Technician at work on the Maranchon wind plant, Spain.

IBERDROLA

353.5 TWh

The estimated electricity production from wind power in the EU in 2017

WIND ENERGY BAROMETER

A study carried out by EurObserv'ER.

The global wind energy market contracted for the second year in succession. According to EurObserv'ER, the additional capacity, less decommissioned capacity, should be about 51 GW in 2017, compared to 55.5 GW in 2016. Restrained Chinese market development is the main reason for this downturn. The European Union market witnessed a flurry of activity before the new European Commission regulatory framework came into force. Installed global wind energy capacity passed the half-million MW mark in 2017, i.e. 539 256 MW.

539.3 GW
Worldwide installed wind power capacity at the end of 2017

14.8 GW
Wind power capacity installed in the EU during 2017

WIND ENERGY BAROMETER – **EUROBSERV'ER** – FEBRUARY 2018

Today's wind energy development context is a far cry from that of a few years ago. The cost of onshore wind energy is dropping very fast, helped by the introduction of tendering mechanisms, while the cost of its offshore counterpart is dropping even faster (see the paragraphs on Germany and the UK), as the floating wind energy market opened up much sooner than expected (see "Floating wind energy finds its feet" inset). In many of the world's regions, wind energy is now engaged in head-on competition with the construction of new gas-fired power stations. GWEC (the Global Wind Energy Council) points out that in several markets, wind energy is now the most competitive technology, with bidding prices less than 3¢ per kWh recorded in India, Morocco, Canada and Mexico. Financial analysts concur that prices will continue to fall over the next few years if not decades.

The annual New Energy Outlook 2017 publication produced by Bloomberg New Energy Finance (BNEF) claims that onshore wind energy costs could fall by another 71% by 2040, thanks to new, more efficient turbines, lower financing costs, not to mention economies of scale made through increasingly extensive projects and more powerful turbines. By BNEF's projections, the costs of new wind energy should be even lower than those of gas- and coal-fired power plants already operating: by 2030 in Germany (gas and coal), in China by 2020 (gas) and 2030 (coal), in India by 2020 (gas) and a little later than 2030 for the USA (gas). Thus, according to BNEF, only 35% of the currently planned new coal-fired power plants will actually be built. BNEF claims that coal consumption could realistically diminish to less than 15% of its 2016 global level by 2040.

With the prospects of lower costs expected by investors and operators, the first challenge for wind energy is no longer to compete with the conventional sectors but to break down the barriers to grid integration (managing production variability) and garner general public acceptance of wind farms.

The new price advantage of both the wind energy and solar power sectors, paves the way to developing a new storage industry, be it intraday (e.g.: stationary electrochemical storage) or inter-season (power to gas), with very fast cost reduction dynamics, comparable to those of renewable energy, as far as lithium-ion batteries are concerned.

Tabl. n° 1

Worldwide installed wind power capacity at the end of 2017* (MW)

	2016	2017	Capacity installed in 2017	Decommissioned in 2017
European Union	154 847	168 993	14 750	605
Turkey	6 091	6 857	766	0
Norway	838	1 162	324	0
Russia	15	15	0	0
Rest of Europe	668	744	76	0
Total Europe	162 459	177 771	15 916	605
United States	82 060	89 077	7 017	0
Canada	11 898	12 239	341	0
Mexico	3 527	4 005	478	0
Total North America	97 485	105 321	7 836	0
China	168 732	188 232	19 500	0
India	28 700	32 848	4 148	0
Japan	3 230	3 400	177	7
Other Asian countries	3 442	4 062	622	2
Total Asia	204 104	228 542	24 447	9
Brazil	10 741	12 763	2 022	0
Other Latin America	4 571	5 128	557	0
Latin America	15 312	17 891	2 579	0
Africa & Middle East	3 917	4 538	621	0
Pacific region	4 948	5 193	245	0
Total world	**488 225**	**539 256**	**51 644**	**614**

Estimate.* ***Sources: EurObserv'ER 2018 (European Union figures), AWEA 2017 for United-States, WindEurope 2017, GWEC 2017 (others)*

I - GLOBAL INSTALLED WIND ENERGY CAPACITY PASSES THE HALF-MILLION MEGAWATTS MARK

Across the world, slightly less additional wind turbine capacity was installed between 2016 and 2017, but the fall was not as bad as the previous year's. EurObserv'ER reckons that it fell by 8% compared to 13.2% between 2015 and 2016. Nonetheless, at 51 MW, the additional capacity figure for 2017 was still over the 50 GW mark (i.e. 51.6 GW installed, and 0.6 GW decommissioned), compared to additional capacity of 55.5 GW in 2016 **(table 1).** Our estimate is a little lower than that of the GWEC (Global Wind Energy Council) released on 14 February 2018 which puts additional capacity at 52.6 GW. The installed capacity estimates for the individual European Union countries are responsible for the difference.

The GWEC Secretary-General denies there is any cause for concern and ascribes the fall to the sector's greater maturity. Wind energy is now in transition to a market-based system, where it will compete directly with the other conventional and renewable technologies.

As previously, the top three wind energy markets are China – No. 1 (19 500 MW), followed by the USA (7 017 MW) and Germany (6 440 MW) with the same market forces operating as in 2016 (see below). India consolidated its fourth place with an installation volume of 4 148 MW in 2017 (a 14.8% rise). The UK market picked up (adding 2 783 MW, or 46.4%) which enabled it to claw back its place in the top 5, overtaking Brazil (which added 2 022 MW) whose year-on-year installation volume was stable.

The additional capacity installed in 2017 pushed up global capacity by 10.5% over the 2016 figure to 539 256 MW **(graph 1),** with the upshot that the annual global output milestone of 1 000 TWh should be exceeded in 2017.

A global geographical analysis confirms that Asia is still driving the wind energy market, as it now accounts for almost half (47.3%) the global capacity installed in 2017 **(graph 2A and 2B)** and 42.3% of the worldwide capacity installed to date. Europe is the No. 2 region (30.8%) but only accommodates 33% of the global wind turbine fleet. The North American market (including Canada and Mexico) accounts for slightly over 15% of the annual installations and 19.5% of the global fleet.

