70	-	-	-
Montenegro	60	-	-	-	60	-	160	-	-	-	-	-	-	-
North Macedonia	-	-	20	-	60	-	60	-	60	-	110	-	110	-
Norway	-	-	-	10	-	10	-	-	150	-	180	750	190	750
Serbia	160	-	150	-	400	-	100	-	200	-	130	-	160	-
Switzerland	-	-	-	-	80	-	180	-	330	-	280	-	290	-
Turkey	1,350	-	1,600	-	1,900	-	2,300	-	2,240	-	2,240	-	2,240	-
UK	1,020	2,680	1,220	2,900	1,270	4,350	1,860	4,600	1,480	3,240	2,360	5,510	2,570	5,440
Ukraine	10	-	-	-	-	-	-	-	-	-	-	-	-	-
Total others	**2,680**	**2,680**	**3,010**	**2,910**	**3,880**	**4,360**	**4,770**	**4,600**	**4,590**	**3,240**	**5,460**	**6,260**	**5,680**	**6,190**
Total Europe	**16,110**	**5,010**	**20,870**	**6,660**	**22,600**	**8,210**	**25,140**	**8,390**	**26,970**	**10,380**	**26,620**	**23,870**	**27,660**	**31,430**

3.4 Repowering

Repowering decisions are driven by many factors and are carried out on a case-by-case basis. The most relevant factors when making a decision to repower include:

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

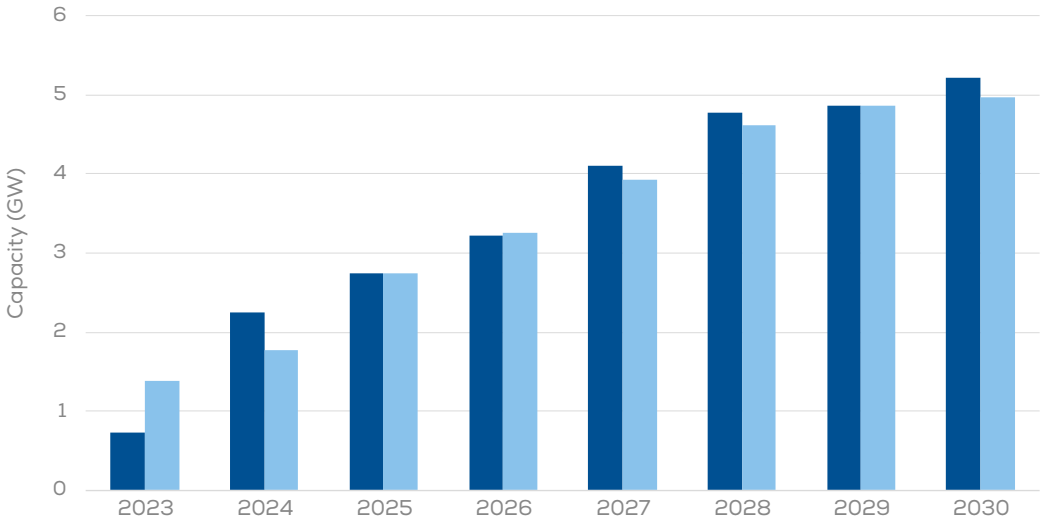
Over the next seven years we expect annual installations of repowered projects to increase from 1.4 GW to 5 GW by 2030 – with the total build-out from repowered wind farms exceeding 27.5 GW.

Over the same period we expect almost 28 GW of old wind farms to be decommissioned. It is tempting to regard repowering as having little impact on the total annual build-out of wind each year, since in the projection the annual decommissioned and repowering volumes are similar. On average however, we assume that the capacity of repowered projects will be more than double that of the original wind farm.

The annual repowered project capacity tends not to exceed the decommissioned amount in each year for two main reasons. First, not all projects are repowered. The proportion of projects which are repowered varies considerably by region and the policies which govern repowering. Second, the capacity repowered each year arises from the repowering of projects in previous years.

