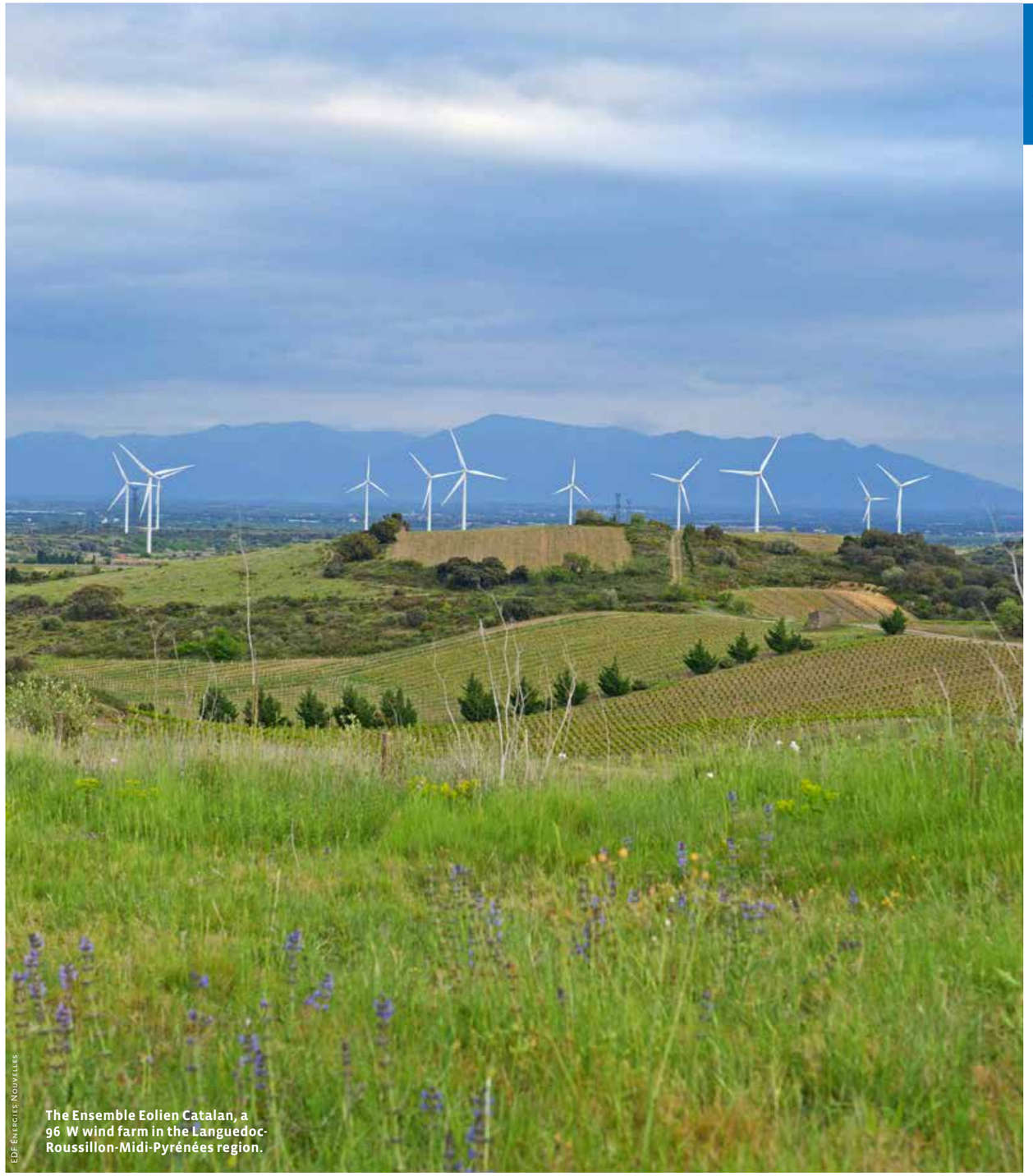


EDF Energies Nouvelles

The Ensemble Eolien Catalan, a 96 W wind farm in the Languedoc-Roussillon-Midi-Pyrénées region.