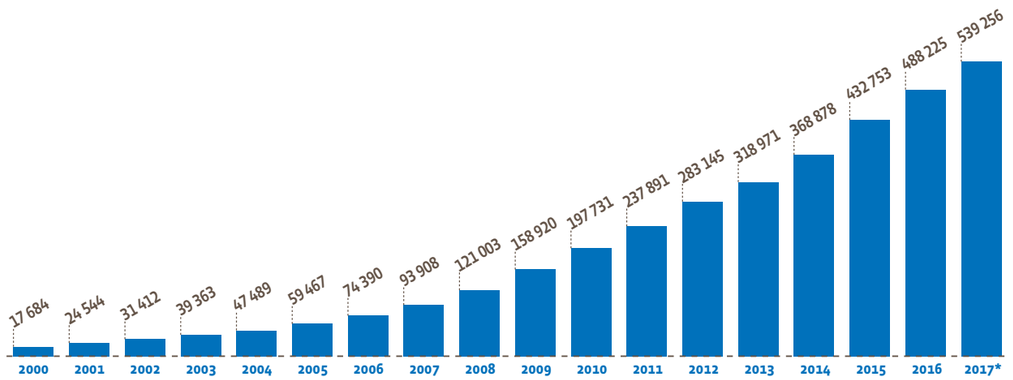
The global offshore wind energy fleet (18 228 MW, a 25.9% increase) is in Europe but wind farms are being set up off the Asian continent... China having installed 1 161 MW in 2017. The USA has embarked on the construction of several hundred megawatts of capacity.

CHINA KEEPS BETTER CONTROL OF ITS GROWTH

Global market contraction in 2017 and 2016 can be explained by the slowdown in the Chinese market which only installed 19 500 MW in 2017 (following 23 370 MW in 2016 and 30 500 MW in 2015). The government is no longer intent on a rush to install but wants to contain the market so that its expansion is better synchronized with grid infrastructure investments. Its prime aim is to optimize turbine output and yield with an appropriate connection pace for its grid integration capabilities. The policy has led to restrictions on the main local Chinese wind energy markets located in the north of the country, where production losses were particularly heavy. The National Energy

Graph. n° 1

Total cumulative wind power capacity installed worldwide since 2000 (MW).



** Estimate.* ***Source: EurObserv'ER 2018.***


The San Clemente Island wind farm in California.
WARREN GRETZ/NREL

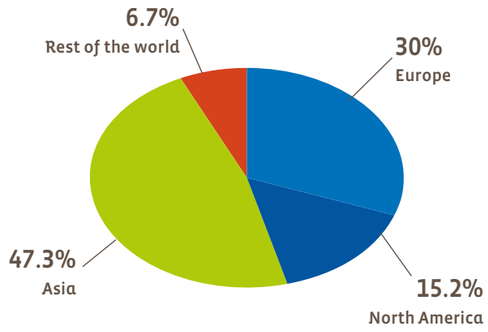
Administration (NEA) has targeted its investment efforts in the southern, central and eastern provinces, whose electricity demands are greater, and that have better infrastructures. Accordingly, the government has reduced production incentives and plans new, more severe reductions. In the windiest, Category 1 production zones, the rates dropped from 0.47 RMB/kWh on 1 January 2016 to 0.40 RMB on 1 January 2018, while for the least windy, Category 4 zones they dropped from 0.60 RMW/kWh to 0.57 RMB/kWh. The NEA's goal, which was stated in the 13th five-year plan, is to install combined capacity of 210 GW (including 5 GW offshore) and achieve 420 TWh of output by 2020, i.e. the equivalent of 6% of the country's electricity output.

A WIND OF OPTIMISM IS BLOWING THROUGH THE AMERICAN MARKET

For tax reasons we must wait until the last quarter of the year to gauge the wind energy sector's activity in the USA. According to AWEA (the American Wind Energy Association), the industry managed to install 4 125 MW during the fourth quarter, which raised the installed capacity for 2017 to 7 017 MW. While this installation level is a little lower than the previous year's (8 068 MW), market prospects still look very positive. The AWEA claims that the American wind turbine industry

Graph. n° 2A

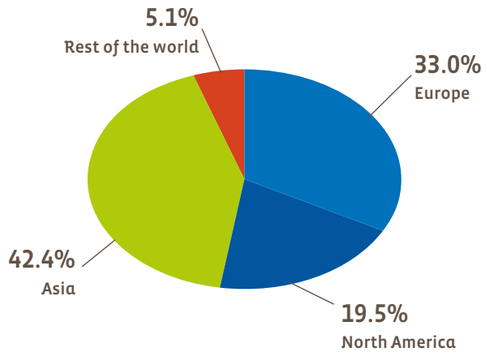
World wind turbine market - breakdown for 2017*



** Estimate.* ***Source: EurObserv'ER 2018.***

Graph. n° 2B

Cumulative breakdown as the end of 2017*



** Estimate.* ***Source: EurObserv'ER 2018.***


The Caniçal wind farm in Madere, Portugal.
WINDEUROPE/BICKLEY

is now operating at full capacity with a raft of projects under construction, or at an advanced stage of development, for four times more capacity than was installed in 2017. This pipeline of projects is 34% bigger than it was in 2016 and totals 28 668 MW. Growth is supported by the permanent and ongoing fall in the cost of wind power that AWEA attributes to new turbine technologies that improve yield and production stability, combined with the growing use of big data, which has dramatically reduced operating and maintenance costs. Lazard Investment Bank claims that the cost of wind power fell by a further 4% in the USA during 2017, with cumulative reduction in costs running to two-thirds between 2009 and 2016. Lazard also confirms that in many of the country's regions, unsubsidized wind power is cheaper than conventional energy sources. Another point to bear in mind is that Power Purchase Agreements (PPA) are becoming more popular (5 496 MW of contracts signed in 2017). These contracts are concluded between electricity utilities and independent electricity producers, and guarantee profitability for the latter by ensuring that their output is paid for at a pre-set price. While the utilities account for 60% of PPA volumes, these contracts also attract the major, image-conscious electricity consumer groups such as Facebook and Google Energy that want to demonstrate that their businesses are based on sustainable energy. The American offshore market is also emerging with five projects under construction for 490 MW of capacity. Evidence of the interest in this market has been shown by MHI Vestas, which in Q4 2017 invested 35 million dollars on a Clemson University site, South Carolina to test its next 9.5 MW offshore turbine.

