Wind offshore fundations installation, Belfast, Ireland.

379.3 TWh

The estimated electricity production from wind power in the EU in 2018

WIND ENERGY BAROMETER

A study carried out by EurObserv'ER.

EurObserv'ER

Data released by the GWEC shows that newly-installed capacity across the globe slipped slightly (by 3.6%) in 2018 with 51.3 GW compared to 53.2 GW in 2017. This additional capacity takes total wind turbine capacity to 591 GW at the end of 2018, including 23 GW of offshore capacity. The most recent drop in the global installation figure – the third in succession – can be put down to significant contraction in the European and Indian markets that was not entirely offset by the return to growth of the Chinese and United States markets.

591 GW

Worldwide installed wind power capacity at the end of 2018

10.1 GW

Wind power capacity installed in the EU during 2018

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Dali Zhemoshan wind plant, China
DR

INSTALLED CAPACITY ACROSS THE WORLD NEARS THE 600 GW MARK

The first Global Wind Energy Council (GWEC) data, published on 26 February, reports that the global wind energy industry installed 51.3 GW of additional onshore and offshore wind turbine capacity across all 5 continents, which is just 3.6% less than its 2017 installation figure (53.2 GW). The GWEC claims that the additional capacity installed by the end of 2018 raised the total to 591 GW. This capacity potentially corresponds to global output of about 1 182 TWh (a conservative assumption of an average load factor of 23%) which is about 4.7% of global electricity output (calculated on a 25 000 TWh base).
The GWEC attributes most of this contraction to the slowdown to two markets – Europe (with 4.6 GW less, i.e. 11 7 GW installed) and India (dropping by 1.9 GW to 2.2 GW). The drop was partly offset by the return to growth of the Chinese market (which added 2.7 GW to achieve 23 GW) and United States market (which added 0.6 GW to achieve 7.6 GW), and by the gradual pick-up of the Mexican, African and other South-East Asian markets. It forecasts an annually rising global market of up to 55 GW or more until at least 2023. The Council expects installation volumes in Europe and the United States to be stable, contrasted by significant growth levels in the South-East Asian and offshore wind energy markets. It puts the offshore market installation level in 2018 is 4.49 GW, which is an increase of 0.5%. This takes global installed offshore capacity to 23 GW. The Council points out that China is now the leading offshore wind energy market, with 1.8 GW, ahead of the UK and Germany. The GWEC feels that Asia is on course to become the main offshore installation area shortly with an annual market volume put at 5 GW.

WIND ENERGY COVERED 5.2% OF CHINESE ELECTRICITY OUTPUT IN 2018

The GWEC data corresponds to the market and installed capacity and therefore differs slightly from the connection figures published by the official agencies. According to the National Energy Administration (NEA), China actually connected 20.59 GW of additional wind turbine capacity to its grid in 2018, taking the country's capacity to date to 184 GW. The NEA also claims that wind energy now accounts for 9.7% of the country's electricity generating capacity. The NEA puts wind energy output at 366 TWh, or 5.2% of the country's electricity output (0.4 percentage points more than in 2017). The 2018 installation level eclipsed the previous year's effort (15.03 GW) and is even higher than its 2016 level (19.3 GW), yet is lower than its 2015 record level (32.97 GW). The Chinese government is focussed on optimizing its new installations on the basis of its grid infrastructure integration capacities. Thus, its policy is starting to produce results by restricting the amount of capacity installed in its north-eastern and north-western regions that were marked by heavy production wastage. According to Li Chuangjun, deputy director of the NEA's renewable energy section, the percentage of wind power generated but unused dropped to 7% in 2018 (i.e. 27.7 TWh wasted). The figure is 5 percentage points lower than in 2017 when wind energy wastage amounted to 41.9 TWh, or 12.1% of the year's output.
China also announced that it was rolling out its first pilot subsidy-free wind and solar power projects. The National Development and Reform Commission (NDRC) claims that the electricity prices of these installations will match or be lower than those charged by coal-fired power plants. These subsidy-free plants will take up long-term fixed feed-in tariffs and will not have to trade on the electricity market. The NEA points out that the development of these pilot plants does not mean that national subsidies for all new wind and solar power projects are about to be abandoned. During the current phase, the regions that enjoy the best resources and guaranteed energy consumption will trial these pilot projects, while the other regions will continue to resort to auctioning to reduce prices and subsidy costs.