302.7 TWh

The estimated electricity production from wind power in the EU in 2016

WIND ENERGY BAROMETER

A study carried out by EurObserv'ER.

The global wind energy market appears to have encountered its initial limits. Since the beginning of the millennium it has expanded almost continuously to achieve 64.4 GW in 2015. Preliminary estimates for 2016 point to sales of 54.2 GW, which is down on the previous year's performance. Nonetheless, the results were good enough to give double digit growth of 12.4%, which took the global installed base up to 486.7 GW.

486,7 GW

Worldwide installed wind power capacity at the end of 2016

12.1 GW

Wind power capacity installed in the EU during 2016

WIND ENERGY BAROMETER – **EUROBSERV'ER** – FEBRUARY 2017

The Shimen Wind farm in Taïwan.

If we gloss over the one-off mishap in 2013 (when the US wind power market collapsed when extension of the Federal Production Tax Credit scheme was unduly delayed) the global wind energy market has grown almost uninterruptedly all along. Now it appears to be on the brink of a new phase. So far, the market has been driven by constantly falling production costs (onshore and offshore), the launching of new machines that are efficient even in low wind sites. Now it increasingly deals with grid integration issues and falling growth in the electricity demand. These development constraints are affecting the Chinese market in particular, which registered a net downturn in 2016 (of 24.2% compared to 2015), i.e. 23 328 MW (see below).

Tabl. n° 1

Worldwide installed wind power capacity at the end of 2016* (MW)

	2015	2016	Capacity installed in 2016	Decommissioned in 2016
European Union	142 041.5	153 640.5	12 068.1	469.1
Turkey	4 718.3	6 101.1	1 382.8	0.0
Norway	822.0	838.0	16.0	0.0
Russia	15.0	15.0	0.0	0.0
Rest of Europe	643.0	666.0	23.0	0.0
Total Europe	148 239.8	161 260.6	13 489.9	469.1
United States	73 992.0	82 183.0	8 203.0	12.0
Canada	11 219.0	11 900.0	702.0	21.0
Mexico	3 073.0	3 527.0	454.0	0.0
Total North America	88 284.0	97 610.0	9 359.0	33.0
China	145 362.0	168 690.0	23 328.0	0.0
India	25 088.0	28 700.0	3 612.0	0.0
Japan	3 038.0	3 234.0	196.0	0.0
Other Asian countries	2 482.0	3 019.0	544.0	7.0
Total Asia	175 970.0	203 643.0	27 680.0	7.0
Brazil	8 726.0	10 740.0	2 014.0	0.0
Other Latin America	3 492.0	4 556.0	1 065.0	1.0
Total Latin America	12 218.0	15 296.0	3 079.0	1.0
Africa & Middle East	3 488.0	3 906.0	418.0	0.0
Pacific region	4 823.0	4 963.0	140.0	0.0
Total world	433 022.8	486 678.6	54 165.9	510.1

*Estimate. **Sources : EU: EurObserv'ER 2017 / US: AWEA 2017 / TR: Turkish Wind Energy Statistics 2017 / NO, RU: WindEurope 2017 / Others: GWEC 2017**

486 679 MW ACROSS THE WORLD

THE TOP 5 SPREAD OVER 5 MAJOR GEOGRAPHIC ZONES

Although the Chinese market may have stalled slightly, the wind turbine industry enjoyed rather good health with a global market of 54 166 MW in 2016 (connected capacity). This installation level is the industry's second best performance after that of 2015, an exceptional year when about 64 400 MW of capacity was installed **(table 1)**. The USA maintained its 2015 installation level in 2016, i.e. a market of 8 203 MW (ranked world No. 2) and the European Union held up well with 12 068 MW, on the strength of the performance of the German (5 443 MW, ranked world No. 3), French (1 346 MW) and Dutch (789 MW) markets. As for India, it posted a new installation record (3 612 MW) that secured it the No. 4 place in the wind energy market rankings. Although Brazil's installation level declined by 27.1% compared to with 2015, it maintained its leading South American market ranking (at 2 014 MW), and remained in the world top 5.

