



Wind energy in Europe in 2019

Trends and statistics

Wind[•]
EUROPE

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Trends and statistics

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This report summarises new installations and financing activity in Europe's wind farms from 1 January to 31 December 2019.

WindEurope regularly surveys the industry to determine the level of installations of wind farms, and the subsequent dispatch of first power to the grid. The data represents gross installations per site and country unless otherwise stated. Rounding of figures is at the discretion of the author.

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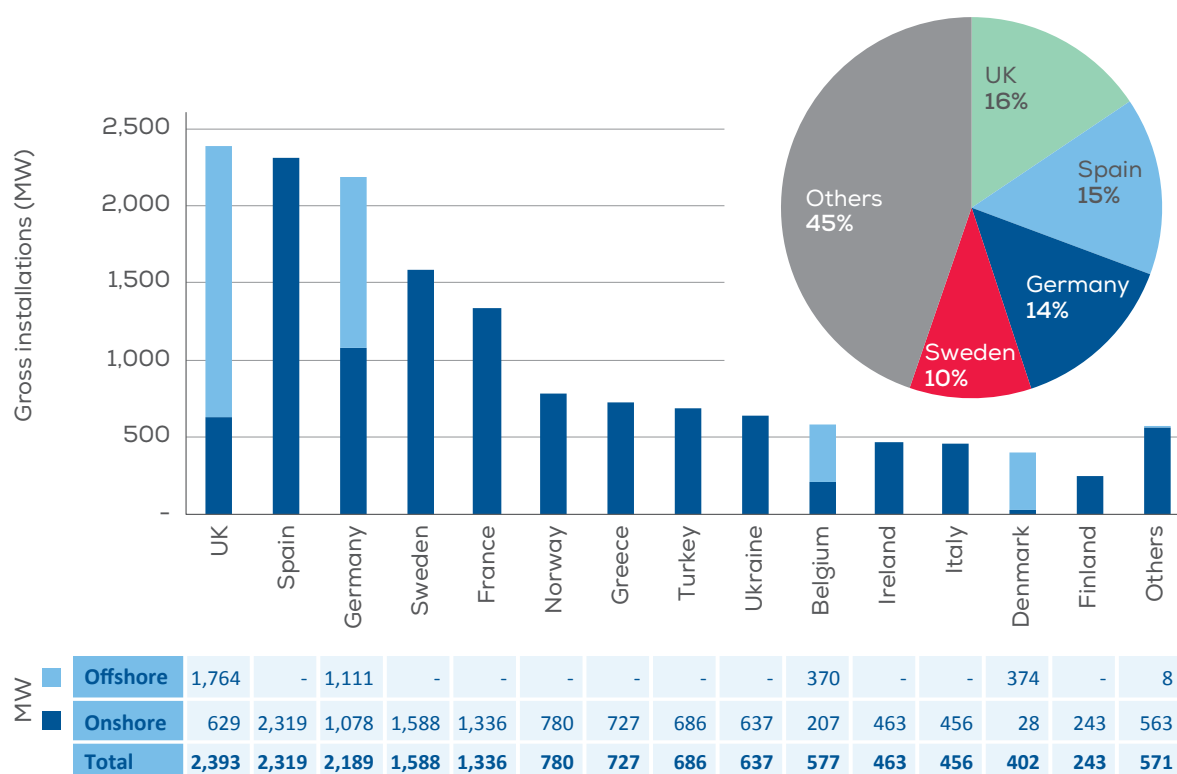
EXECUTIVE SUMMARY

Europe installed 15.4 GW of new wind power capacity in 2019 (13.2 GW in the EU). This is 27% more than 2018 but 10% less than the record in 2017.

Europe now has 205 GW of wind energy capacity. And wind accounted for 15% of the electricity the EU-28 consumed in 2019.

Three quarters of the new wind installations last year were onshore. Spain installed the most with 2.2 GW of new onshore wind farms. New installations and investments were down sharply in Germany.

FIGURE 1
2019 new onshore and offshore wind installations in Europe



Source: WindEurope

2019 annual figures

- Europe installed 15.4 GW of new wind power capacity in 2019. This is 27% more than 2018 but 10% less than the record in 2017. 13.2 GW of the new installations were in the EU¹.
- Onshore wind was 76% of the new installations with 11.7 GW.
- Offshore wind installations were a record 3.6 GW.
- With 417 TWh generated, wind power covered 15% of the EU's electricity demand in 2019.
- A further of new wind farms reached Final Investment Decision: 10.1 GW in onshore and 1.4 GW in offshore wind. The new investments were worth €19bn.
- Around 15 GW of new wind farms were awarded in Government auctions and tenders. The UK awarded 5.5 GW of offshore wind in one auction. Poland awarded 2.2 GW of onshore wind in another.

Country highlights

- The UK installed the most wind power capacity in 2019 (2.4 GW). 74% of that was offshore wind.
- Spain (2.3 GW), Sweden (1.6 GW) and France (1.3 GW) led the installation of onshore wind farms. Germany came fourth with 1.1 GW.
- Spain was also number one in new investments with €2.8bn investment decisions in new onshore wind farms covering 2.8 GW of capacity. France was the largest investor in offshore wind, raising €2.4bn for the Saint-Nazaire wind farm.
- Investments in Germany reached a historic low of €300m, covering a mere 180 MW of onshore wind projects.
- Denmark is the country with the largest share of wind energy in its electricity demand (48%). This was followed by Ireland (33%), Portugal (27%), Germany (26%) and the UK (22%).

Trends and cumulative installations

- There are now 205 GW of installed wind power capacity in Europe: 183 GW onshore and 22 GW offshore.
- Europe decommissioned 178 MW of wind capacity in 2019. It commissioned 185 MW of repowered capacity. The total net capacity additions were 15.2 GW (15.4 GW is the gross figure).
- The average power rating of new onshore wind turbines was 3.1 MW. The average power rating of new offshore turbines was 7.2 MW.

1. That is EU-28 as it was in 2019

15.4 GW

TOTAL EUROPE

13.2 GW

IN THE EU-28

Cumulative
installed
capacity
(GW)²

GW

GW

New
installations
in 2019 (GW)