Tabl. n° 1

Wind power capacity installed* in the European Union at the end of 2018 (MW)

	2017	2018	Installed 2018	Decommissionning
Germany	55 719	58 908	3 374	185
Spain	23 100	23 494	394	
United Kingdom	19 835	21 243	1 407	
France*	13 550	15 108	1 558	
Italy	9 766	10 300	549	15
Sweden	6 611	7 407	809	13
Poland	5 848	5 864	16	
Denmark	5 486	6 131	657	13
Portugal	5 313	5 380	67	
Netherlands	4 202	4 292	162	72
Ireland	3 318	3 564	246	
Romania	3 030	3 030	0	
Austria	2 887	3 045	187	29
Belgium	2 806	3 191	385	
Greece	2 624	2 844	235	15
Finland	2 044	2 041	0	3
Bulgaria	698	698	0	
Croatia	576	576	0	
Lithuania	518	521	3	
Hungary	329	329	0	
Estonia	312	312	0	
Czechia	308	310	1	
Cyprus	158	158	0	
Luxembourg	120	120	0	
Latvia	77	77	0	
Slovenia	5	5	0	
Slovakia	4	4	0	
Malta	0	0	0	
Total EU 28	**169 244**	**178 950**	**10 051**	**345**

Overseas departments are not included.* ***Sources: EurObserv'ER 2019*

THE USA HAS 100 GW IN ITS SIGHTS

The US wind energy sector has returned to growth. Data released by AWEA (the American Wind Energy Association), shows that the USA installed 7 588 MW of wind turbine capacity in 2018 (7 016 MW in 2017), equating to year-on-year growth of 8.2%, and takes its capacity to date to 96 488 MW. The AWEA is confident about the sector's prospects for the next few years, as at the end of 2018 the USA had some 16 521 MW of projects under construction and 18 574 MW approaching launch, giving a total of 35 095 MW to be installed in the near future. Another trend that has taken hold, is that Power Purchase Agreements (PPAs) are gathering strength. This type of contract signed between an electricity supplier and an independent electricity producer, enables the latter to guarantee its wind farm's profitability by ensuring that there is an outlet for its output at a pre-set price. According to the AWEA, project developers claim to have finalized feed-in tariff contracts for 8 507 MW in 2018. Furthermore, the renovation or "repowering" market is also booming, covering 1 344 MW of capacity (1 237 MW

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in partial renovation and 107 MW of wind turbine replacement). The repowering market entails replacing all or part of a wind turbine (e.g.: replacing the rotor) to increase its capacity and improve yield. Repowering can increase a site's electricity output, reduce its costs and also continue to harness wind energy in areas with the best wind resources.

SHARP DROP IN NEW INSTALLATIONS IN THE EU

The EurObserv'ER indicators also differ slightly from those published by the GWEC and WindEurope, because of the methodology used. EurObserv'ER prefers to use the on-grid capacity data provided by the ministries, statistical offices, national energy agencies or grid operators, and only supplements them with data produced by national wind energy industry associations or guilds in the absence of any other information channels (sources listed at the end of this barometer).
According to EurObserv'ER, after rising to a record level in 2017, newly-installed wind turbine capacity in the European Union, dropped sharply in 2018. It was put at 9 706 MW in 2018 (i.e. the figure left after subtracting 345 MW of decommissioned wind turbines from the 10 051 MW of newly-installed capacity), compared to a 14 783 MW capacity increase in 2017. The European wind energy base now stands at 178 950 MW **(see table 1)**, with output of 379.3 TWh **(see table 3).** The 2018 figures have yet to be firmed up and should improve slightly Publication of the 4th quarter installation data of the UK's figure is awaited in particular, as the BEIS (Department for Business, Energy & Industrial Strategy) estimates were unavailable at the end of February. EurObserv'ER reckons that the 10 GW threshold of additional capacity should be exceeded but the figure will be lower than in 2013 (10 969.3 MW).
Much of this slowdown can be attributed to the contraction of the European Union's top three markets' installation levels – Germany (3 189 MW, 48% down on 2017), the UK (1 407 MW, 61.6% less, interim 3rd quarter figure) and France (1 558 MW, with 23.6% less). However, this contraction has not spread to all the Member States. In fact, many Western and Northern European countries have returned with new vigour and some of them have achieved triple-digit growth rates. Examples of this are Sweden (796 MW of additional capacity, 349.7% growth), Denmark (645 MW of additional capacity, 168% growth), and Spain (336 MW of additional capacity, 258.2% growth). Italy also put in a good performance with double-digit growth (534 MW of additional capacity, 39.8% growth). These positive trends contrast starkly with many countries' sluggish markets – half the European Union Member States – where business is about to stall or has been at a standstill for many years. Some of them have already made (or are very close to) their European renewable energy targets for 2020.