Although it had declined, the market level for 2016 was still high enough to give the global base double digit growth (12.4%) which is now at 486.7 GW **(graph 1)**. China now has more than one third of the world's installed capacity (168.7 GW) which is more than the whole of the European Union's capacity put together (153.6 GW). Furthermore, China's capacity is double that of the USA (82.2 GW) and more than three times as much (3.4 times) as Germany's (50 GW). Another six countries across the world have more than 10 GW of installed capacity, namely India (28.7 GW), Spain (23 GW), the UK (15 GW), France (11.7 GW), Canada (11.9 GW) and lastly Brazil that joined them in 2016 (10.7 GW).

A more general geographic analysis confirms that more than ever before, Asia is the wind energy market driving force. The continent accounted for a little over half (51.1%) the world's installed wind turbine capacity in 2016 **(graph 2A)**. Europe came in a strong runner-up with almost a quarter (24.9%), ahead of North America (17.3%) and the rest of the world (6.7%). In terms of total capacity to date, Asia (41.8%) is establishing an increasing lead over Europe (33.1%) and North America (20.1%) **(graph 2B)**.

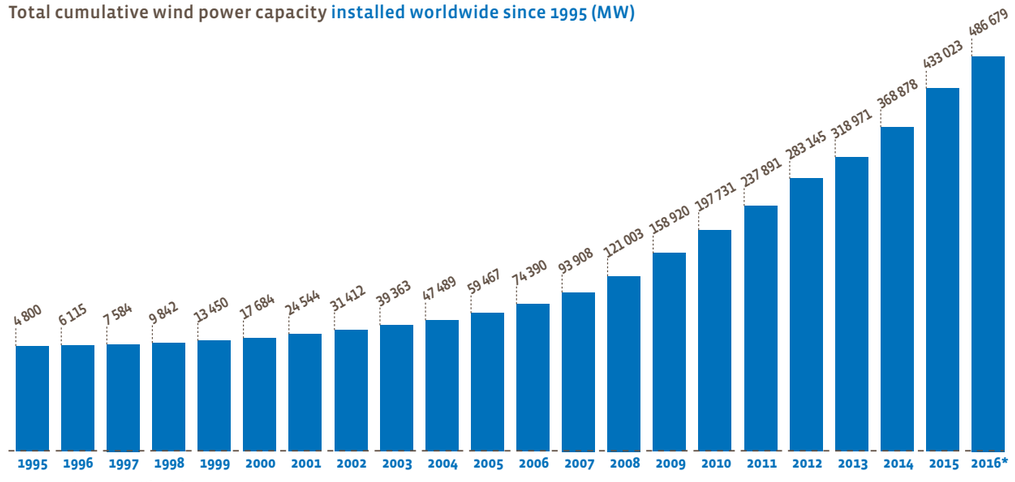
While the main core of the global market remains onshore, the offshore segment is still bracing its foundations. A little more than 2 GW of capacity was connected in 2016, which takes global offshore installed capacity to date to 14 160 MW.

Methodology note

It should be pointed out that the sources used to create the indicators of this theme-based barometer (listed at the end of the survey) may differ from those used in our publication: *The state of renewable energies In Europe, 2016 edition.* EurObserv'ER prefers to use the same source for the two years it is presenting in the interests of statistical consistency and to chart market trends more accurately. This choice may explain the slight differences from the indicators previously published sourced from official bodies that will become available later on in the year.

Graph. n° 1

Total cumulative wind power capacity **installed worldwide since 1995 (MW)**



** Estimate.* ***Source: EurObserv'ER 2017.***

China, which according to GWEC (Global Wind Energy Council) added 592 MW (pushing its total up to 1 627 MW) is gradually rising up the global offshore wind energy rankings and has knocked out Denmark to take third place behind the UK and Germany.