Germany (15.8 GW) and Spain (6.5 GW) are expected to install more than 80% of repowered capacity in Europe by 2030.

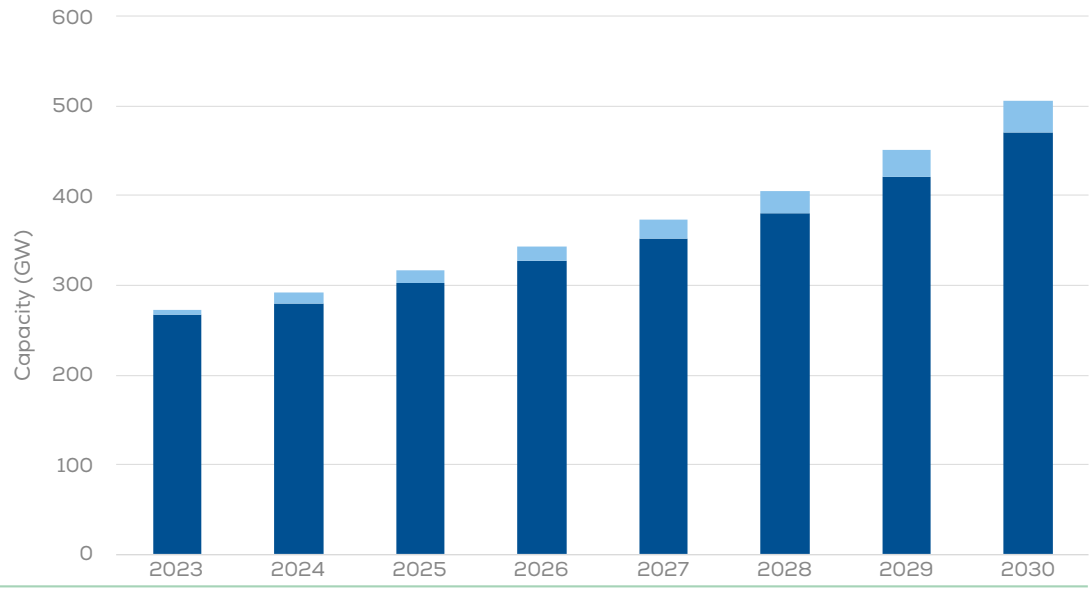
FIGURE 22. Decommissioned and repowered wind power capacity in Europe - WindEurope's Outlook



	2023	2024	2025	2026	2027	2028	2029	2030
Decommissioned capacity	0.7	2.3	2.7	3.2	4.1	4.8	4.9	5.2
Repowered capacity	1.4	1.8	2.7	3.3	3.9	4.6	4.9	5.0

Source: WindEurope

FIGURE 23. New and repowered wind energy installations in Europe - WindEurope's Outlook



	2023	2024	2025	2026	2027	2028	2029	2030
Repowered wind farms	6	11	14	17	21	26	31	36
New wind farms	267	280	302	327	352	380	421	470

Source: WindEurope

Repowered wind farms are expected to make up just 7% of all installed power capacity in Europe by 2030. But we expect 55 GW of projects to reach 20 years of age or older over the next seven years. And with 19 GW of projects becoming 25 years old and 3 GW of projects becoming more than 30 years old, we will have up to 77 GW of projects that will need to either be repowered, undergo a lifetime extension or be decommissioned.

Of the 55 GW set to become at least 20 years old by 2030, we expect 5 GW to be repowered or under repowering and 2 GW to be completely retired. We use repowering rates that are higher for wind farms which are decommissioned earlier as we expect the economic benefits of repowering to be the main driver for earlier decommissioning. The older the wind farm, the less likely that it will be repowered since on average, we expect that if it could have been repowered. We therefore assume the oldest wind farms are operated until they are eventually decommissioned.

The remaining 48 GW will continue to operate and will probably be assessed for lifetime extension services (perhaps with partial replacement of certain components such as gearboxes or blades).