LESS OFFSHORE CAPACITY CONNECTED

Offshore wind energy development also contracted in 2018. EurObserv'ER's calculations are based on the preliminary official data available (BEIS, AGEE-Stat, ENS, CBS, etc.), which show that the European Union's net offshore wind turbine capacity increased by 2 667.7 MW in 2018, equating to a 27.5% share of its combined newly-connected capacity (onshore and offshore). The additional offshore capacity was 3 200.6 MW in 2017, which equates to a 21.6% share **(table 3)**. However, the 2018 figure is an estimate that should be consolidated within the next few weeks, primarily when the BEIS publishes its Q4 data. Europe's offshore capacity base to date is now at least 18 461.3 MW, broken down as in **table 2** (including French and Spanish pilot sites), which amounts to 16.9% year-on-year growth. Once again, the UK and Germany led the offshore installation scene. According to WindEurope, six wind farms were fully connected to the UK grid, and a 7th partially, so the fully-connected wind farms include the extensions to Walney Phase 3 (329 MW) and West Phase (66 MW), Galloper (277.2 MW), Rampion (220.8 MW), Race Bank (50.4 MW) and EOWDC (93.2 MW), to which should be added the partial connection of the Beatrice 2 wind farm (273 MW). The UK also connected "Kincardine", a pilot floating wind turbine off the Scottish coast.
Germany followed the UK, according to preliminary data from AGEE-Stat, the Federal Ministry for Economics Affairs and Energy's Working Group on Renewable Energy Statistics, by connecting 978 MW of capacity in 2018, which raises the capacity of the German offshore wind farm base to 6 405 MW. The additional capacity derives from full or partial commissioning of the North Sea wind farms Borkum Riffgrund 2 (450 MW) and Merkur (396 MW), and the Baltic Sea wind farms Winkinger (350 MW) and Arkona (384 MW). The capacities stated in brackets are the wind farms' total capacities, not the additional capacity connected to the grid.

Tabl. n° 2

Installed offshore wind power capacities in European Union at the end of 2018 (MW)

	2017	2018
United Kingdom	6 987.9	7 940.0
Germany	5 427.0	6 405.0
Denmark	1 263.8	1 700.8
Belgium	877.2	1 178.0
Netherlands	957.0	957.0
Sweden	203.0	195.8
Finland	72.7	72.7
Spain	5.0	10.0
France	0.0	2.0
Total EU 28	15 793.6	18 461.3

Source: EurObserv'ER 2019

Denmark came third in the running for installations, according to the Danish Energy Agency, by connecting 437 MW in 2018. The country now has a 1 700.8 MW offshore base, primarily since the Horns Rev 3 wind farm (407 MW) came on stream. Belgium the connected the Rentel Wind Farm (309 MW), and we should mention the connection of a second pilot offshore wind farm (Elican Project, 5 MW), off the Canary Islands (Spain) and the connection of a floating wind farm off France (Floatgen project, 2 MW) and a 200 kW prototype, i.e. 1/10 of the Eolink project.
While Sweden did not connect new offshore wind turbines, it increased the capacity of its Bockstigen Wind Farm by 3.3 MW, by installing more powerful rotors and blades on five of its turbines (resulting in additional per turbine capacity of 500–650 kW). It also decommissioned seven of the Utgrunden I Wind Farm's turbines, losing 10.5 MW of capacity.
Looking to future schemes, WindEurope has listed twelve projects worth about 10.3 billion euros that are awaiting final investment decisions. The figure is higher than the 2017 figure (7.5 billion euros) and is for an installation volume of around 4.2 GW due to be connected in the next few years, with 95% concentrated in four countries: the UK, Belgium, Denmark and the Netherlands. The list of financed projects includes Triton Knoll and Moray East for the UK (totalling 1.8 GW between

Tabl. n° 3

Electricity production from wind power in European Union in 2017 et 2018 (TWh)

	2017	Of which offshore	2018	Of which offshore
Germany	105.693	17.675	111.590	19.341
United Kingdom	50.004	20.916	55.802	25.503
Spain	49.127		50.787	
France	24.711		27.900	
Italy	17.742		17.492	
Sweden	17.609	0.670	16.716	0.636
Poland	14.909		15.000	
Denmark	14.772	5.180	13.892	4.630
Portugal	12.248		12.657	
Netherlands	10.569	3.700	10.549	3.630
Ireland	7.445		7.500	
Romania	7.407		7.410	
Austria	6.574		6.700	
Belgium	6.511	2.645	6.418	3.311
Finland	4.795	0.109	5.857	0.244
Greece	5.537		5.800	
Bulgaria	1.504		1.600	
Lithuania	1.364		1.400	
Croatia	1.204		1.334	
Hungary	0.758		0.800	
Estonia	0.723		0.800	
Czechia	0.591		0.615	
Luxembourg	0.235		0.268	
Cyprus	0.211		0.220	
Latvia	0.150		0.150	
Slovakia	0.006		0.006	
Slovenia	0.006		0.006	
Malta	0.000		0.000	
Total EU 28	362.404	50.894	379.270	57.295

Source: EurObserv'ER 2019

Offshore wind plant, Lillgrund, south of Sweden.

the two of them), as well as Kriegers Flak (606 MW) off Denmark and Seamade (487 MW) off Belgium.