THE EUROPEAN UNION SETS A NEW INSTALLATION RECORD

The European Union wind energy market enjoyed a 14.1 GW installation peak in 2017 (14 750 MW of newly-installed capacity less 605 MW of capacity decommissioned) compared to the previous year's 13.1 GW of additional capacity. The European Union wind energy fleet rose to 169 GW **(table 2)**. Momentum came from its three major markets, and mainly

from the top market, Germany, which set a new installation record of 6 440 MW in 2017. The UK found new momentum and added at least 2 780 MW of capacity. The French market recovery was firmer as almost 1 800 MW of capacity was installed last year.
Other European Union markets have maintained their efforts, such as Ireland, which added 538 MW, Finland which added 512 MW and Belgium which added 465 MW. The Swedish (additional 226 MW), Austrian (additional 195 MW) and Greek (additional 171 MW) markets slipped from their 2016 performance levels. However, this build-up contrasts with the apathy displayed by many European Union markets. Our figures show that no additional capacity was installed in more than half (13 out of 28) of the EU Member States and that other country markets were fairly sluggish (the Netherlands, Lithuania, Poland). Spain's net capacity in service has only progressed slightly since January 2012 when the moratorium was declared on state aid for renewable energies. The Italian market has also slowed down since 2013. In 2017, it only added 359 MW, which is nonetheless an improvement on the 247 MW it added in 2016.
In the offshore segment, 2017 turned out to be a good year, confirming that the UK market decline in 2016 was just a temporary glitch. The data collected by EurObserv'ER suggests that European Union offshore wind turbine capacity increased by at least 2 568.7 MW in 2017 (1 650 MW in 2016) **(table 3).** However, this figure is an estimate and will be consolidated in the next few weeks. As by mid-February, the BEIS (Department for Business, Energy and Industrial Strategy) had only released the connection status for the third quarter of 2017, EurObserv'ER has had to extrapolate for the whole year. The cumulative capacity of the European Union offshore fleet comes to about 15 200 MW on the basis of this installation level. This installed capacity total factors in the decommissioning and dismantling of 11 turbines off Denmark (the 450 kW Bonus turbine) in the Vindeby wind farm originally commissioned in 1991, and the dismantling of 10 turbines of the former WinWind masts in Finland's Kemi Ajos 1 and 2 wind farms (the offshore turbines were replaced by 8 Siemens SWT-3.3-130 turbines).
The volume of wind turbine capacity installed in 2017 was higher according to WindEurope, the European association that defends wind energy interests in Europe. Its figures differ slightly from the data released by the official bodies (BEIS, UBA, ENS, etc.). It claims a new installation record of 3 148 MW was set last year, with additional capacities recorded in 5 countries – Germany, the UK, Belgium, Finland and lastly France, which installed its first prototype. The association has counted the installation of 560 new turbines across 17 wind farms, raising the total number of offshore wind turbines to 4 149, which amounts to 15 780 MW of capacity to date. If we subtract the French floating wind turbine demonstrator Floatgen, 12 offshore wind farms were fully connected to the grid in 2017. Partial connection of four wind farms, all British: Race Bank (498 MW connected in 2017), Walney (256 MW), Rampion (179 MW) and Galloper (72 MW) should be added to that figure. The fully-connected UK wind farms are Dudgeon East (402 MW), Burbo Bank Extension (200 MW), Blyth (42 MW) and Hywind Scotland (30 MW). Hywind is the first offshore wind farm in the world, (excluding demonstrators) on floating foundations (see "Floating wind energy finds its feet" inset). Germany also has five new wind farms that are fully connected: Veja Mate (402 MW), Wikinger (350 MW), Nordsee One (332 MW), Nordergründe (111 MW) and Sandbank (52 MW). For its part Belgium inaugurated the NobelWind

Tabl. n° 2

Installed wind power capacity in the European Union at the end of 2017 (MW)

	Cumulative capacity at the end of 2016	Cumulative capacity at the end of 2017*	Capacity installed in 2017*	Decommissioned in 2017*
Germany	49 592	55 602	6 440	430
Spain	23 075	23 170	95	0
United Kingdom	16 217	19 000	2 783	0
France**	11 761	13 559	1 798	0
Italy	9 384	9 743	359	0
Sweden	6 495	6 721	226	0
Poland	5 747	6 397	650	0
Denmark	5 246	5 521	373	98
Portugal	5 313	5 313	0	0
Netherlands	4 257	4 270	81	68
Ireland	2 827	3 365	538	0
Romania	3 025	3 029	4	0
Belgium	2 383	2 848	465	0
Austria	2 649	2 844	195	0
Greece	2 370	2 541	171	0
Finland	1 532	2 044	515	3
Bulgaria	699	699	0	0
Croatia	483	527	44	0
Lithuania	509	521	12	0
Hungary	329	329	0	0
Estonia	310	310	0	0
Czech Republic	282	282	0	0
Cyprus	168	168	0	0
Luxembourg	117	116	0	1
Latvia	70	66	0	4
Slovenia	5	5	0	0
Slovakia	3	3	0	0
Malta	0	0	0	0
Total EU 28	**154 847**	**168 993**	**14 750**	**605**

** Estimate. ** Overseas departments not included for France.* ***Source: EurObserv'ER 2018.***

Tabl. n° 3

Installed offshore wind power capacities in European Union at the end of 2017*

	2 016	2 017
United Kingdom	5 293,0	6 360,5
Germany	4 132,0	5 407,0
Denmark	1 271,1	1 291,8
Netherlands	957,0	957,0
Belgium	712,2	877,0
Sweden	201,7	201,7
Finland	32,0	72,7
Ireland	25,2	25,2
Espagne	5,0	5,0
Total EU 28	**12 629,2**	**15 197,9**

Estimate.* ***Source: EurObserv'ER 2018.*

Tabl. n° 4

Worldwide connected offshore wind power capacity at the end of 2017 (MW)

	2 016	2 017
United Kingdom	5 293,0	6 360,5
Germany	4 132,0	5 407,0
China	1 627,0	2 788,0
Denmark	1 271,1	1 291,8
Netherlands	957,0	957,0
Belgium	712,2	877,0
Sweden	201,7	201,7
Vietnam	99,0	99,0
Finland	32,0	72,7
Japan	60,0	65,0
South Korea	35,0	38,0
United States	30,0	30,0
Ireland	25,2	25,2
Taïwan	0,0	8,0
Spain	5,0	5,0
Norway	2,0	2,0
Total World	**14 482,2**	**18 227,9**