NEWS FROM THE TWO MAIN GLOBAL MARKETS

China plans to invest 2.5 trillion yuan

The Chinese market's poorer performance can be largely be ascribed to the scheduled Feed-In Tariff reduction from 1st January 2016 in addition to the reasons cited in the introduction (grid integration and weaker growth of electricity demand). The FiT reduction naturally sparked off an installation race in 2015 to benefit from the higher rates and this marred the results in 2016. The Chinese Feed-In Tariff is set along the lines of 4 major production regions in diminishing order of wind resources – the North West (class 1), the North Central (class 2), and the North East (class 3) where wind conditions are relatively good and class 4 for the regions with low wind energy potential. The Feed-In Tariff for the first three classes was lowered by 0.02 CNY/kWh (€ 0.003/kWh) and that of class four by 0.01 CNY/MWh. A new reduction is already planned for 2018 of 0.03 CNY/kWh for the first three and 0.02 CNY/kWh for the fourth. The 2015 Feed-In Tariff was paid at 0.49 CNY/kWh, 0.52 CNY/kWh, 0.56 CNY/kWh and 0.62 CNY/kWh respectively. This equates to a FiT ranging from 0.071 to 0.085 euro cents/kWh (applying the mid-February 2017 exchange rate).

The GWEC, which published the initial estimates of the Chinese market, forecasts a return to growth in 2017, on the basis of its massive renewable energy development prospects. On 5 January 2017, the NEA (National Energy Administration) announced a renewable energy plan earmarking 2.5 trillion Yuan for investment from 2016–2020 which is the equivalent of 343 billion euros. No breakdown of the allotted funds has been provided so far. The NEA aims to reduce the country's coal consumption by 800 million tonnes per annum by 2020, by developing gas and nuclear power plants at the same time. At the end of January 2017, the NEA announced that it was suspending the construction of 104 coal-fired power plants with combined capacity of 120 GW, almost half of which (54 GW) was already underway. Reducing the country's coal consumption will be an enormous task. The NEA pointed out the renewable energy would only account for 15% of China's total energy consumption in 2020. We need to bear in mind that this 15% equates to the consumption of 580 million tonnes of coal.

For the time being America's wind energy market is intact

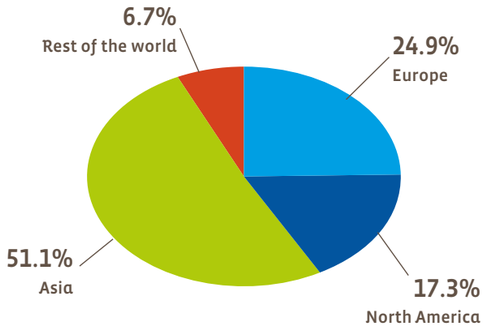
Every year, most commissioning work in the USA takes place during the last quarter of the year for tax reasons, and 2016 was a good year judging by the AWEA (American Wind Energy Association) data. The association claims an installation figure of 6 748 MW for the fourth quarter of the year (the second best quarter ever recorded), which took the newly-connected capacity to 8 203 MW in 2016. Therefore the 2016 market slipped slightly (by 4.6%) over the previous year (8 598 MW). Total US capacity stood at 82 183 MW by the end of 2016.

As a matter of interest, the AWEA points out that a strong market trend is being created as a considerable proportion of wind energy projects (more than 4 000 MW signed for in 2016) are subject to Power Purchase Agreements (PPA), whereby electricity providers and independent electricity producers enter into the electricity purchasing contracts. The agreement gives the producer the assurance that the power plant will be profitable by guaranteeing a market for the output at a pre-determined price.