EU WIND ENERGY OUTPUT RISES TO 379.3 TWH

Although the weather conditions of some countries essentially in Northern Europe were not as good as in 2017, wind energy output across the EU continued to rise. According to EurObserv'ER, wind power output should reach 379.3 TWh, which is 16.9 TWh more than in 2017 (a 4.7% rise). Growth was particularly driven by offshore wind energy, which according to preliminary estimates, should come to 57.3 TWh (12.6% more than in 2017). The offshore wind energy share of total wind energy output increased from 14% in 2017 to 15.1% in 2018. The three countries that contributed the most to this increased output are Germany with an additional 5.9 TWh (a total of 111.6 TWh in 2018), the UK (which added 5.8 TWh, for a total of 55.8 TWh) and France (which added 3.1 TWh, for a total of 27.8 TWh). The UK's offshore installations generate 45.7% of its wind power output. The wind energy share of Europe's electricity mix is gaining weight in that it now accounts for 11.4% of the total electricity output of the Europe of 28.

GERMANY HALVES ITS INSTALLATION VOLUME IN 2018

Preliminary figures released by AGEE-Stat reveal that Germany installed 3 374 MW in 2018 and at the same time decommissioned 185 MW of onshore capacity. Thus, nett additions (3 189 MW) were roughly halved (48%) compared to 2017, when the additional capacity recorded was 6 127 MW. At the end of 2018, the German wind turbine base to date was 58 908 MW split between 52 503 MW onshore (a nett increase of 3 189 MW) and 6 405 MW offshore (a nett increase of 978 MW). Thus, it has practically reached the 2020 installation target of 6.5 GW offshore, enshrined in its renewable energy law. The Federal Grid Agency says that about 7 700 MW of offshore capacity should be connected to the grid by the same time-line. The decline in Germany's wind energy growth can partly be ascribed to the fact that a large proportion of the awarded volumes has been won by "citizens' projects". The latter benefit from longer lead times, which has created slippage in the annual commissioning timetable.

The results of the last two onshore tenders provide more concern for the sector because the target volumes were not achieved. Thus only 57 projects for 363.2 MW of the 670.2 MW target volume were allocated in the 1 October tender, and 67 projects for 476 MW of the 700 MW target volume were allocated in the 1 February 2019 tender. WindEurope blames construction permit woes for missing the target figures. The German permit application process for new onshore wind farms "can now take more than 2 years compared to 10 months only 2 years ago". WindEurope also points out that once granted, construction permits are increasingly subject to objections, with already "at least 750 MW" of projects caught up in legal proceedings. One outcome of this trend has made itself felt since the end of 2017, in that the average onshore bid price has tended to increase. It reached its lowest mean price of € 0.0402 per kWh, for the 1 November 2017 tender (for an allocated bid volume of 1000.4 MW). Since then, it has gradually crept up to a mean price in excess of € 0.06 per kWh, i.e. € 0.0617 per kWh, for the 1 October 2018 tender (the lowest bid was for € 0.05 per kWh and the highest € 0.063 per kWh, which matched the bidding price cap) and € 0.0611 per kWh for the 1 February 2019 tender (the lowest bid was for € 0.0524 per kWh and the highest € 0.062 per kWh, which matched the bidding price cap).

Price rises also came into play for the second offshore wind energy tender of 1 April 2018. Although this tender resulted in successful project bids for zero, such as the Borkum Riffgrund West 1 (420 MW) project in the North Sea, the mean bidding price at € 46.6 per MWh was higher than that of the 1 April 2017 bid of € 0.044 per kWh. The rise in this mean price may be explained by a successful bid made by Iberdrola at € 0.0644 per kWh for the Baltic Eagle project (476 MW) in the Baltic Sea, and most of all by the highest bid for this tender (€ 0.0983 per kWh) won by Orsted for the Gode Wind 4 project (131.75 MW) in the North Sea. There were fewer bids placed for this last allocation (1 610 MW), because the only projects eligible to bid had permits or were very close to achieving them and had failed during the 2017 procedures.

THE FRENCH WIND ENERGY MARKET LOOKS INLAND

While France is preparing its fourth offshore wind energy tender for the area of Oléron, in the Bay of Biscay (Charente-Maritime), the commissioning of its first

Offshore wind energy wins the cost reduction battle

Offshore wind energy production costs are project-specific and depend on many factors: the depth and nature of the seabed, the wind resource and country-specific regulations and taxation conditions. They are also linked to the country's industrial sector's maturity, investments made in infrastructures (harbour, vessels, foundation and turbine production plants), not to mention learning curve effects and project rationalisation level. When developers group their offshore wind farms over the same area or make bids on adjacent wind farms, they pool maintenance and installation costs and profit from shared investment. Meanwhile, the per MW equipment cost has also dropped through the increase in unit capacity of wind turbines, whose foundation requirements diminish at a given capacity. Increasingly long blades also optimize the time the turbines are in use. The annual load factors of some wind farms are already 50% and over during the winter. Major progress has also been made to limit maintenance costs as far as possible, with new generations of extremely reliable turbines.