** Estimate.* ***Source: EurObserv'ER 2018.***

WIND ENERGY BAROMETER – **EUROBSERV'ER** – FEBRUARY 2018

Floating wind energy finds its feet

After installing a few demonstrators, the inauguration of the first commercial-scale floating wind farm project, Hywind Scotland, ushers in a new era in the development of marine energies. The facility was commissioned on 18 October 2017 and is operated by Statoil, a Norwegian oil company in partnership with Masdar, an energy utility based in the United Arab Emirates. The wind farm is 25 km off the coast of Peterhead, Aberdeenshire, Scotland. The wind farm comprises five 6-MW wind turbines equipped with 254 metre rotors and 253 metre high masts (175 metres of which are submerged). The investment cost is 210 million euros, which equates to a per MW cost of 7 million euros. This project is particularly innovative in that it is coupled with a battery storage project capable of restoring 1 MWh and aims to minimize production variability while optimizing yield. Statoil's ambition is to reduce the wind farm's costs by 40–60 euros per MWh by 2030, with a view to extending the scope of offshore wind energy research.
Another floating wind energy event in 2017 was the October inauguration of the first French demonstrator, carried out under the framework of the European Floatgen project. This wind turbine equipped with a floating foundation built by the French manufacturer Ideol, will be installed early in 2018, 22 km off Le Croisic on a test site managed by the Centrale Nantes engineering school. The project is led by a European consortium, comprising the French company Ideol, Bouygues Travaux Publics and the Ecole Centrale, Nantes. In 2016 the French government announced 4 pilot projects (three in the Mediterranean and one in Brittany) comprising 3 to 6 wind turbines as part of a call for tenders launched in 2015. The Eolmed project in the Mediterranean will deploy four 6-MW Senvion wind turbines equipped with Ideol foundations, another project of Groix and Belle-Ile, with four 6-MW GE wind turbines equipped with Naval Energies and Vinci Construction France foundations, the Provence Grand Large project led by EDF Energie Nouvelle comprising three 8 MW Siemens wind turbines equipped with foundations designed by SBM Offshore and finally a project led by Engie off Leucate (Aude) comprising four 6-MW wind turbines equipped with metal floaters designed by the company Principle Power.
Some other pre-commercial projects identified by WindEurope have been announced and should see the light of day by 2020 – Dounreay, Scotland (10 MW expected in 2018), Kincardine, Scotland (48 MW, installation kicks off in 2018), Windfloat Atlantic off Portugal (30 MW, expected in 2019), the Atlantis Ideol project for the UK (100 MW) and the Gaeletic project by Ireland (30 MW).
WindEurope states that 80% of offshore wind energy of the future will be sited at depths of more than 60 metres, where it is not commercially viable to install the turbines on foundations fixed on the seabed. The association puts Europe's potential at 40 000 MW, which would pave the way to opening the offshore wind energy market to Spain, Portugal and Norway and stimulate the French, Scottish and Irish markets.

The last Hywind Scotland wind turbine is setting off for Scotland from Stord (Norway).

wind farm (165 MW) while Finland commissioned the Pori Tahkoluoto (42 MW) wind farm and replaced all the wind turbines of its Kemis Ajos (26.4 MW) wind farm. The French floating wind turbine demonstrator Floatgen (2 MW) was inaugurated in October 2017. While it produced its first kWh at dock in December 2017, it will be connected on its real test site off Le Croisic early in 2018. Accordingly, its capacity is not yet officially considered to be operational and therefore has been left out of our **tables 3 and 4.**
The sector's activity over the next three years should keep its momentum and a new installation record is expected in 2019. WindEurope forecasts European installed capacity in 2020 will be 25 GW, with another 3.3 GW expected from the UK, 2.3 GW from Germany, 1.3 GW from Belgium, 1.3 GW from the Netherlands and 1 GW from Denmark.

OUTPUT FOR THE YEAR 2017 BACK TO NORMAL

The year 2016 was particularly bad for wind power production across the European Union, with major shortfalls off the coasts of the British Isles, the North Sea, the Baltic Sea and across more than half of Northern Europe. The wind power output of Germany, the UK, Denmark and Sweden fell despite the growth in capacity of their respective fleets. The contrast was all the more glaring because weather conditions in 2015 had been particularly conducive to wind power production in those countries.
In 2017, weather conditions returned to normal in Northern Europe and Germany. According to ENS data, Denmark's wind energy load factor was 30.5% in 2017 compared to 27.8% in 2016. In Germany, according to UBA, the mean load factor increased sharply to 22.7% in 2017 (i.e. 1990 hours of operation at full load) compared to 18.1% in 2016, boosted by the deployment of its offshore wind farms. In France, the monthly load factor picked up only slightly in 2017, hence the increase in production (24 TWh according to RTE) was primarily due to the connection of new wind turbines. In Italy, it decreased slightly, according to Terna (from 21.5% in 2016 to 20.6% in 2017), but output was stable at 17.7 TWh, thanks to newly-connected capacity.
Wind energy's return "to normal" resulted in a spike in wind power output (16.7% more than in 2016), as the production capacities installed over the two previous years realised their potential. EurObserv'ER reckons that European Union output reached 353.5 TWh, which is a 50.6 TWh year-on-year gain **(table 5).** More than half of this increase came from German wind farms. According to AGEE-Stat, German output increased by 26.3 TWh to reach 104.9 TWh. Spanish wind power output should remain stable at 49.1 TWh, ahead of the UK, which should be more than 45 TWh (on the basis of the Q4 output extrapolation made by EurObserv'ER).

NEWS FROM THE MAIN MARKETS

German tenders on the way to 0 euro cents per kWh

Germany is the driving force behind the European Union wind energy market, and in 2017 it posted a new installation record. According to AGEE-Stat, it installed 6 440 MW of which 5 165 MW was onshore and 1 275 MW offshore. If we discount decommissioned capacity (430 MW in 2017), Germany's installed capacity to date is 55 602 MW (50 195 MW onshore and 5 407 MW offshore).
Installed capacity per 1000 inhabitants rose to 671.5 kW, which puts it in 4th place in the European Union ranking **(graph 3).** The reason for the annual installation peak can be put down to the developers' endeavours to take advantage of the highest payment conditions. This is because the German government implemented major changes in its support mechanisms for the wind energy sector in 2017 by moving to a tendering system and direct sales. In January 2018, the Franco-German Energy Transition Office (Ofate) reported on support mechanism trends. Tenders were implemented as part of the 2017 renewable energy law (EEG 2017) and are now compulsory for all installations with capacity in excess of 750 kW (excluding pilot projects of up to 125 MW per annum). The new law also provides for limiting the volume of tenders, thereby capping the installation of new wind energy production capacities. As we explained in our 2017 barometer, the law provided for an annual onshore tendering volume last year of 2 800 MW, distributed over three tenders (800 MW in May, 1000 MW in August and 1 000 MW in November). For 2018 and 2019, there will be four tenders for 700 MW in the months of February, May, August and October, and from 2020 onwards the annual capacity of 2 900 MW will be distributed over three tenders.
Ofate points out that a reference yield model will be used to correct the value declared by the bidders to ensure even project distribution over German soil. The coefficient applied to the less windy sites will raise the stated reference value, while a correction coefficient will be applied to sites with high wind potential to reduce

WIND ENERGY BAROMETER – **EUROBSERV'ER** – FEBRUARY 2018

Tabl. n° 5

Electricity production from wind power in European Union in 2016 et 2017* (TWh)