The American market should be maintained over the next three years because it is protected by the Production Tax credit system until 2020. Until 2016, the tax incentive was $ 23 per MWh (€ 0.22/kWh). It has dropped to 80% of this amount for scheme constructed from 2017 onwards, and will fall to 60% in 2018 and 40% in 2019. Projects constructed after 31 December 2019 will not be covered by the arrangement. From 2020 onwards, the US market context could toughen, as the new openly climate-sceptic US president is opposed to incentive schemes promoting renewable energies.

Graph. n° 2A

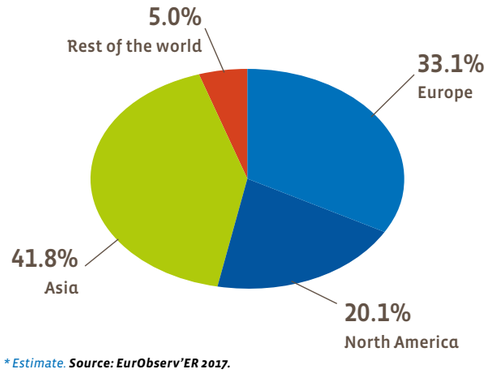
World wind turbine market - breakdown for 2016*



*Estimate. **Source: EurObserv'ER 2017.**

Graph. n° 2B

Cumulative capacity breakdown at the end of 2016*



*Estimate. **Source: EurObserv'ER 2017.**

A MULTI-SPEED EUROPEAN UNION

Despite the trying electricity market context (characterised by weak demand and production overcapacity), the European Union wind energy market held up rather well in 2016. It stayed above the 12 GW threshold (12 068 MW according to EurObserv'ER), and took the total installed capacity base of the European Union to 153.6 GW **(table 2).** Yet again Germany's excellent results of 5 443 MW, which amounted almost half (45.1% to be exact) of the EU market this year have to take the credit for this upbeat outcome. France turned up trumps as in 2016 it finally picked up and passed the one GW installed capacity mark (1 346 MW) – which is a new installation record. Other EU markets excelled themselves including the Netherlands (788.5 MW) which this year made it into the global wind energy top 10, boosted by connecting up the second biggest offshore wind farm ever installed (the 600 MW Gemini project). Finland beat its installation record (by

Tabl. n° 2

Installed wind power capacity in the European Union at the end of 2016 (MW)