In countries that already have several GW installed, the entry costs into the offshore market, which warranted a relatively high electricity price when the first tenders were made, have already been amortized. But as investments have poured in, new wind farms can be installed at ever-diminishing marginal cost. Nowadays, prices excluding connection range from 50 to 80 euros per MWh, while connection adds another € 10–20 per MWh depending on the site. The connection cost may be borne by the developer, as occurs in the UK, or by the grid operator, as occurs in Germany, Denmark and the Netherlands. In 2017, the Danish Kriegers Flak Wind Farm (600 MW) was awarded at a cost of € 49.90 per MWh. Another example, the winning bid for the Dutch Borssele III and IV (680 MW) offshore wind farm project in the North Sea was for € 54.5 per MWh. Several successful bids for wind farms made in the latest German and Dutch tendering rounds, went for zero (€ 0 per MWh), which means that investors will only get their payback from selling their electricity at market price. Examples of this are in the Netherlands for the Hollandse Kust Zuid (700 MW) project due to be commissioned in 2022; in Germany, OWP West (240 MW), Borkum Riffgrund West 1 (420 MW), Borkum Riffgrund West 2 (240 MW), EnBW He Dreiht (900 MW) scheduled for 2024 and 2025, which also successfully bid at € 0 per MWh. Some less accessible sites and sites in areas new to the sector, still command higher minimum guaranteed prices (see paragraph on Germany).

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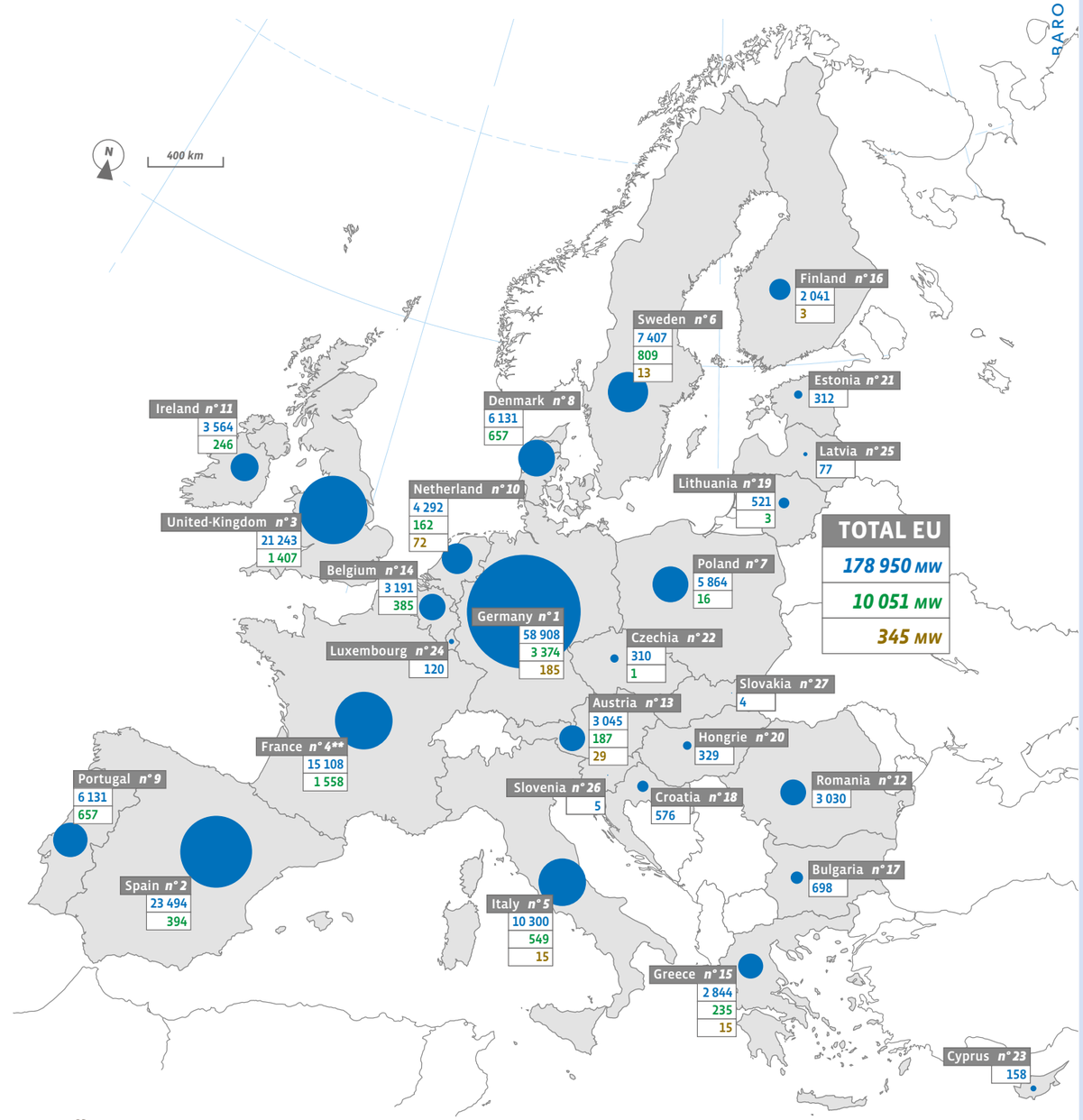
two offshore wind farms from tenders is unlikely to happen any earlier than 2021 (the first was launched on 11 July 2011). Until that time, the French wind energy market will be landlocked. According to the 2018 Renewable Electricity Panorama produced by RTE, Enedis, the Syndicat des énergies renouvelables and others, France passed its 15 GW installation target at the end of 2018, with combined capacity to date of 15 108 MW. That makes 2018 the second best year for the sector with 1 558 MW connected to the grid, despite having dropped from its 2017 level. The last quarter witnessed the best progress ever made by the wind turbine base over three months, as 780 MW were connected. Three regions were particularly active in 2018, responsible for two-thirds of the capacity installed, namely the Hauts-de-France, Occitanie and the Grand-Est regions. Development projects account for 11 593 MW of volume, which is almost the same as at the end of 2017 (11 516 MW). Mainland wind energy output is surging and should reach at least 27.8 TWh (27.9 TWh if the overseas territories are included), equal to almost 13% more than in 2017. This rise in output is very largely due to the new turbine capacities connected, as the country's overall load factor is about the same as in 2017.