	2016	2017
Germany	78,598	104,900
Spain	48,906	49,100
United Kingdom	37,367	45,510
France**	21,400	24,000
Italy	17,689	17,492
Sweden	15,479	17,100
Denmark	12,782	14,772
Poland	12,588	14,412
Portugal	12,474	13,040
Netherlands	8,170	10,223
Romania	6,590	7,100
Ireland	6,149	6,600
Belgium	5,436	6,174
Austria	5,235	6,100
Greece	5,146	5,676
Finland	3,068	4,802
Bulgaria	1,425	1,450
Lithuania	1,136	1,357
Croatia	1,014	1,107
Hungary	0,684	0,700
Estonia	0,594	0,700
Czech Republic	0,497	0,573
Cyprus	0,226	0,211
Luxembourg	0,101	0,211
Latvia	0,128	0,150
Slovakia	0,006	0,006
Slovenia	0,006	0,006
Malta	0,000	0,000
Total EU 28	**302,893**	**353,472**

Estimate. **Overseas department not included.* ***Source: EurObserv'ER 2018.*

this value. Limits are also prescribed to grid development zones to optimize wind energy integration. Citizen projects have special terms for bidding.

The results of the three tenders in 2017 manifested a sharp drop in bidding value. The average reference price of the first three tenders closed in May, August and November 2017 dropped from 5.71 euro cents per kWh (807 MW allocated) to 4.28 euro cents per kWh (1 013 MW allocated) to 3.82 euro cents per kWh (1 000 MW allocated). The lowest bid proposed in the last tender was 2.2 euro cents per kWh.

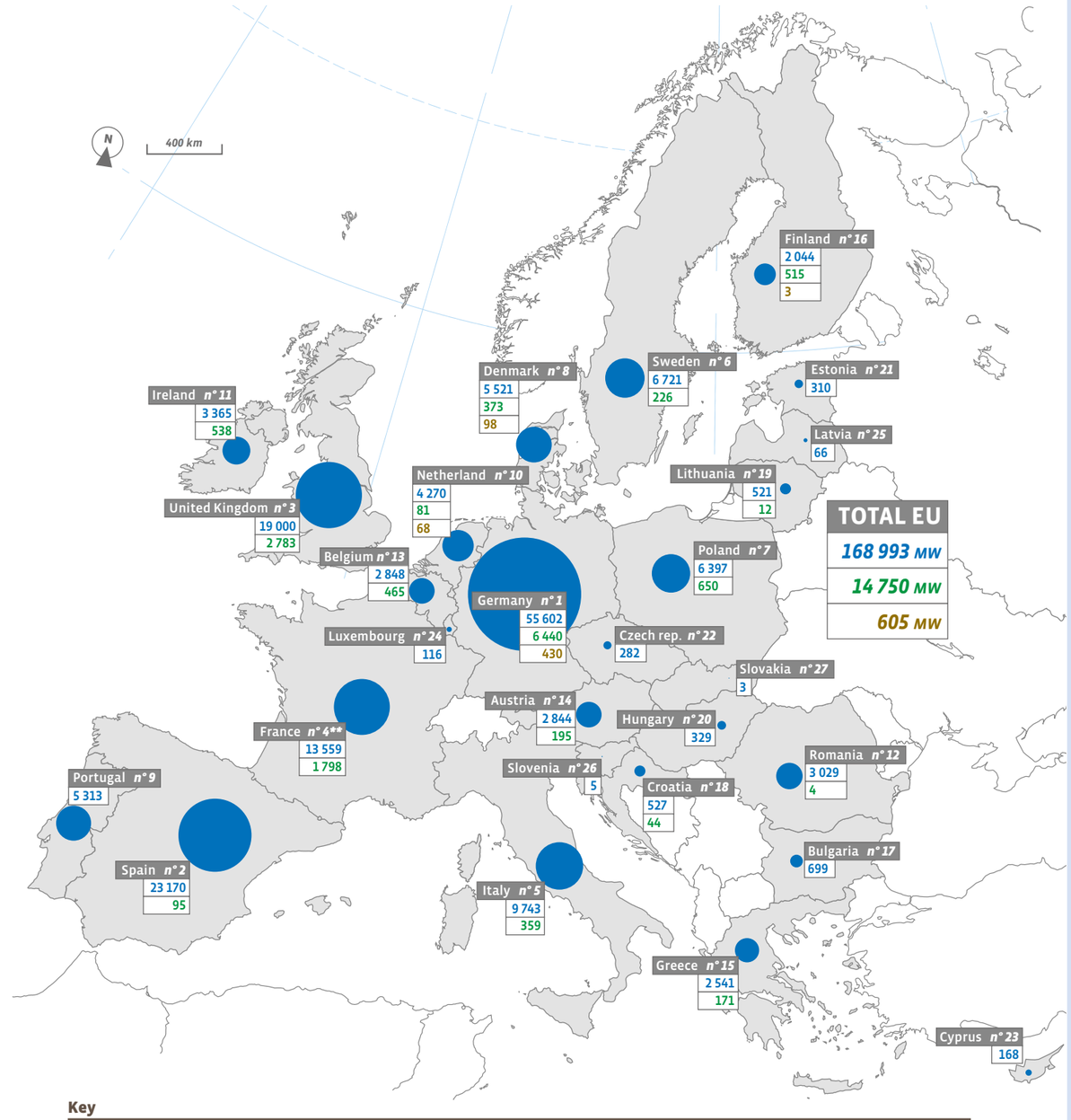
As for offshore, a tender closed on 1 April 2017 and another one is slated for 1 April 2018, both are for a volume of 1 550 MW. These two tenders cover existing projects, namely projects that already have secured authorisation or have a scheduled consultation date. They aim to result in the installation of 500 MW in 2021 (exclusively in the Baltic Sea), 500 MW in 2022 then 700 MW per annum between 2023 and 2025. The tender that closed on 1 April 2017 resulted in an average reference price of 0.44 euro cents per kWh with three bids at 0 euro cents per kWh and one bid at 6 euro cents per kWh. All the successful projects are for the North Sea – He dreiht, Borkum Riffgrund II West, Gode Wind 3 and OWP West.

Thorsten Falk, Mission Head for the Renewable Energy Office of the German Ministry for Economic Affairs and Energy (BMWi) says that if the tender results in 2018 bear out the strong downward trend in onshore wind energy pricing, future bids at 0 euro cents per kWh cannot be ruled out, as already witnessed in the last round of bidding for offshore wind energy. In that case, the remuneration level for onshore wind farms would depend exclusively on spot price changes. He believes this would have a direct impact on project financing terms, and result in heavy concentration of the market players in years to come.