Share
of wind
in power
demand³⁻⁵

40-50%

30-40%

20-30%

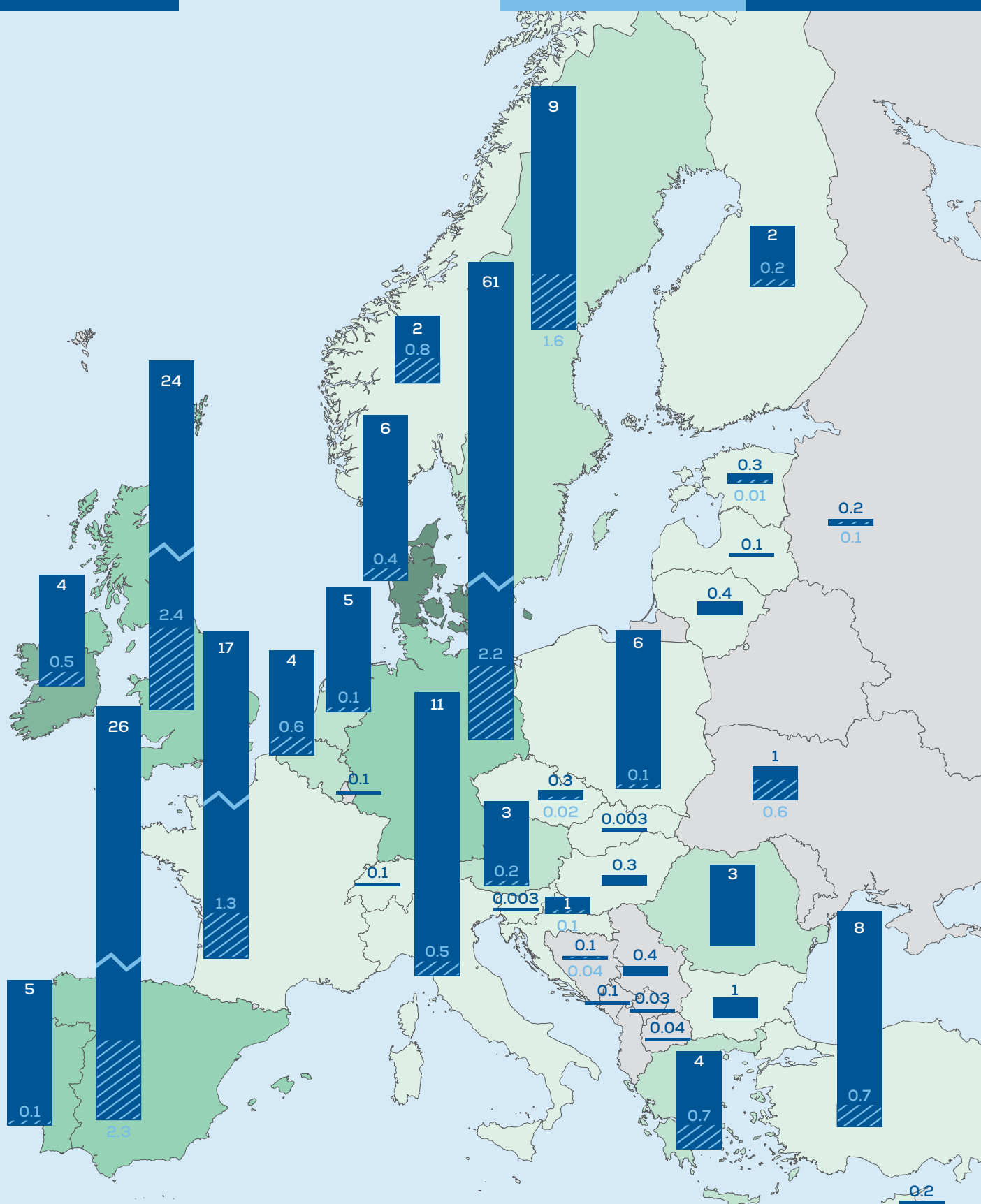
10-20%

0-10%

WIND ENERGY
COVERED

15%

OF EU ELECTRICITY
DEMAND IN 2019



2. Cumulative in each country reflects decommissioning in 2019: Austria (32 MW), Denmark (32 MW), Germany (97 MW), and the UK (17 MW).

3. Grey colored countries did not provide data for electricity generation and consumption to ENTSO-E transparency platform.

4. Data for Croatia's electricity generation and consumption was provided by the Croatian Energy Market Operator (HROTE).

5. Data for Turkey's electricity generation and consumption was provided by the Turkish Wind Energy Association.

Source: WindEurope

TABLE 1

New installations and cumulative capacity in 2019⁶

EU-28 (MW)	NEW INSTALLATIONS 2019		CUMULATIVE CAPACITY 2019 ⁷		
	ONSHORE	OFFSHORE	ONSHORE	OFFSHORE	TOTAL
Austria	152	-	3,159	-	3,159
Belgium	207	370	2,323	1,556	3,879
Bulgaria	-	-	691	-	691
Croatia	69	-	652	-	652
Cyprus	-	-	158	-	158
Czechia	20	-	337	-	337
Denmark	28	374	4,426	1,703	6,128
Estonia	10	-	320	-	320
Finland	243	-	2,213	71	2,284
France	1,336	-	16,644	2	16,646
Germany	1,078	1,111	53,912	7,445	61,357
Greece	727	-	3,576	-	3,576
Hungary	-	-	329	-	329
Ireland	463	-	4,130	25	4,155
Italy	456	-	10,512	-	10,512
Latvia	-	-	66	-	66
Lithuania	-	-	548	-	548
Luxembourg	16	-	136	-	136
Malta	-	-	-	-	-
Netherlands	97	-	3,482	1,118	4,600
Poland	53	-	5,917	-	5,917
Portugal	61	8	5,429	8	5,437
Romania	-	-	3,029	-	3,029
Slovakia	-	-	3	-	3
Slovenia	-	-	3	-	3
Spain	2,319	-	25,803	5	25,808
Sweden	1,588	-	8,794	192	8,985
UK	629	1,764	13,570	9,945	23,515
Total EU-28	9,552	3,627	170,162	22,069	192,231

OTHERS (MW)	NEW INSTALLATIONS 2019		CUMULATIVE CAPACITY 2019 ⁷		
	ONSHORE	OFFSHORE	ONSHORE	OFFSHORE	TOTAL
Bosnia & Herzegovina	36	-	87	-	87
Kosovo	-	-	32	-	32
Montenegro	-	-	118	-	118
North Macedonia	-	-	37	-	37
Norway	780	-	2,442	2	2,444
Russia	50	-	191	-	191
Serbia	-	-	374	-	374
Switzerland	-	-	75	-	75
Turkey	686	-	8,056	-	8,056
Ukraine	637	-	1,170	-	1,170
Total others	2,190	-	12,581	2	12,583

Total Europe	11,742	3,627	182,743	22,071	204,814
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6. All numbers are rounded and therefore may not add up

7. Cumulative capacity reflects decommissioning

1. WIND POWER INSTALLATIONS

1.1 OVERVIEW

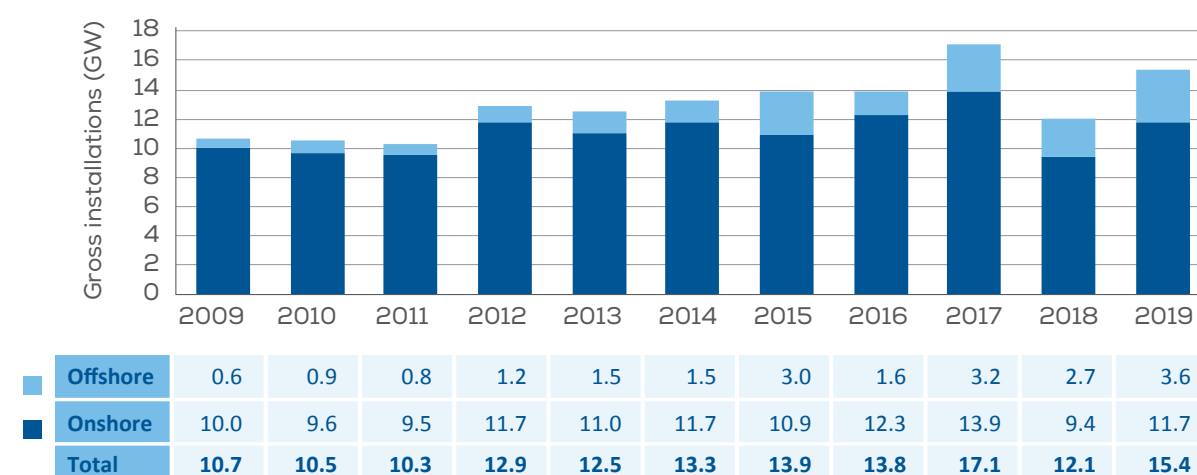
In 2019 new wind installations in Europe were 15.4 GW. This is up 27% of 2018 but 10% less than the record year of 2017. Onshore wind installations in Germany continue to fall. Installations in Spain and Sweden rose significantly. Onshore installations remained stable in France while installations in the UK rose due to offshore additions.

76% of the new installations (11.7 GW) were onshore wind. Spain, Sweden and France together accounted for 45% of these.

Offshore wind was 24% of the new installations, with a record 3.6 GW of new capacity connected to the grid in 2019. About half the offshore installations were in the UK, with the rest in Germany, Belgium, Denmark and Portugal.

New wind installations in the EU-28 were 13.2 GW. This represents 86% of installations in Europe. Installations rose in Norway, Turkey and Ukraine. Europe decommissioned 178 MW of wind capacity in 2019. So the net new installations were 15.2 GW.