The repowering of wind farms is crucial if Europe is to meet its energy and climate targets. But the current barriers to repowering prevent us from taking full advantage of it. We estimate that if repowering rates are doubled for wind farms between 20 and 30 years of age, an additional 10 GW of repowered capacity could be installed by 2030. The potential is much higher.

4.

Reaching the EU's 2030 Energy and Climate targets

4.1 State of play

The European wind industry was in a difficult place in 2022. The supply chain was struggling with cost inflation, ongoing permitting delays and poorly designed auctions that squeezed revenue for both developers and manufacturers. Uncoordinated Government measures to address rising electricity prices had also eroded investor confidence, stalling final investment decisions for large-scale offshore projects.

In response and in recognition of the critical role of wind energy in achieving the EU's climate and energy security goals, the European Commission launched the Wind Power Package – a set of 15 immediate measures to accelerate wind deployment and bolster the competitiveness of European manufacturing.

This Package was then endorsed by 26 EU Governments and 300 wind energy companies who signed the European Wind Charter. This commitment signalled a united front in implementing the EU Wind Power Package and is expected to have a positive impact on permitting, finance, and auctioning mechanisms, crucial aspects for expanding wind energy and reinforcing European energy security.

A number of the actions set out in the Wind Power Package have already been taken. The EU is currently running a €4 billion call under the Innovation Fund that will allocate grants to clean tech manufacturing. The European Investment Bank has changed its lending rules to be able to finance wind manufacturing, and a €5 billion counter-guarantee scheme dedicated to wind turbine manufacturing.

The measures set out in the Wind Power Package on auction design are now being enshrined in EU legislation as part of the Net-Zero Industry Act. The new law mandates pre-qualification criteria (on cybersecurity, responsible business conduct and the ability to deliver a project), factoring in supply chain resilience, and non-price award criteria, for 30% of renewable energy auctions to begin with.

The Act aims to strengthen Europe's domestic clean technology manufacturing capacity, aligning with the Wind Power Package and the REPowerEU Action Plan's ambitious goal of reaching 425 GW of wind energy by 2030 .

The European wind industry is now in a stronger place than it was a year ago. Industry and Governments have the will and the way and now Europe must focus on delivery. Implementation of the Wind Power Package at the national level is critical. Governments must also look at their grid development plans with urgency – grid permitting and development is quickly becoming the number 1 bottleneck for wind energy deployment in Europe.

Finally with only 23% of its energy demand currently being met with electricity, Europe urgently needs to accelerate the pace of electrification. Achieving a climate-neutral continent by 2050 demands an ambitious leap to 58-71% reliance on electricity.

4.2 Grids

In 2023 Europe ramped up its political oversight on electricity grids and took promising steps to accelerate the development of network infrastructure that can deliver its climate goals. The European Commission estimates that €584bn will need to be invested in electricity grids this decade. And according to the first Offshore Network Development Plans, €85bn will need to be invested to build 11,000 km of new offshore electricity transmission networks by 2030.

These announcements have trigged an unprecedented momentum to connect new renewable energy assets and grid equipment supply chains. National Authorities should use this opportunity to plan anticipatory investments to expand, reinforce or optimise their transmission and distribution networks so that they can reach the targets in their National Energy and Climate Plans. They will also need to reserve the necessary grid connection capacity for all technologies identified as strategic in their net-zero transition. This will enable Europe to reinforce its grid equipment manufacturing base.

But grid permitting remains the number 1 bottleneck for deploying wind energy at scale. Significant volumes of wind power capacity are stuck in grid permitting procedures across Europe, which can last up to 10 years in some countries. The "first come, first served" approach that all countries apply now for connecting new assets to their grids will not deliver the necessary pace.

In terms of offshore network infrastructure, National Authorities must try to find an optimal and fair way to share costs and benefits at sea basin level.