The French government finally published the draft of its multi-year energy programme (PPE) on 25 January 2019, which is now subject to consultations with various bodies such as the Higher Energy Council, The National Council for Energy Transition, energy transition expert commissions, the European Commission and countries whose electricity systems are interconnected with that of France. The PPE is effectively the government's roadmap for the next 10 years, set in order to achieve its legal targets, with in particular a 32% target share of renewable energy consumption by 2020 broken down by energy vector (40% of electricity output;

Installed wind power capacity in the European Union at the end of 2018* (MW)



Key

178 950 Installed capacity to date in the countries of the European Union at the end of 2018 (MW)

10 051 Capacity installed in the countries of the European Union 2018 (MW)

345 Capacitiy decommissioned during 2018 (MW)

Estimate. ** Overseas departments not included for France.* ***Source: EurObserv'ER 2019.*

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38% of final heat consumption; 15% of final fuel consumption and 10% of final gas consumption must be renewably sourced). The current draft version of the PPE provides for an onshore wind turbine base of 24.6 GW in 2023 and envisages two scenarios for 2028 – one at 34.1 GW and the other at 35.6 GW. These targets equate to a wind turbine base of 14 200–15 500 units in 2028 (compared to about 8 000 units at the end of 2018). As for offshore wind energy, the programme provides for 2.4 GW of capacity by 2020, ranging from 4.7 and 5.2 GW by 2028. The wind energy industry considers that the French offshore programme falls far short of the country's potential as it was banking on a target at least three times bigger.

MORE MANUFACTURER CONCENTRATION TO COME

Intense competition has triggered a round of mergers and acquisitions between wind turbine manufacturers over the last few years (Siemens and Gamesa in 2017, General Electric and Alstom in 2014, Nordex and Acciona in 2016, Enercon and Lagerey in 2018, etc.), which is set to continue. In its "Global Wind Energy Innovation" report, Intelsor, a market intelligence platform for renewable energy, points out that the number of manufacturers has dropped from 200 a few years ago to 37 in 2018. The report shows that very few wind turbine models achieved a satisfactory return on invested capital (ROIC)... of the 1 200 developed, only 11.6% achieved positive ROIC. Intelsor goes further by disclosing that only 18 of the remaining 37 wind turbine manufacturers across the world have sold at least one product with positive ROIC. The report also expects to witness another consolidation drive by 2023, on the basis that pressure on prices will not let up and that competition will be further heightened by tendering procedures – especially as the initial capital requirements for developing new products rise to support continued improvement of the wind turbines being sold.
Accordingly, at the start of 2019, Vestas launched a new turbine system called EnVentus that will enable the company to manufacture onshore turbines for 5.6 MW machines. Two models are planned with rotor diameters of 150 and 162 metres. The first is a V150-5.6 MW for stronger winds, and the second is a V162-5.6 MW for low to medium winds. This development calls for technological changes to the wind turbine drive train. The change of scale will make for a 26% increase in annual energy output compared to the results of a previous 4.2 MW model. Vestas' technological achievement should soon find its place on the market and become profitable.
In this context, some companies are seeking solutions through standardisation to cut costs. For example, research projects are being developed between SGRE, Vestas and MHI Vestas in offshore wind energy to standardise components and industrial processes. These could extend to manufacturing foundations, same sourcing, establishing common perimeters for masts and standardising internal parts. However, there are certain items that this trio does not want to standardise, i.e. the blades, hub, pod or control software.