FIGURE 2
New annual onshore and offshore wind installations in Europe



Source: WindEurope

1.2 NATIONAL BREAKDOWN OF 2019 INSTALLATIONS

The UK accounted for 16% of the new installations in Europe, more than any other European country. 74% was offshore, where in the UK installed a record 1.8 GW, half of all the European offshore installations. The Beatrice 2 wind farm was fully commissioned. Hornsea One connected all its turbines to the grid, making it the largest offshore wind farm in the world with 1,218 MW.

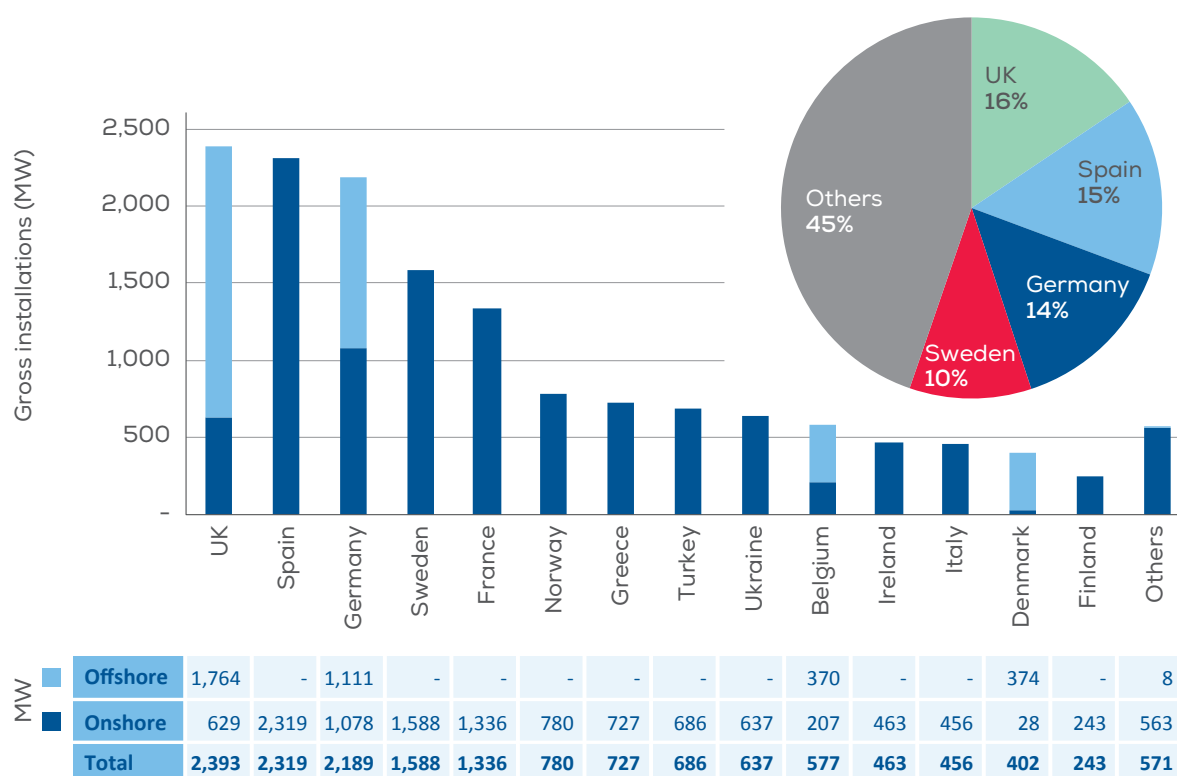
The UK connected 629 MW of onshore capacity, mostly in Scotland and Wales (434 MW and 167 MW respectively). Most of this capacity (595 MW) had been awarded Contracts for Difference (CfD) in Round 1 back in 2015. Today only remote onshore wind in the Scottish isles can participate in the CfD auctions. Projects in other areas rely on Power Purchase Agreements (PPAs) and other merchant options.

55% OF NEW WIND POWER

IN EUROPE WAS INSTALLED IN JUST 4 COUNTRIES: THE UK, SPAIN, GERMANY AND SWEDEN

Spain installed 2.3 GW of onshore wind⁸, 15% of all new wind capacity in Europe last year. This is its highest volume since 2009. Most of the installed capacity was awarded in the 2016 and 2017 auctions, when more than 4 GW of wind energy projects won. The remaining capacity from those auctions should be connected in 2020.

FIGURE 3
2019 new onshore and offshore wind installations in Europe



Source: WindEurope

8. Data for Spanish wind installations comes from Red Eléctrica España

Germany installed a mere 2.2 GW: 1.1 GW onshore and 1.1 GW offshore. Germany's onshore installations have fallen sharply in the last two years. Over 2014 to 2017 they were installing on average 4.6 GW of new onshore wind every year. The main problem is complex and lengthy permitting processes. Most of Germany's new onshore wind auctions in 2019 were undersubscribed because there weren't enough permitted projects. Out of the 3.7 GW of auctioned capacity, only 1.8 GW was awarded. So onshore installations are unlikely to pick up much in the short term. Germany connected 1.1 GW of offshore capacity across three wind farms: Merkur Offshore, Deutsche Bucht and EnBW Hohe See.

Sweden was the fourth-largest market with 10% of Europe's new installations. Sweden more than doubled its installations within a year – from 720 MW in 2018 to 1,588 MW in 2019. The strong onshore installations in Sweden are expected to remain high in the next couple of years, but as the joint Swedish-Norwegian electricity certificate is set to phase out after 2021 there is significant uncertainty for future installations. Given the decreasing value of the green certificates, projects that are being built will operate in a largely merchant environment.

France installed 1.3 GW, 9% of new installations in Europe. France was one of the four countries that installed more

than 1 GW of onshore wind in 2019. In France challenging weather conditions and administrative delays have slowed down the construction of new wind farms. But the industry is ready to deliver on the pace set out in France's Energy Plan.

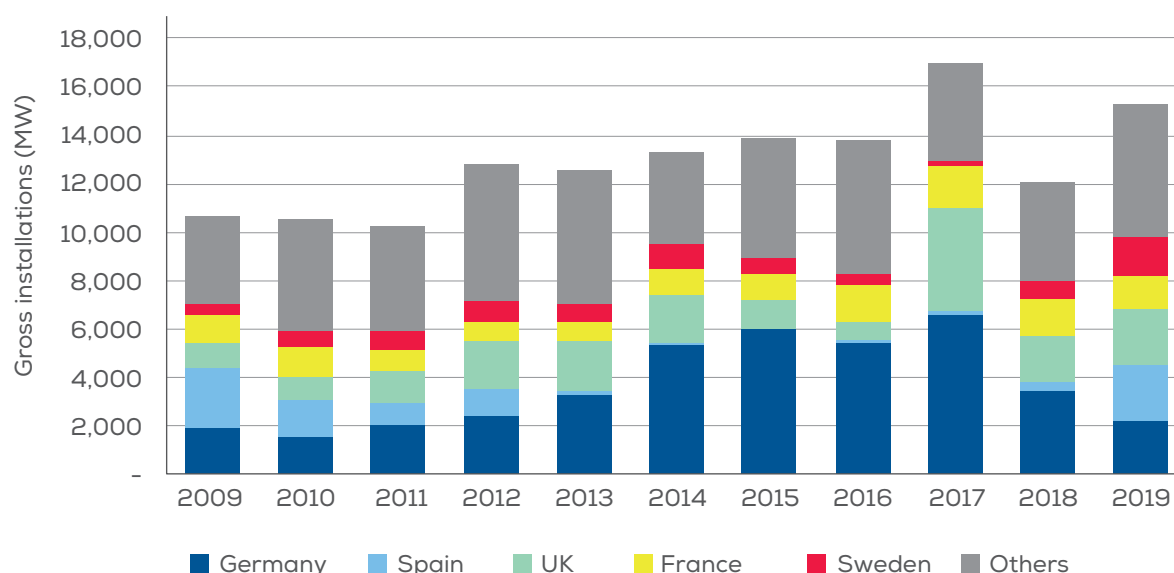
24% OF WIND INSTALLATIONS
IN 2019 CAME FROM OFFSHORE WIND

Installations in **Greece** (723 MW) were a record with a good outlook for the next couple of years. Ireland (463 MW) maintains its pace of new installation, while Italy (456 MW) remains a constrained market given the scale of both the size of the country and electricity demand.