France returns to the fray

At the start of the year, the first data available on the wind energy market and the installed fleet capacity on mainland France are released in "Panorama of renewable electricity in 2017" co-published by RTE (the high voltage grid manager), Enedis (the public electricity distribution grid manager), ADEeF (the Association of electricity distribution network operators in France) and the Association of Renewable Energy Industrialists. The Panorama indicators, finalized on 31 January 2017, are provisional and differ slightly from the official Directorate General of Energy and Climate (DGEC) figures that will be released later in the year because they use different calculation methods (they factor in connections for the grid data instead of the obligation to purchase figures). According to the Panorama publication, an installation record was set for the second year running in 2017 with 1 797 MW connected, compared to 1 437 MW in 2016. Total French capacity increased by 15.3% to reach 13 559 MW. The number of new projects in the pipeline also remained high. Development projects account for a volume of 11 516 MW, which is a 5% year-on-year rise, despite the faster connec-

Installed wind power capacity in the European Union at the end of 2017* (MW)



Key

168 993 Installed capacity to date in the countries of the European Union at the end of 2016 (MW)

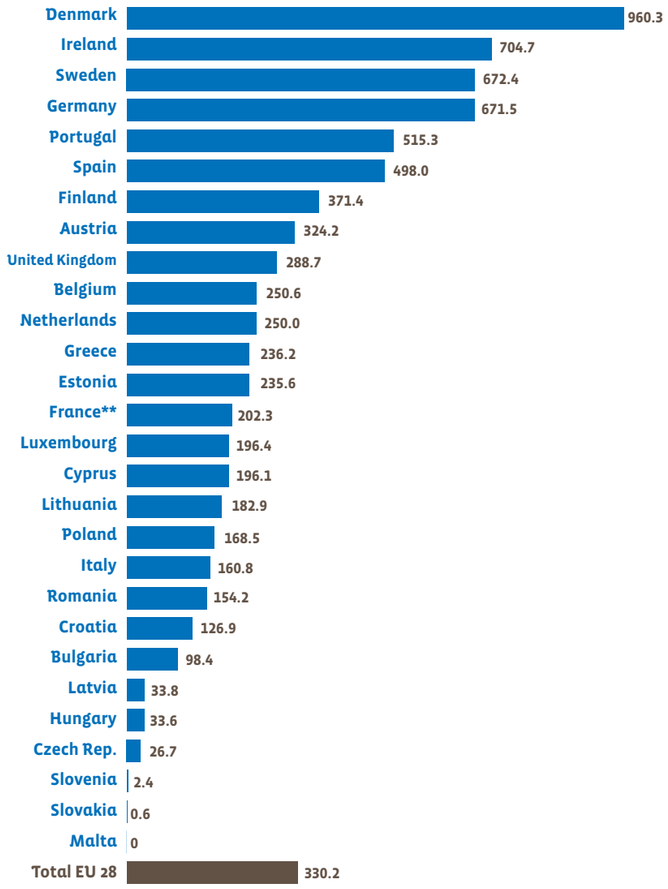
14 750 Capacity installed in the countries of the European Union 2016 (MW)

605 Capacitiy decommissioned during 2016 (MW)

Estimate. ** Overseas departments not included for France.* ***Source: EurObserv'ER 2018.*

Graph. n° 3

Wind power capacity per 1,000 inhabitants in the EU in 2017 (kW/1,000 inhab.)*



Estimate. **Overseas departments not included for France.* ***Source: EurObserv'ER 2018.*

tion pace that demonstrates the sector's upstream impetus.
The weather conditions were more conducive to production in 2017 than in 2016, enabling the acceleration in the installation pace over the past two years to be exploited. It stood at 24 TWh, boosted by a particularly windy fourth quarter (7.8 TWh produced). Wind energy covered 5% of France's electricity consumption in 2017, which is a 0.7% increase over 2016. The coverage rates in the Haut-de-France and Grand-Est regions were 11.2% and 12.1% respectively.

The positive momentum in France is the outcome of the stabilisation of the regulatory framework in 2016, which abandoned Feed-in Tariffs in favour of top-up remuneration added to the market price. This was aided in 2017 by the introduction of a two-part support mechanism comprising a first-come-first-served direct engagement basis for wind farms comprising up to and including six turbines, none of which may have a design capacity of more than 3 MW (wind farms up to 18 MW) and the introduction of tenders for other wind farms. There are two top-up remuneration support systems, either set by a tariff order (first come first served basis), or by tendering. A management premium is added to this top-up amount to offset the marketing costs, balancing costs and operator mark-ups for direct sales. This management premium was set at € 2.80 per MWh for 2016 and 2017. The capacity market income is subtracted from the producer's total remuneration. In the case of tenders, the capacity market income and management premium are directly factored into the formulated bid price.
The government aims to continue rationalising the administrative rules for wind energy, by enacting the single environmental authorisation in 2017 and by setting up a Ministry of Ecological Transition working party to simplify planning and authorisation rules. Thus, sector development will be accelerated while protecting the environment and promoting project involvement by elected representatives and the local population.
The first onshore wind energy tender specifications were published in May 2017 (a few months late because of the post-presidential election change of government), with the intention of connecting an additional 3 gigawatts of capacity in the next 3 years. The first bidding round for 500 MW closed on 1 December 2017. Five new rounds, each for 500 MW, should be launched in succession until May 2020. As for fixed-bottom offshore wind energy, summer 2018 should see the publication of the results of the 3rd tender for operating a wind farm with a capacity of 250–750 MW in an area off the coast of Dunkirk. A tender is being prepared for a wind farm off the Isle of Oléron. Lastly, in October 2017, Nicolas Hulot, the Minister of Ecological Transition announced the launching of studies of sites and winds to serve as the bases for new floating wind energy tenders off the coasts of Brittany and the Mediterranean with the opening of public debates during 2018.

UK offshore wind energy gets underway again

The BEIS (Department for Business, Energy and Industrial Strategy) official installation figures were incomplete for Q3 2017 by mid-February. Nonetheless they point to a stronger installation pace than in 2016 with 1 536 MW installed onshore


DR

The Breteuil-Equenoy wind farm in Oise department, France.

and 834 MW offshore, for a total fleet of 18 597 MW. Given this momentum, EurObserv'ER reckons the cumulative capacity by the end of Q4 will be at least 19 GW including 6.4 GW of offshore capacity.
The dramatic drop in offshore wind energy prices makes headline reading. On 11 September 2017, the UK announced the results of its second round of "Contract for Difference" bidding – the mechanism that the UK government introduced to guarantee a purchase price for renewable electricity producers. The "Contract for Difference" has a 15 year term from the time production starts (except for the 35 year term for the Hinkley Point project). The operator sells the output on the market throughout the contract term. If the market price is lower than the strike[1] price, the State, via the Low Carbon Contracts Company (LCCC), repays the difference to the operator. If the price is higher, the operator repays the surplus to the LCCC. Offshore wind energy emerged as the winner of this tender as it secured more than 95% of the allocated capacity. The auction's flagship project is the Hornsea 2 offshore wind farm developed by Breesea Limited. With its design capacity of 1 386 MW (capable of supplying electricity to 1.4 million

1) A price for electricity reflecting the cost of investing in a particular low carbon technology.