DIGITALISATION – A LEVER THAT IS BECOMING INCREASINGLY IMPORTANT

Further down the value chain, major industrial issues such as digitalisation are also emerging. This term, which shook the industry in 2018, can be defined as transferring data sharing and processing to a virtual world, which enables the quantity of data exchanged to be increased and moreover exchanged instantly. The wind turbine industry's digitalisation efforts will streamline machine production and manage their integration into electricity grids. The industry players see digitalisation as a way of cutting technology production costs, primarily by ensuring that each MWh produced can be sold at the best possible price. This is aided by the fact that digitalisation is also under development for the purposes of electricity storage. Digitalisation coupled to a battery is used to define the best time to inject a wind energy electron into the grid, which not only means waiting for the time that the electron is most needed by the global electricity market but also when it commands the best price for its producer. The Batwind battery that has been installed on the Hywind Scotland Wind Farm really illustrates this point. The wind farm is a 30 MW floating offshore project developed by Equinor and was completed in September 2017. In June 2018, the company added a 1 MW/1.3 MWh battery manufactured by Younicos. This battery is said to be "smart" because its purpose is to become independent, namely, to decide for itself when to hold back the electricity and when to send power to the grid. To achieve this, it needs regular data feed. Eventually the project's load factor will be increased further than the 48–60% already achieved. Another example is the Spanish Barasoain Wind Farm, operated by Acciona, whose five 3 MW wind turbines are supplemented by two 1 MW/0.39 MWh and 0.7 MW/0.7 MWh lithium-ion batteries. Furthermore, blockchain technology certifies that the electricity produced really comes from this wind farm.

3D Still Image, Artwork representing data visualization and flow throughout an onshore wind farm.

POWER PURCHASE AGREEMENTS ARE ON THE UP AND UP

The fact that 2018 was a disappointment in terms of installation concentrated minds on the need to complement wind power outlets with private sales contracts, called Power Purchase Agreements (PPA).
In the European Union, 4.7 GW of wind energy will be covered by PPAs, 1.5 GW of which was installed in 2018 (1.3 GW in 2017). Incidentally, the European Commission has asked Member States to set up a regulatory framework that could promote PPAs in their forthcoming national action plans. In Poland, the regulatory framework changed in 2018, to allow producers to trade and sell their electricity freely to the grid. As a result of this move, Mercedes Benz will purchase electricity for its Polish plant in Jawor from the 45 MW Taczalin Wind Farm operated by VSB Energie since 2013.
The number of PPAs should rise in Germany, because they enable wind farms that are still technically viable to run after twenty years in operation but have come to the end of their sales contracts, to sell their electricity. Thus by 2020, 4.4 GW of Germany's onshore wind turbines will no longer be bound by their 20 year contracts. The first two PPAs have been signed. In the first, GreenPeace Energy will purchase 9 MW of electricity from the Ellhöft Wind Farm in the state of Schleswig-Holstein. The 5-year PPA will take effect in 2021. The second PPA has been signed by Statkraft which will purchase a total of 41 MW of electricity produced by six citizen wind farms, whose contracts expire between 2021 and 2023. This electricity will be aggregated and sold on to an undisclosed industrial concern. PPAs offer old wind farms the advantage of prices that do not necessarily fluctuate along with market prices.
The challenge of the next generation of PPAs will be to extend the contract terms, and to get them signed as the projects emerge rather than when the wind farm

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Tabl. n° 4

Main European wind farm developpers and operators 2018

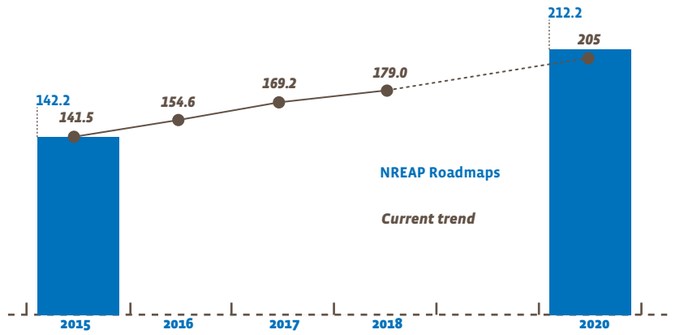
Company	Country	Wind capacity developped or operated (in MW including offshore) 2018 [1]	Annual turnover 2018 (in M€)	Employees 2018
Iberdrola Renovables	Spain	16 215	4 045 [2]	n.a.
EDP Renewables[3]	Portugal	11 228	1 239	1 364
EDF Energies Nouvelles	France	10 309	1 675	3 853
Enel Green Power	Italy	9 900	n.a.	n.a.
E.ON Climate Renewables	Germany	8 611	n.a.	n.a
Acciona Energy	Spain	7 634	1 737 (2017)	2 000
Vattenfall	Sweden	5 989	1 185	894
Orsted	Denmark	3 831[4]	4 107	6 080
RWE Innogy	Germany	3 811	n.a.	n.a.
WPD AG	Germany	3 588	n.a.	n.a.