Outside the EU, Norway, Turkey and Ukraine each installed between 600 and 800 MW.

14 countries did not have any wind installations in 2019. Nine of these were EU-28 Member States.

FIGURE 4
Distribution of the new wind installations in Europe



Source: WindEurope

1.3 CUMULATIVE WIND POWER INSTALLATIONS

205 GW of wind power capacity is now installed in Europe. 89% of this is onshore. 11% of it is offshore. Germany remains the country with the largest installed capacity in Europe, followed by Spain, the UK, France and Italy.

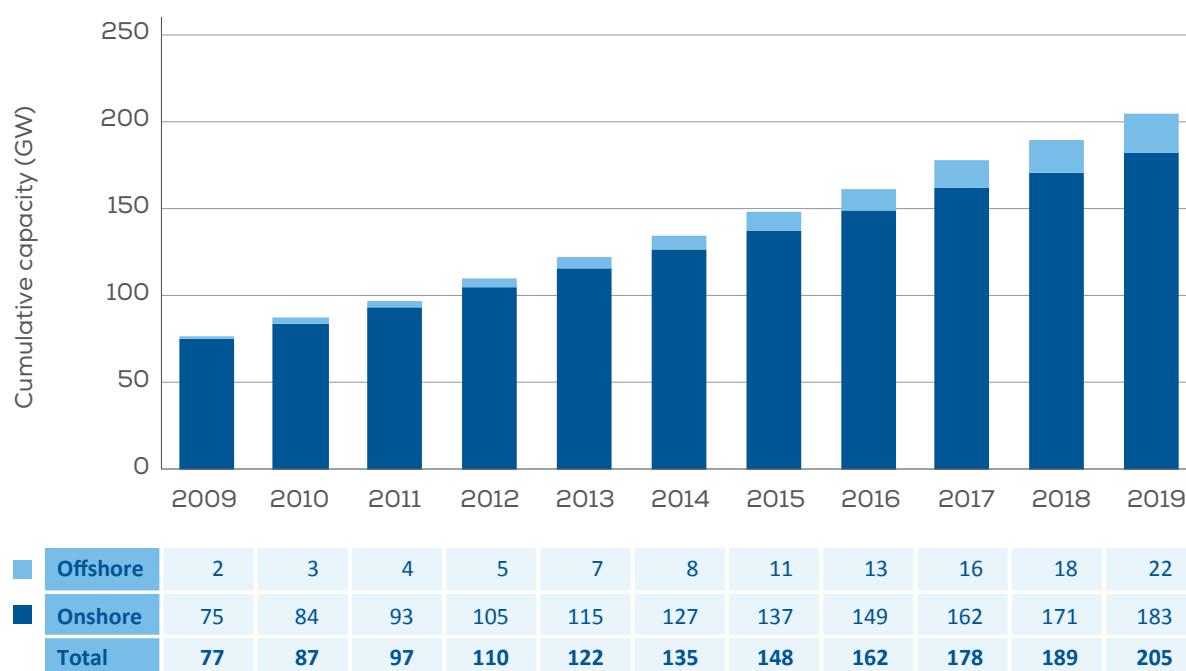
Five other countries (Sweden, Turkey, Denmark, Poland and Portugal) have more than 5 GW installed. Five more countries have over 3 GW of installed capacity: the Netherlands, Ireland, Belgium, Austria and Romania.

205 GW
OF WIND POWER ARE NOW INSTALLED
IN EUROPE

In the EU-28 installed capacity reached 192 GW. EU-27 now have 169 GW of installed wind capacity.

FIGURE 5

Total installed wind power capacity in Europe

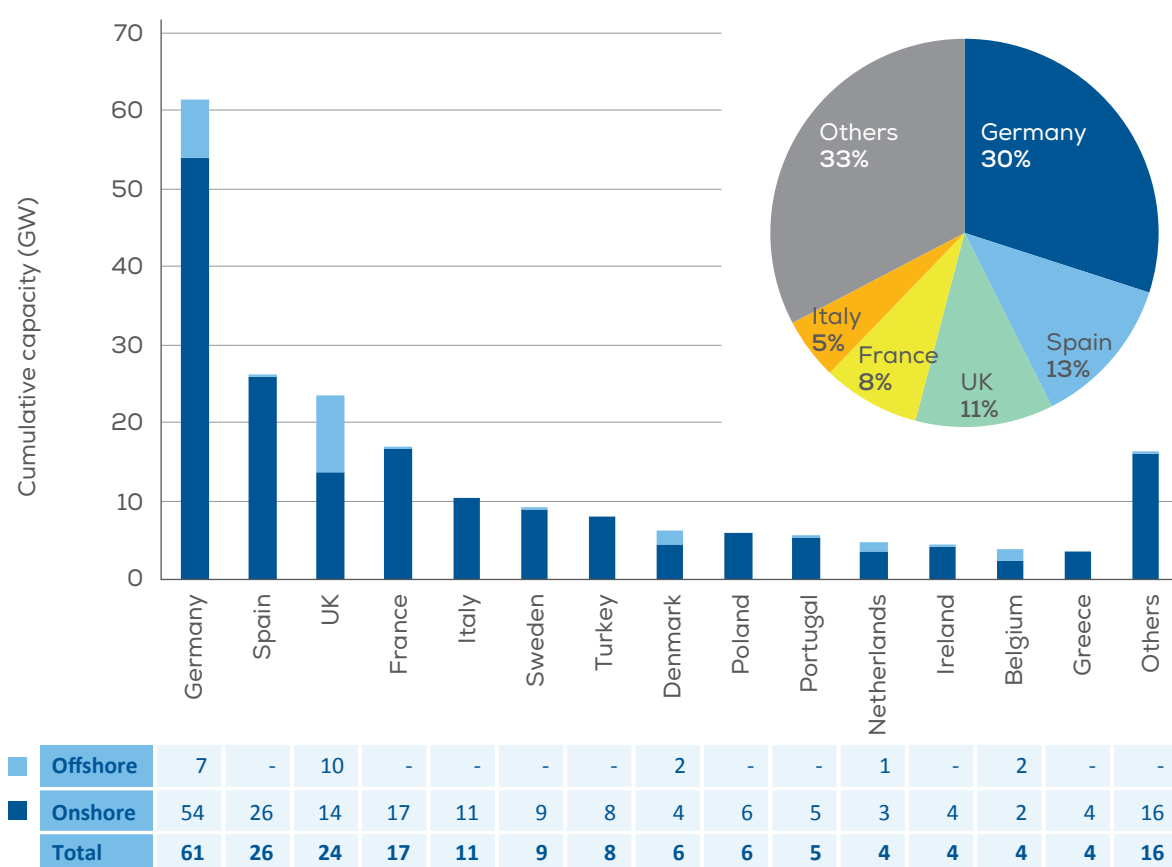


Source: WindEurope

67% of all wind power capacity in Europe is in 5 countries: Germany (61 GW), Spain (26 GW), the UK (24 GW), France (17 GW), and Italy (11 GW). Sweden, Turkey and Poland follow with 9 GW, 8 GW and 6 GW respectively.