Tabl. n° 6

Main European wind farm developpers and operators 2017

Company	Country	Wind capacity developped or operated (in MW including offshore) 2017[1]	Annual turnover 2017 (in m€)	Employees 2017
Iberdrola Renovables	Spain	16 077	2 585[2]	n.a.
EDP Renewables[3]	Portugal	10 652	1 651	1 206
EDF Energies Nouvelles	France	9 946	1 348	3 142
Acciona Energy	Spain	9 173	2 000	n.a
E.ON Climate Renewables	Germany	8 610	n.a	n.a
Enel Green Power	Italy	8 500	n.a.	n.a.
Vattenfall	Sweden	5 538	944	773
Orsted	Denmark	4 486	2 727	2 253
RWE Innogy	Germany	4 139	n.a.	n.a.
WPD AG	Germany	4 104	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. 2017 figure. ***Source: EurObserv'ER 2017.***

JAN OELKER/REPOWER

The Ormonde offshore wind farm in Irish Sea near Barrow-in-Furness.

UK homes), it won the bid with a strike price of £ 57.50 per MWh (actual price in 2012) and is scheduled to go on stream between 2022 and 2023. Two other offshore projects were retained – the Moray Offshore Windfarm East, with 950 MW of capacity and the same strike price of £ 57.50 per MWh, scheduled to go on stream between 2022 and 2023. Another project scheduled for 2021/2022, Triton Knoll Offshore Wind Farm with 860 MW of capacity was awarded a strike price of £ 74.75 per MWh. The results show that renewable energy costs have been slashed by comparison with the projects selected in the first round of bidding in 2015, when the lowest strike price awarded was £ 114.39 per MWh. This amounts to a reduction of about 50% in the space of two years. The price fall is much more drastic than forecast by the BEIS in 2016, when it suggested that offshore wind energy projects commissioned in 2025 would cost £ 100 per MWh. UK offshore wind energy is fast approaching the country's electricity wholesale price which is around £ 50 per MWh. Note that in contrast with Germany, whose average bidding prices for offshore power are already close to 0 euro cents per kWh, site developers have to bear the grid connection costs under the British system, which results in higher prices.

II - THE ONSHORE INDUSTRY IS MATURE. CAN THE SAME BE SAID FOR OFFSHORE?

EUROPEAN INDUSTRY HAS THE WIND ENERGY INDUSTRY AS ONE OF ITS MAINSTAYS

A few years ago, many major wind energy industry groups merged. One instance was the merger of Siemens and Gamesa to create a new giant (Siemens Gamesa Renewable Energy, SGRE), that was the sector No. 2 for installed capacity in 2016. The sector's importance could be demonstrated by analysing the size of these emerging giants. Now this vision can be deepened using a different assessment grid. Today, over and above its environmental virtues, wind energy has become a job and added-value creator… an industry like any other that should be included in European socio-economic analyses.

In November 2017, WindEurope and Deloitte published a study entitled "Local impact, global leadership". It analyses the impact of the wind energy industry on Europe's economy from 2011 to 2016. Firstly, it states that in 2016, the wind energy industry contributed approximately 36.1 billion euros to the European Union's Gross Domestic Product (GDP), or 0.26% of the total. In addition, we should remember that the European wind energy industry creates value as it is a net exporter. This is because the industry's imports amount to € 5.4 bn whereas exports amounted to € 7.8 bn in 2016, giving a positive trade balance of € 2.4 bn. These results are the fruit of many years' experience and the desire for "high product and service quality". The Wind Power Monthly journal in its top ten global wind energy equipment manufacturers classification for the 3rd quarter of 2017, disclosed that the Danish company Vestas, the No. 1, had sold fewer wind turbines than Goldwind in 2016. Nonetheless, as the unit capacity of its turbines is higher, the global capacity of its sales in MW, is higher than that of its Chinese rival. The turbine manufacturers are the highest contributors to this trade balance, accounting for 42.5% of exports, followed by the manufacturers of specific components (33.4%). The industry paid € 4.9 bn in taxes to the European Union economy. Lastly, the study reminds us that wind power production gives greater geopolitical significance to energy independence. The European Union currently imports almost 50% of its energy. Thanks to wind energy, between 2011 and 2016, 171 952 ktoe of energy were not purchased outside Europe's borders. Savings of € 32 bn have been made – mainly on imports of natural gas. EurObserv'ER also points out that the sector employs 309 000 individuals in Europe, all skills levels and all activities taken together.

At a global level, the technology challenge being addressed by the industry is to improve turbine load factors. BNEF explains that with bigger rotors, higher masts, improved control and more efficient maintenance, the load factor has risen from 16% in 2000 to 31% in 2016, with some projects in excess of 50%. By 2040, a further 8–17% of improvement is expected. Wind power storage solutions also address the variable nature of wind. Vestas has developed many pilot projects including storage since 2012. In September 2017, it announced that it was working with Tesla on the issue. In December, it announced that it was investing € 10 million in a project to be conducted in partnership with Northvolt, a battery manufacturer, to develop a lithium-ion battery platform for wind energy projects.

OFFSHORE WIND ENERGY LETS US THINK EVEN BIGGER

The figures in this study result from adding onshore and offshore wind energy figures together. They are particularly representative of onshore wind energy, but there is no doubt as to offshore wind energy's maturity. Firstly, the competitive environment is intense, and the manufacturers have entered a race to see who can build the biggest turbines, which is fast seeing the arrival of technology giants onto the market. Proof of the speed of this development, is that the company SGRE has stopped selling its 7 MW offshore wind turbines even though the first 7 MW model to be sold has yet to be installed. The company wants to install 8-MW turbines in 2020. In May 2017, at the American Wind Energy Association exhibition, the German company Senvion stated its intention to develop a 10 MW turbine. In 2017, the offshore segment-dedicated joint-venture between Vestas and Mitsubishi (MHI Vestas) installed an 8 MW wind turbine and modified its production lines to be able to manufacture 9.5 MW wind turbines.

The competitive environment is slashing project costs, and the nature of these cost cuts has changed. Thus, they are no longer necessarily technology-related, and are concomitant with market maturity. Lower financing costs are the first example. Borrowing money and raising funds from investors are becoming cheaper. This trend reflects investors' and insurers' confidence, as wind energy projects pose less perceived risk than a few years ago. The sector appears not to have made a quantified study of the reductions in capital costs of offshore wind energy, but the industry's professionals involved in setting up projects sector's certainly talk about it.