Finally, curtailment of wind energy is becoming more common right across Europe and is now a serious uncertainty factor for investments in new renewable capacity. Europe will need targeted mechanisms and regulatory adjustments to handle curtailment in a cost-effective manner. With the implementation of the new Electricity Market Design and the provisions for non-fossil flexibility, National Authorities will have the opportunity to deploy their assessments on flexibility needs and targets and prioritise flexibility from non-fossil resources.

4.3 Supply chain

Over the past few years, the European wind energy supply chain has faced rising pressure from a range of factors such as inflation, difficulty in accessing raw materials, competition from non-European manufacturers and a lack of clear project pipelines because of delays in the permitting process.

The sector may be turning a corner as demonstrated by renewed confidence from wind manufacturers. New and expanded factories in Poland, the Netherlands and Germany are already being developed which will add to the existing 250 factories across Europe.

Despite the policy and manufacturing progress, we are still seeing delays in the wider supply chain. This includes waiting periods of 3 - 4 years in some cases for offshore foundations. The availability of cable and installation vessels will also become an issue in the short-term if more are not produced – particularly in light of expected competition for vessels as new markets in Asia and North America open up to offshore wind. Europe's wind energy ports, which are a vital part of both the on- and offshore supply chain, still struggle to access the European funding that they need. Boosting port capacity is a long-term process, meaning ports need to plan longer term as the capacity cannot be turned on at short notice.

Onshore wind, which will continue to make up the lion's share of installations up to 2030, is facing its own set of challenges. Delays in permitting and grid connections, along with rising material costs and non-European competition, are putting extra pressure on the supply chain to be able to plan for the future. The improvements in these areas outlined in the Net-Zero Industry Act and the Wind Power Package will certainly help. But we'll need to see a coordinated effort from policymakers, industry and local communities to ensure the onshore wind market is able to deliver the volumes that Europe needs.

To meet these challenges, the focus should be on achieving implementation. It's vital that we see the progress made in the Net-Zero Industry Act and the Wind Power Package enshrined in national law as soon as possible. With less than 7 years to go until 2030, we need these supporting measures to be quickly adopted, to guarantee a viable European wind energy supply chain which can help Europe to reach its 2030 targets.

4.4 Permitting

Europe has turned a corner on the permitting of new onshore wind farms, mainly thanks to new EU permitting rules. A key element in the new rules agreed as part of the Revised Renewable Energy (RED) was the Overriding Public Interest (OPI) principle. Crucially, the RED also reconfirms and clearly defines which permits need to be granted within the 2-year deadline. It also calls on Governments to simplify and digitalise their permitting procedures.

In 2023, most European countries awarded more permits than the years before. Germany permitted 7.5 GW, marking a 70% increase on the previous year. The contrast is even more significant when compared to 2017-2019 when less than 2 GW of permits were handed out on a yearly basis. This puts Germany on a promising trajectory but it still falls short of the Government's goal to auction 10 GW of new capacity annually by 2025. So the number of permits need to grow even more.

Spain saw a similar increase with more than 3 GW of permits granted in 2023, 70% more than in 2022. Before 2022 permitting volumes were consistently below 1 GW. In France, 2.2 GW of onshore wind was permitted (a 12% increase) and the United Kingdom saw a 10% rise, approving just over 1 GW of onshore projects.

Germany has done an especially good job at rigorously implementing many of these new rules already. The application of the concept of "Overriding Public Interest" (OPI) has proven highly effective in expediting projects caught up in legal disputes. Projects are winning court cases they used to lose. France, Portugal, and Austria have followed suit by incorporating OPI into their legal frameworks.

Other new permitting regulations have played a role all across Europe to speed up permitting. In Spain the notable increase can be primarily linked to the expansion of permitting staff. Poland made a positive change by eliminating its contentious 10H distance rule (which required turbines to be built a minimum of ten times their own height from the nearest settlement), but it still requires turbines to be a minimum of 700 m away from settlements. This modification opens up some more land in Poland for wind energy development. Other countries have started developing Renewables Acceleration Areas or have set stricter limits on how long certain steps of the permitting procedure can take.