67% OF WIND POWER
IN EUROPE IS IN 5 COUNTRIES

FIGURE 6
Total installed wind power capacity by country



Source: WindEurope

1.4 DECOMMISSIONING AND REPOWERING OF WIND FARMS

In 2019 only 178 MW of wind power was decommissioned, down from 451 MW in 2018. Germany decommissioned 97 MW, Austria 32 MW, Denmark 32 MW, the UK

17 MW and France 0.2 MW. Nearly all of the decommissioned capacity was onshore (174 MW) and 4 MW were offshore.

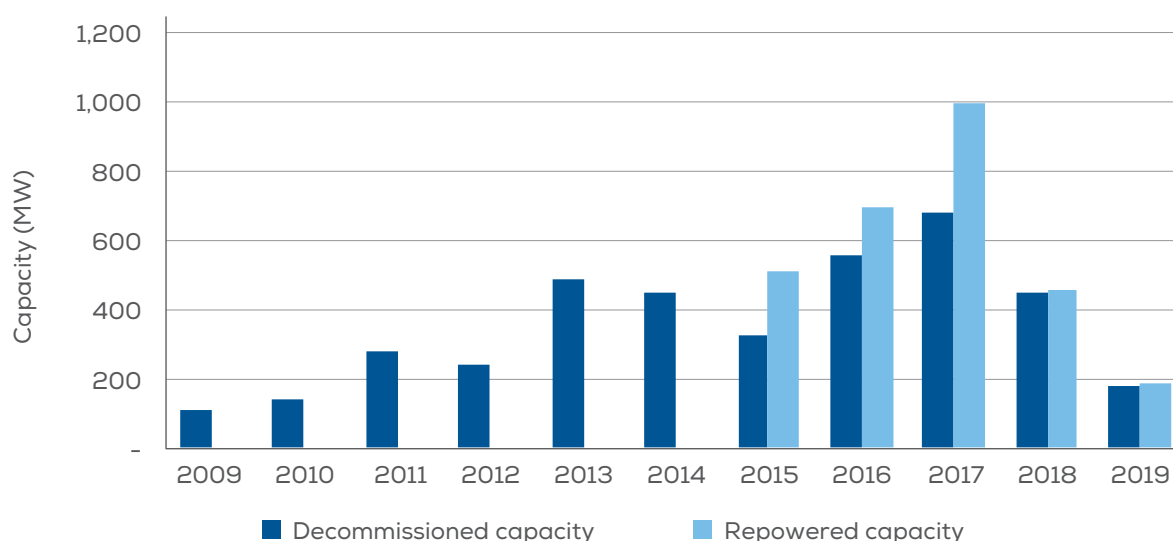
178 MW

OF WIND POWER WERE DECOMMISSIONED IN 2019. 185 MW OF REPOWERED CAPACITY CAME ON LINE.

Of the 11.7 GW of new onshore wind installed in 2019, only 185 MW were repowering projects. This comes from projects decommissioned in 2018 and 2019. The majority came from Germany, but there was also repowering in Austria, Greece and the UK. Lack of regulatory support, complex permitting rules and high wholesale electricity prices were the main reasons for low market activity in decommissioning and repowering.

FIGURE 7

Decommissioned and repowered capacity



Repowering terminology Example - Tauerwindpark (Austria)			
Old project		New project	
Number of turbines	13	Number of turbines	9
Turbine power rating	1.8	Turbine power rating	3.5
Capacity under repowering	23	Repowered capacity	31

Decommissioned capacity = Capacity under repowering + Fully decommissioned capacity

Source: WindEurope

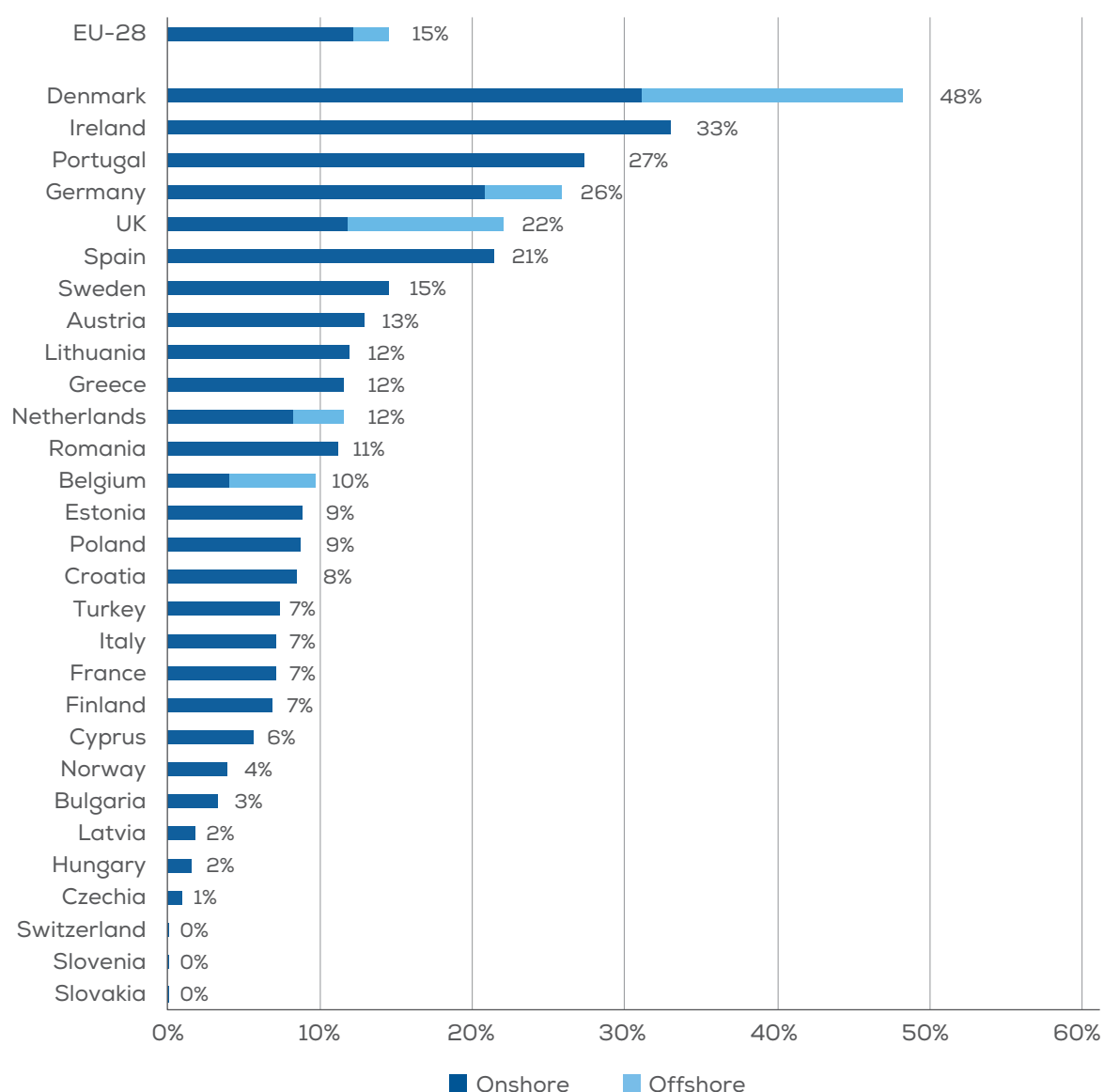
1.5 WIND POWER GENERATION

In 2019 wind energy generated enough electricity to meet 15% of the EU's electricity demand⁹. This is one percentage point higher than 2018 and results from the new installations as well as windy conditions around Europe throughout 2019¹⁰.

Denmark had the highest share of wind in its electricity mix (48%), followed by Ireland (33%), Portugal (27%) and Germany (26%). 12 Member States had a wind share above 10%.

FIGURE 8

Percentage of the electricity demand covered by wind in 2019¹¹



Source: WindEurope

9. At time of publication, generation data for Luxembourg and Malta was not available (their combined demand represents less than 1% of EU demand).
10. Data from ENTSO-E transparency platform. It excludes data for Luxembourg and Malta. Data for the UK comes from BEIS quarterly reports (estimated for Q4 2019). Data for Croatia comes from the Croatian Energy Market Operator (HROTE). Data for Turkey comes from the Turkish Wind Energy Association.
11. The figures represent the average of the share of wind in final electricity demand, captured hourly from ENTSO-E and corrected thanks to national TSOs and government data. Data is not available from all European countries.