Incidentally, project costs can be reduced further through better fluidity of the value chain. Thus, the European Commission has funded the Leanwind project to the tune of 10 million euros, which has been looking for ways to reduce costs through the marine wind energy value chain since 2013. The project's final report was published at the end of 2017 and highlighted three cost-cutting mechanisms. The report observes that expertise is highly internalised in the major groups, because of the importance of intellectual property and the lack of global experience ascribable to the sector's relative youth. However, the sector should move towards a stronger outsourcing culture, provided it is accompanied by the transfer of developers' know-how to the materials suppliers. Additionally, the report warns that contracts are of prime importance when the value chain is extended. They must be clear about how responsibilities and risks are allocated between the parties. Anticipating and consolidating the value chain through contracts can lead to cost reductions. Lastly, the report recommends greater resort to local businesses to supply developers, to reduce financing and environmental costs.

The industry is also enthusiastic about floating wind energy, for since the idea was mooted they have emphasized the fact that this technology can harness greater expanses of offshore surface. But in 2017, the industry has highlighted another industrial advantage that floating wind energy has over fixed-based

WIND ENERGY BAROMETER – **EUROBSERV'ER** – FEBRUARY 2018

wind energy in the form of standardised industrial production of the installations. As it happens, the production of floating wind turbines is easier to harmonise, whereas each fixed-base wind turbine project is unique because of the specifics of the seabed and its depth. However, the standardisation of floating wind turbine models is contingent on the shape of the floater. So far, the industry working on this issue has yet to decide which is the optimum floater shape. The offshore wind turbine developed by Eolfi uses a "semi-sub" platform, also known as "buoyancy stabilised", where the wind turbine is semi-submerged.

III - FUTURE DEVELOPMENTS ARE PARTLY LINKED TO THE LEVEL OF EUROPEAN COOPERATION

The wind energy market rebound in 2017 can be ascribed to the implementation of a new regulatory framework for renewable electricity production incentive mechanisms. In a press release, Giles Dickson, the CEO of the WindEurope association declared "a lot of the new projects were 'pushed through the gates' to benefit from feed-in-tariffs and other old support schemes while they still applied". This was true of Germany, but also of France and the UK. He then goes on to say that "despite the strong figures the medium and longer term outlook for wind is uncertain. The transition to auctions has been messier than we hoped. And crucially we lack clarity from many Governments on their ambitions for renewables post-2020. Countries need to start clarifying how much wind energy they want to deploy in the future".

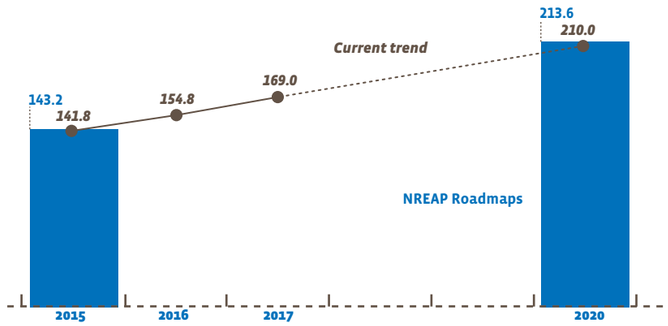
Until 2020, the trend is overall in phase with the National Renewable Energy Action Plan targets across the European Union (graph 4). The reduction in wind energy prices and their competitivity in relation to other technologies open new prospects for the sector. Yet the future wind energy development pace, in contrast with the American and Chinese markets will be constricted by the dearth of outlets in the European electricity market, whose overcapacity situation relating to the inflow of "variable" renewable energy has resulted in reducing the price of electricity on the wholesale market and weakened many historic operators who are lobbying and asking for time to decarbonise their production systems. This situation explains the difficult negotiations over the next energy climate package that will condition the development framework of the various renewable sectors until 2030. The European Parliament is trying to throw all its weight behind negotiating a new final renewable consumption target of 35% for 2030, which is more ambitious than the 27% renewable energy target of the draft directive currently proposed by the European governments and the European Commission.

As part of the current negotiations, a solution being pushed by the European Commission's Directorate General for Competition will entail setting up cross-border tenders that will make it easier to develop renewable energy in the most conducive zones, with the lowest possible costs. At an Ofate conference that was held on 10 October 2017, Pierre Loaec of DG Energy reminded the audience that nine European countries (Germany, Luxembourg, Denmark, Estonia, Romania, Greece, Italy, Portugal and Belgium) have already committed to the European Commission and under the future "Clean Energy Package" they will open all or part of their support mechanism to neighbouring countries. At the same time, other Member States are updating their legislation to create the legal framework to enable these cross-border tenders to be established. Giving access to 10–15% of tenders to foreign capacities would reduce the European Commission's support costs from 2021 to 2030 by roughly 4–5%. The European Commission also believes that opening tenders to cross-border bidding is the most effective way of encouraging the harmonisation of support mechanisms, and furthermore believes that this openness would enable a European renewable energy development target to be set linked to a "European" support mechanism.

This framework vision with the implementation of the Union of Energy that aims to strengthen the European electricity market, will enable all electricity suppliers to sell their energy to customers in another European country, via the cross-border interconnections. The development of these interconnections will increase the security of supply, optimise the use of production facilities within the European Union and, for renewable energy, make the most of the complementarities between the different European countries in terms of windy zones and sunshine ranges, while benefiting from the proliferation effects. The development of interconnections will lead to moving on from a national optimisation rational to a European optimisation rationale, which is more efficient for deploying renewable energies and energy transition. The future development pace of wind energy will be closely linked to the level of European cooperation within the framework of a common energy vision, and the efforts to combat global warming agreed by the Member States by the 2030 timeline. □

Graph. n° 4

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



Source: EurObserv'ER 2018.

Sources T2 and T5: UBA, AGEE-Stat (Germany), WindEurope (Spain), BEIS, EurObserv'ER (United Kingdom), RTE, SER (France), Svensk Vindenergi (Sweden), DGEG (Portugal), HOPS (Croatia), Terna (Italy), ENS (Denmark), Ministry of Industry and Trade (Czech Republic), www.boschenvanrijn.nl (Netherlands), IWEA (Ireland Republic), IG Windkraft (Austria), Tuuleenergia (Estonia), Litgrid (Lithuania), VTT, Finnish Energy (Finland), CERA (Cyprus), HWEA (Greece), Apere (Belgium), STATEC (Luxembourg), WindEurope (Poland), WindEurope (Romania), Tuuleenergia (Estonia), WindEurope.

The next barometer will cover photovoltaics.

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