Large energy companies are well represented in this ranking because of their size and their ability to raise capital, but besides these type of players, there is a large number of private developers specialized in renewable energy, with substantial portfolios. Some wind manufacturers like Gamesa, Enercon or Nordex also chosen to develop projects with their own machines.
1) Worldwide figure. 2) Turnover for all renewables technologies. 3) Jan. to Sept. 2018 figure. 4) Represents what the group calls "Generation capacity". ***Source: EurObserv'ER 2019.***

contract expiry dates draw near. On that basis, Statkraft will purchase the electricity produced by Valeca from three French wind farms with a combined capacity of 40.5 MW for 5 years, that will come on stream in May and September 2019. The widest-ranging PPAs were signed in Denmark in July 2018. The pharmaceutical company Novo Nordisk and biotechnology company Novozymes have set up an agreement to ensure that part of their electricity is provided by Kriegers Flak, the largest offshore wind farm. These two companies will thus purchase 20% of the electricity produced by a 600 MW wind farm. This type of contract, which manufacturers prefer, should proliferate in the next few years and redesign wind power and renewable electricity trading models.

Graph. n° 1

Comparison of the current trend against the NREAP (National Renewable Energy Action Plans) roadmaps (in GW)



Source: EurObserv'ER 2019

INTEGRATION SPEED IS SUBJECT TO POLITICAL CHOICES

While renewable energies such as onshore wind energy, offshore wind energy, and photovoltaic have won the price competitiveness battle and are assured a rosy future, the speed of their integration into the EU's electricity mix still hangs in the balance. Over the next decade it will depend on the strength of the common commitment and thus the solidarity between its Member States that aim for a 32% share of renewable energy in final energy consumption by 2030 – the target that was officially adopted when the new renewable energy directive was published in December. Wind energy market contraction was expected in 2018. It reflects the regulatory change taken by the Member States when they revised the European guide to State aids decided on in 2014, once no more projects were eligible for the former support mechanisms. This community-wide framework was set up to promote greater integration of renewable energies into the electricity market, while limiting competition distortions caused by state aids such as Feed-in Tariffs.
This system has led the Member States to make a point of introducing market price-based incentive procedures (top-up remuneration) coupled with tendering systems, all of which created a new project development and licencing environment. The capacity installed annually is now almost entirely dependent on the annual tender volumes agreed to by the Member States, which thus keep strict control over the sector's development pace. PPA-type projects are the only exclusion from this mechanism (1.5 GW in 2018 and 4.7 GW in all), whose share is bound to expand in the future. According to EurObserv'ER, the installation pace should nonetheless pick up again from 2019 onwards and be even more robust in 2020, primarily as a result of the scheduled commissioning of many large-scale offshore wind farms. However, the scale of the drop in installation volume in 2018 was greater than expected, therefore we have revised our projection to 205 GW by 2020 **(see graph 1).**
Over and above the Member States' operational management to optimize the integration of renewable energies into their electricity mix, the European Commission gave its long-term vision for a viable planet aiming at carbon neutrality by 2050 on 28 November 2018. In support of this vision, an "In-depth analysis in Support of the Commission Communication COM (2018) 73" examines eight scenarios that provide for varying emission reduction levels in the distinct economic sectors that give different results. These levels range from reducing GHG emissions by 80% in 2050 in comparison to 1990 (strategy factor 4) to carbon neutrality by 2050. The point common to all the scenarios is the central position occupied by wind energy, which in 2050 should amount to 51–56% of total electricity production, with an intermediate stage in 2030 of 26%. These scenarios are in keeping with WindEurope's High Scenario that suggests that offshore wind energy's contribution will rise from 12% of wind energy output in 2017 to 36% in 2030, i.e., that offshore wind turbine capacity would amount to 20% of the total installed capacity of the sector by that time-line. This progress would be made together with solar energy, which combined would provide 37% of electricity output in 2030 and more than 70% in 2050. As for installed capacities, wind energy capacity could thus reach a level ranging from 700 GW (EE "Energy Efficiency" scenario) to 1 200 GW (P2X ("Power to X" scenario), with an intermediate level of 350 GW in 2030. In 2050, onshore wind energy would account for two-thirds of the installed wind energy capacity (from 460 GW in the EE scenario to 760 GW in the "1.5°C Technical" 1.5 TECH scenario). □

Source: AGEE-Stat (Germany), AEE (Spain), APERE (Belgium), CBS (Netherlands), CERA (Cyprus), DBEIS (United Kingdom), DGEG (Portugal), ENS (Denmark), Finnish Energy (Finlande), FWPA (Finland), HWEA (Greece), HOPS (Croatia), Litgrid (Lithuania), Ministry of industry and trade (Czech Republic), RTE (France), SER (France), SCB (Sweden), STATEC(Luxembourg), Terna (Italy), URE (Poland), WindEurope.

The next barometer will cover photovoltaics.

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