TABLE 3

Electricity production from wind power (TWh)

EU ELECTRICITY CONSUMPTION (TWH) ¹²	ONSHORE WIND ENERGY PRODUCTION (TWH)	OFFSHORE WIND ENERGY PRODUCTION (TWH)	TOTAL WIND ENERGY PRODUCTION (TWH)	SHARE OF EU CONSUMPTION MET BY WIND ENERGY
2,900	350	67	417	15%

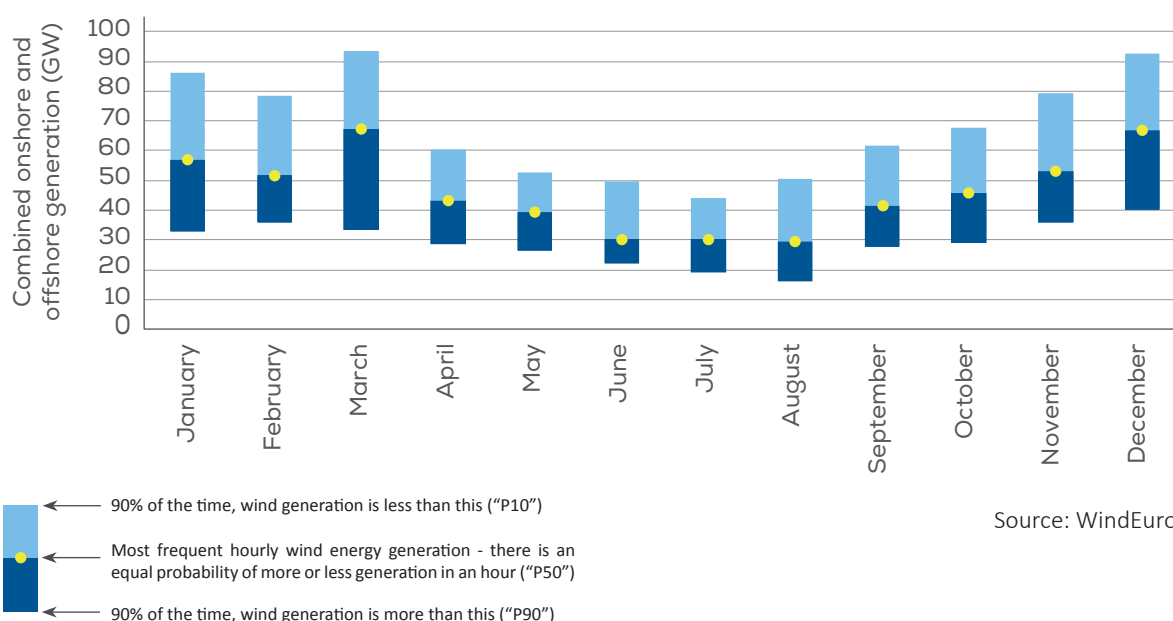
Europe's wind farms produced a stable output throughout the year with a daily peak production¹³ of 102 GW registered on 13 March.

Capacity factors of the EU's fleet of wind farms were on average 26%. Average capacity factors for onshore wind were 24% and for offshore wind were 38%. These numbers are relatively low as they represent the performance of the

entire wind fleet, including very old wind farms. The latter tend to have turbines with relatively small rotors (short blades). Modern turbines have larger blades and can generate power at lower wind speeds, increasing their capacity factors. Capacity factors for new onshore wind farms are 30-35%. For new offshore wind farms they range between 35% and 55%¹⁴.

FIGURE 9

Spread of the hourly electricity demand covered by wind



Source: WindEurope

Wind energy production is variable. The hourly variability follows a clear pattern throughout the year. Figure 9 shows the range of the hourly electricity generation from wind energy in each month during 2019. March was the month with the highest average hourly generation. 90% of the time in March wind energy generated more than 34 GW of electricity an hour in the EU.

Over June to August the amount of electricity produced by wind energy was lower (shown by the size of the boxes above). Wind energy generation peaked in the winter months, although in the winter the variation in hourly generation is also higher than in summer.

12. See footnote 7.

13. Average hourly power output during one full day

14. See Analysis of individual offshore wind farms by Energy Numbers.info (February 2020)

EUROPEAN WIND ENERGY GENERATION | 2019

15%

of EU's electricity demand

26%

Average capacity factor

48% 33% 27% 26% 22%



Highest wind energy shares

ONSHORE

170 GW

onshore wind capacity

12.2%

onshore wind in EU's
electricity demand

24%

average onshore wind
capacity factor

OFFSHORE

22 GW

offshore wind capacity

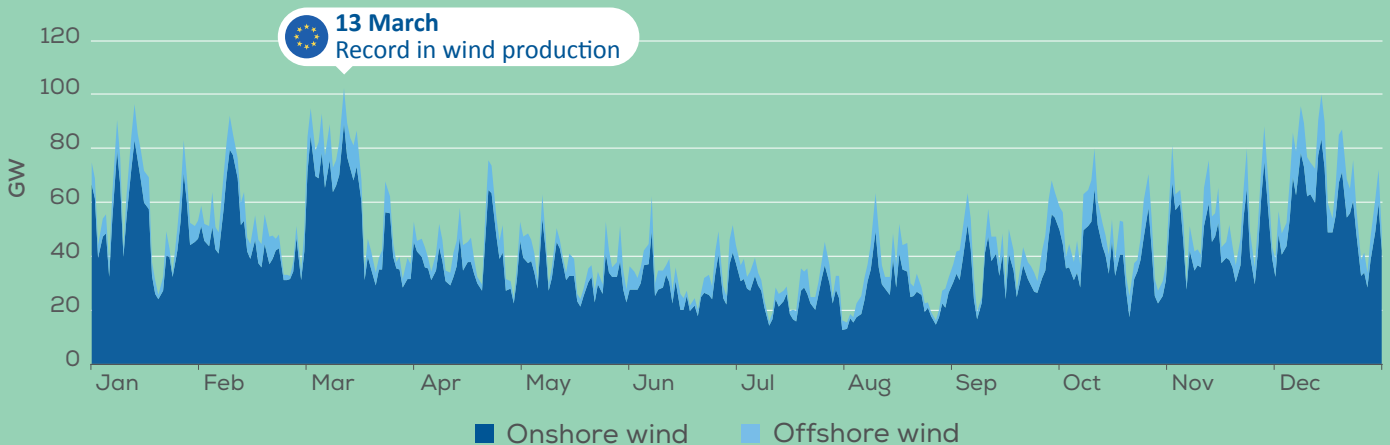
2.3%

offshore wind in EU's
electricity demand

38%

average offshore wind
capacity factor

European wind energy generation in 2019



Data refers to EU Member States only

1.6 WIND TURBINE SIZE

The size and type of wind turbines installed in Europe varied significantly between countries. On average, the most powerful onshore wind turbines were installed in Finland, with an average rating of 4.3 MW. Greece had the lowest average power rating, at 2.3 MW. Based on the available data from 14 countries, the weighted average power rating of onshore turbines was 3.1 MW.