The European Commission and national Energy Ministers have once again stressed their aim to speed up the implementation of the Renewable Energy Directive in the European Wind Power Action Plan. So more improvements in national permitting procedures are likely to follow in the coming years.

4.5 How to deliver

WindEurope's outlook up to 2030 indicates that, on its current trajectory, Europe is likely to miss its 2030 wind energy targets. But things have improved over 2023 and the outlook is more optimistic than it was last year.

To meet our renewable energy and climate targets, Governments in Europe need to ramp-up the build-out of both onshore and offshore wind by:

1. Implementing the action points set out in the Wind Power Package and European Wind Charter at national leel.

2. Accelerating grid expansion including via anticipatory investments, optimising the use of the existing grid, and proactively managing grid connection queues.

3. Increasing the pace of electrification to decarbonise the economy.

Annex 1

Glossary

Support mechanism	Description
Feed-in-Tariffs	A type of price-based policy instrument where eligible renewable energy generators are paid a fixed price at a guaranteed level (irrespective of the wholesale price) for the RES electricity produced and fed into the grid.
Feed-in-premium (fixed)	A type of price-based policy instrument where eligible renewable energy generators are paid a premium price which is a payment (x€/MWh) in addition to the wholesale price.
Feed-in-premium (floating)	A type of price-based policy instrument where eligible renewable energy generators are paid a premium price which is a payment in addition to the wholesale price. The floating premium would be calculated as the difference between an average wholesale price and a previously defined guaran- teed price. Effectively it works as a floor price, always guaranteeing a minimum revenue.
Contracts for differences	Similar to the floating premium. However, under contracts for difference, if the wholesale price rises above the guaranteed price, generators are required to pay back the difference between the guaranteed price and the wholesale price.
Zero-subsidy bids (Dutch model)	Developers compete for the right to build a wind farm in a tender in which the selection criteria are not based on the price. The selection is made according to the experience of the bidders, the quality of the project design, the capacity of the project and the social costs, with added weight given to the quality of the survey, risk analysis and mitigation measures. While the winner doesn't receive any price premium, the transmission costs for the project are covered by the Government.
Green Certificates	A tradable commodity proving that certain electricity is generated using renewable energy sources. May have guaranteed minimum prices. The certificates can be traded separately from the energy produced.

Annex 2

Assumptions for decommissioning and repowering[4]

	Decommissioning rate		Repowering rate		Repowered wind farms	
Projection year	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore
0	-	-	-	-	-	-
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
11	-	-	-	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	-	-	90%	-	-	-
15	1%	-	90%	-	1%	-
16	1%	-	90%	-	1%	-
17	1%	-	90%	-	1%	-
18	1%	-	90%	-	1%	-
19	1%	-	90%	-	1%	-
20	1%	-	90%	-	1%	-
21	1%	-	85%	-	1%	-
22	1%	-	80%	-	1%	-
23	1%	15%	80%	100%	1%	15%
24	1%	15%	80%	100%	1%	15%
25	5%	15%	75%	100%	4%	15%
26	25%	25%	60%	75%	15%	19%
27	25%	50%	45%	50%	11%	25%
28	25%	50%	25%	10%	6%	5%
29	25%	50%	10%	-	3%	-
30	25%	50%	-	-	-	-
31	25%	50%	-	-	-	-
32	25%	50%	-	-	-	-
33	25%	50%	-	-	-	-
34	50%	50%	-	-	-	-
35	100%	100%	-	-	-	-

5. Repowered wind farm assumption represents proportion of original fleet which is repowered each year, i.e. out of all the wind farms installed in year 0, 21% will be repowered.

WindEurope is the voice of the wind industry, actively promoting wind power in Europe and worldwide. It has over 500+ 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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