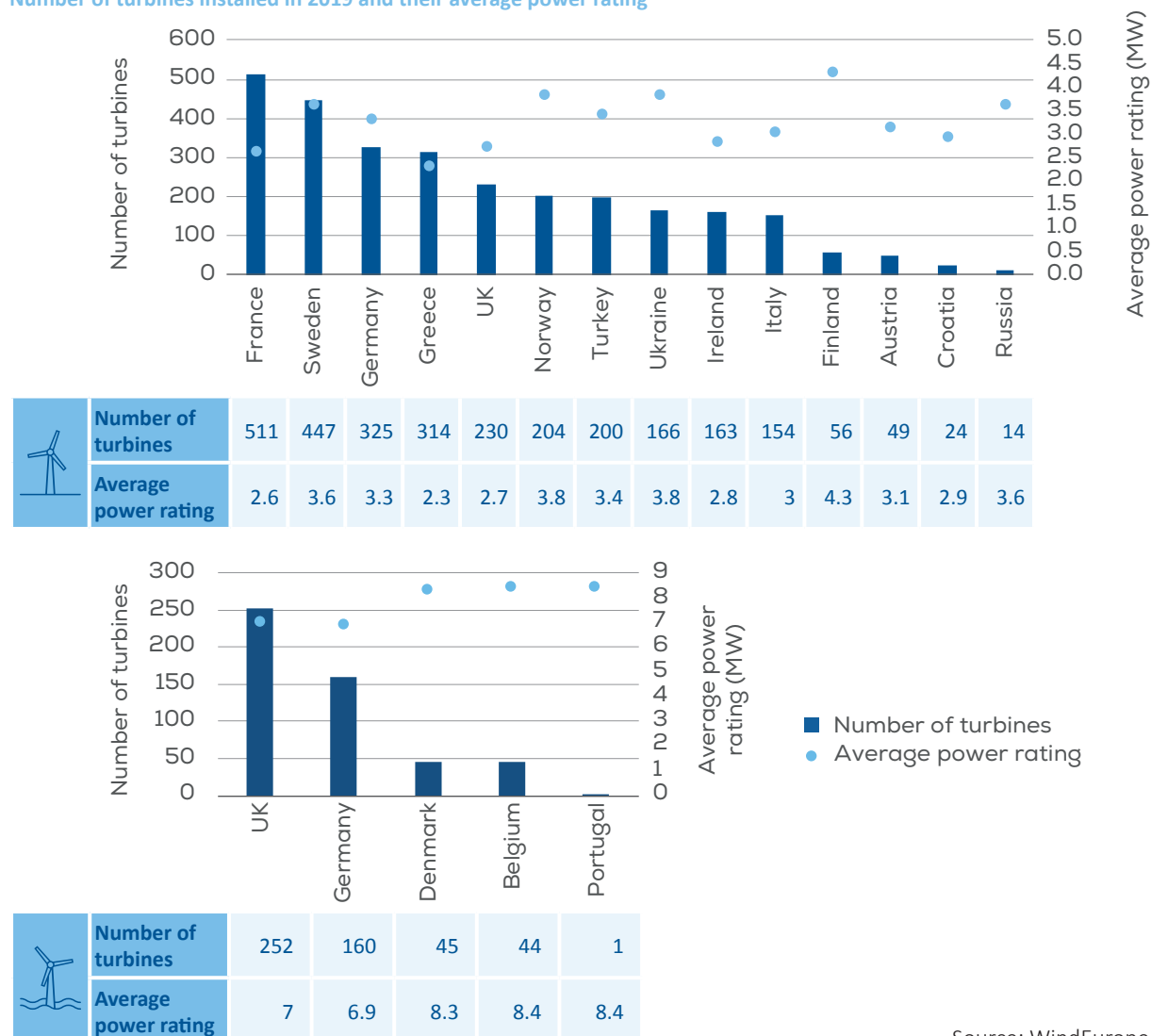
In 2019 the average rated capacity of newly installed offshore turbines was 7.2 MW, up from 6.8 MW in 2018. Belgium and Portugal had the highest average power rating

of 8.4 MW. The V164-8.4 MW from MHI Vestas Offshore Wind, with a rotor diameter of 164m, was installed in Deutsche Bucht (Germany) and North Sea (Belgium). In Portugal the V164-8.4 MW was used at the Windfloat Atlantic floating offshore wind farm.

The largest turbine in the world is GE's Haliade-X, the industry's first 12 MW turbine. The first prototype was installed at the Port of Rotterdam in 2019 (onshore) for testing. Its commercialisation is expected in 2021.

FIGURE 10

Number of turbines installed in 2019 and their average power rating



Source: WindEurope

1.7 AUCTIONS AND TENDERS IN 2019

In 2019 11 countries held renewable energy auctions in which wind energy won, and the total new wind volumes secured were 15.4 GW. Onshore wind secured 8.6 GW and offshore 6.8 GW. It is hard to compare auction results between different countries due to differences between support mechanisms and their length, as well as the maturity of markets, and conditions surrounding the auctions such as cost of capital (WACC), permitting and other sources of revenue or risks for developers.

Nevertheless, several auction results were notable: Poland held Europe's largest onshore wind auction, awarding 2.2 GW of capacity at an average price of €49/MWh. In the UK the latest auction round awarded more than 5.7 GW,

with 5.5 GW of offshore capacity at an average price of £40.63/MWh (€46.16/MWh)¹⁵ including grid-connection.



In Germany five out of the six onshore wind auctions held in 2019 were undersubscribed. Only 1.8 GW out of the offered 3.7 GW were awarded due to difficulties faced by project promoters to gather all the necessary permits.


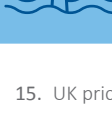
15 GW

WAS AWARDED TO WIND THROUGH AUCTIONS AND TENDERS IN 2019

TABLE 4

Successful auctions and tenders for wind energy in 2019

	Country	MW AWARDED	TYPE OF AUCTION	SUPPORT MECHANISM ¹⁶	PRICE IN €/MWH
	Denmark	135	Technology-neutral	Feed-in-premium (fixed)	1.34 – 2.64 ¹⁷
	France	516	Technology-specific	Feed-in-premium (floating)	63
		576	Technology-specific	Feed-in-premium (floating)	66,5
	Germany	476	Technology-specific	Feed-in-premium (floating)	52.4 – 62
		270	Technology-specific	Feed-in-premium (floating)	54 – 62
		208	Technology-specific	Feed-in-premium (floating)	61.9 – 62
		176	Technology-specific	Feed-in-premium (floating)	61.9 – 62
		204	Technology-specific	Feed-in-premium (floating)	61.9 – 62
		509	Technology-specific	Feed-in-premium (floating)	57.4 – 61.8
	Greece	180	Technology-specific	Feed-in-premium (floating)	59.1 – 69.2
		67	Technology-neutral	Feed-in-premium (floating)	60
		224	Technology-specific	Feed-in-premium (floating)	55.8 – 61.9
	Italy	495	Technology-neutral	Contract for difference	48.6 – 66.5
	Lithuania	75	Technology-neutral	Feed-in-premium (fixed)	0
	Netherlands	143	Technology-neutral	Feed-in-premium (floating)	Not Available
		640	Technology-neutral	Feed-in-premium (floating)	Not Available
	Poland	2,200	Technology-neutral	Contract for difference	37.7 – 53.9
	Spain	217	Technology-specific	CAPEX discount	Not Available
	Turkey	1,000	Technology-specific	Feed-in-Tariff	31 – 40 ¹⁸
	UK	275	Technology-specific	Contract for difference	43.8 – 46

	Country	MW AWARDED	TYPE OF AUCTION	SUPPORT MECHANISM	PRICE IN €/MWH
	France	600	Technology-specific	Contract for difference	44
	Netherlands	760	Technology-specific	Zero-subsidy bid	0
	UK	5,466	Technology-specific	Contract for difference	43.8 – 46

15. UK prices are 2012 indexed

16. For an explanation between the different types of auctions see Annex 1.

17. The price reflects the premium on top of the wholesale electricity price in Denmark, while other countries with a feed-in-premium (floating) already include the wholesale electricity price.

18. Because of the Local Content Rule in Turkey, low revenue can be compensated with local content price premiums.



Photo: Jason Bickley

2.

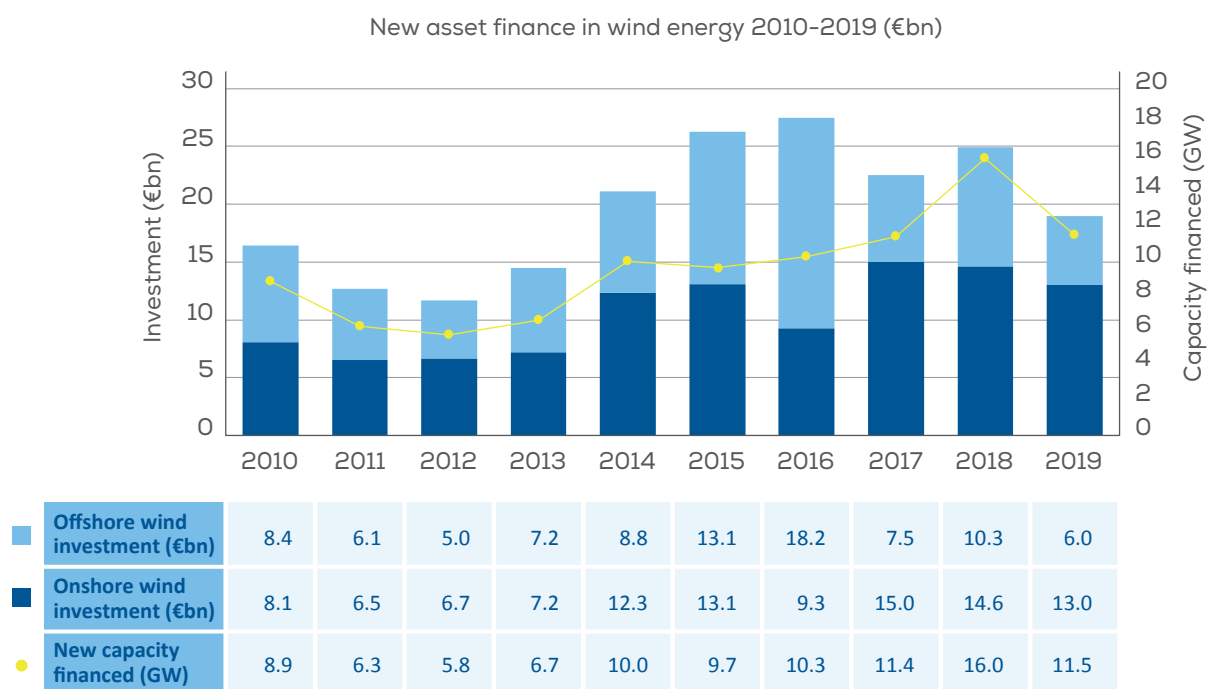
INVESTMENT NUMBERS IN 2019

Investments in new wind farms in 2019 were €19bn, a 24% drop on 2018. 11.5 GW of new wind projects reached Final Investment Decision (FID): 10.1 GW in onshore wind and 1.4 GW in offshore wind. This represents the second largest amount of capacity financed in a year, albeit significantly less than the record 16 GW in 2018.

In monetary terms investments were at their lowest since 2013. The €6bn in offshore wind energy investments (€5.5bn for bottom-fix and €0.5bn for floating) was the lowest amount in the last 6 years. However, onshore investments were solid at €13bn. Cost reductions across the industry's value chain and increased industry competition have made it possible for investors to finance more capacity for less cash.

FIGURE 11

New asset finance in wind energy 2010 – 2019¹⁹



Source: WindEurope

19. Figures include only new asset financing. Project refinancing and public markets are not included in the investment activity. 2018 onshore investments and capacity financed restated.

The geographical spread of investments was similar to 2018, with the top 3 investor countries contributing 44% of FID announcements. This compares to 43%, 64% and 73% in 2018, 2017 and in 2016 respectively.

Spain led the way with investments in new wind energy assets in 2019 generating total financing activity of €2.8bn, supporting the construction of 2.8 GW of new onshore wind farms.

France was the largest investor in offshore wind in 2019, with €2.4bn for the finance of a single offshore wind farm, EDF's 480 MW Saint-Naizaire. The UK was the second largest investor in offshore wind, raising €2.3bn for the

financing of the Neart na Gaoithe wind farm, also to be developed by EDF.

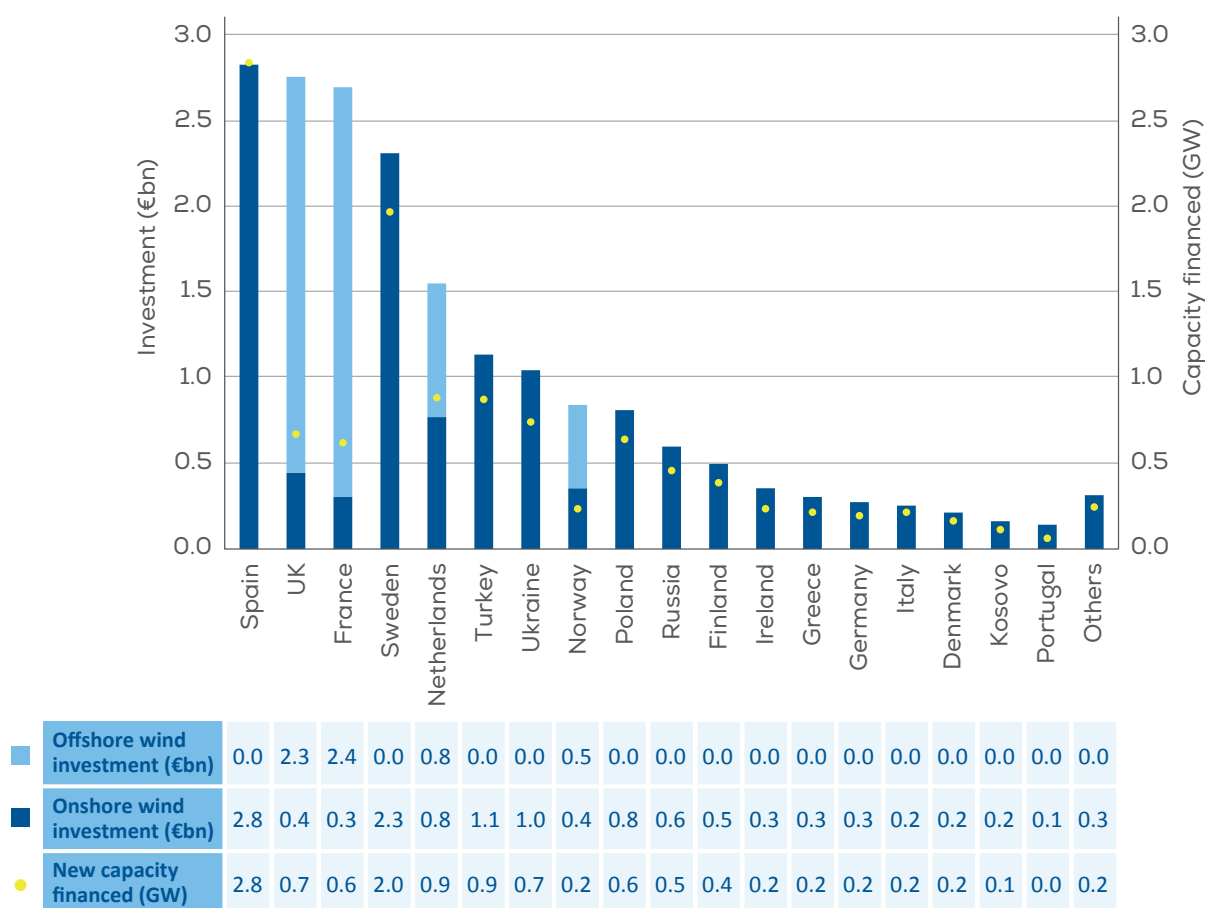
Sweden raised €2.3bn for the construction of 2 GW of onshore wind farms.

Investment in Germany reached a record low of €300m, raising capital for a mere 180 MW of onshore wind projects.

Investments in non-EU countries totalled €3.9bn, representing 21% of total investments. Outside the EU, Turkey, Norway and Ukraine led the investments, mostly in onshore wind.

FIGURE 11

New asset financing in 2019 by country (€bn and GW)



Source: WindEurope

ANNEX 1

TABLE 5

SUPPORT MECHANISM	DESCRIPTION
Feed-in-Tariffs	A type of price-based policy instrument whereby 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 whereby 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 whereby 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 guaranteed price. Effectively it works as a floor price, guarantees always 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 is 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.

WindEurope is the voice of the wind industry, actively promoting wind power in Europe and worldwide. It has over 400 members with headquarters in more than 35 countries, including the leading wind turbine manufacturers, component suppliers, research institutes, national wind energy associations, developers, contractors, electricity providers, financial institutions, insurance companies and consultants. This combined strength makes WindEurope Europe's largest and most powerful wind energy network.



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