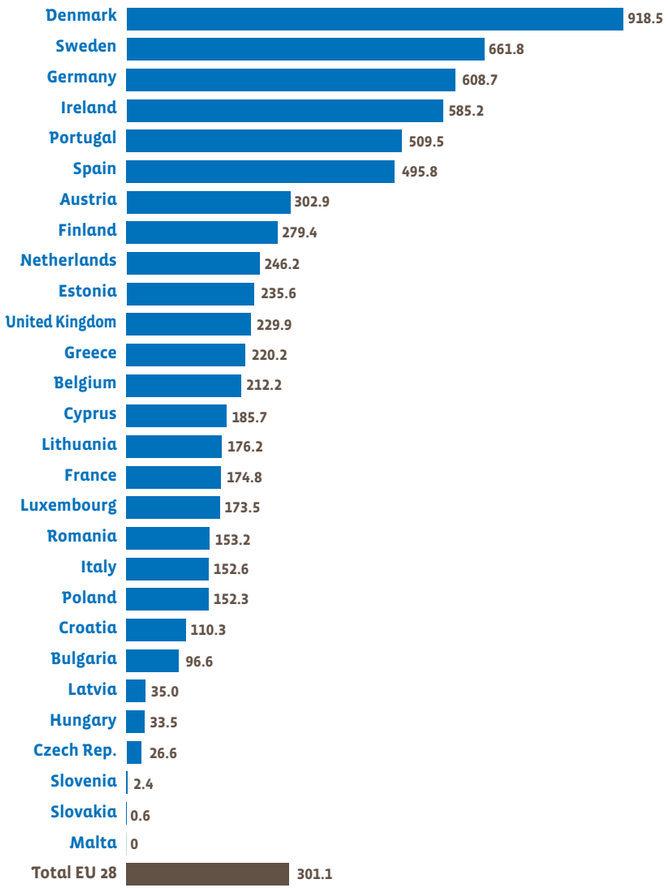
	Cumulative capacity at the end of 2015	Cumulative capacity at the end of 2016*	Capacity installed in 2016*	Decommissioned in 2016*
Germany**	44 942.0	50 019.0	5 443.0	366.0
Spain	22 987.8	23 026.0	38.2	0.0
United Kingdom	14 291.0	15 030.0	739.0	0.0
France***	10 324.0	11 670.0	1 346.0	0.0
Italy	8 972.8	9 255.4	282.6	0.0
Sweden	6 029.0	6 519.0	493.0	3.0
Poland	5 100.0	5 782.0	682.0	0.0
Portugal	5 034.0	5 269.0	235.0	0.0
Denmark	5 075.0	5 242.0	225.0	58.0
Netherlands	3 391.0	4 179.5	788.5	0.0
Romania	2 975.9	3 028.0	52.1	0.0
Ireland	2 440.0	2 764.7	324.7	0.0
Austria	2 404.0	2 632.0	228.0	0.0
Belgium	2 169.0	2 400.0	231.0	0.0
Greece	2 135.7	2 374.3	238.6	0.0
Finland	1 005.0	1 533.0	570.0	42.0
Bulgaria	691.2	691.2	0.0	0.0
Lithuania	438.0	509.0	71.0	0.0
Croatia	428.2	462.4	34.2	0.0
Hungary	329.0	329.0	0.0	0.0
Estonia	300.0	310.0	10.0	0.0
Czech Republic	280.6	280.5	0.0	0.1
Cyprus	157.5	157.5	0.0	0.0
Luxembourg	63.8	100.0	36.2	0.0
Latvia	69.0	69.0	0.0	0.0
Slovenia	5.0	5.0	0.0	0.0
Slovakia	3.0	3.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0
Total EU 28	**142 041.5**	**153 640.5**	**12 068.1**	**469.1**

*Estimate. ** In Germany 5 443 MW installed including 679 MW of repowering. *** Overseas departments not included for France. **Source: EurObserv'ER 2017.**

adding 570 MW) and in the space of twelve months increased its wind turbine base by more than 50%. Then Sweden added almost 500 MW (493 MW to be precise). It should be pointed out that given the size of these countries, their market momentum is very buoyant and is making significant impact on their changing electricity mix.
These promising developments are dogged by the apathy that prevails in a few European Union markets. According to our reckoning, 8 countries did not install any additional capacity, while some other markets were lethargic. Spain for example, which is the No. 2 European country for installed capacity to date, has only installed some tens of MW (38.2 MW in 2016) since January 2012 when it imposed a moratorium on aid to renewable energies. It looks as though it is about to turn the corner, for at the end of December 2015, the government announced that it was working on a tender for 3 000 MW, to include all types of renewable energies (wind, solar, biomass, etc.). The Italian market has slowed down considerably after its boom ended in 2013 and has only added 713 MW of capacity in the intervening three years (282.6 MW in 2016).

Graph. n° 3

Wind power capacity per 1,000 inhabitants in the EU in 2016 (kW/1,000 inhab.)*



*Estimate. **Overseas departments not included for France. **Source: EurObserv'ER 2017.***

THE BRITISH OFFSHORE SEGMENT GOING THROUGH TURBULENT TIMES

EurObserv'ER reckons that connected offshore capacity only increased by 1 412 MW in 2016(1), which is half the amount connected in 2015 when the connection figure was just over 3 000 MW. We reckon that Germany increased its offshore capacity by 824.3 MW and the Netherlands by 600 MW **(table 3).** However the figures for the UK are provisional as the BEIS (Department for Business, Energy & Industrial Strategy) had only released the connection data for the 3rd quarter by mid-February. At the beginning of 2016 the BEIS delayed decommissioning the Beatrice demonstration farm (10 MW). It could count the commissioning of the first wind turbines of the Burbo Bank extension at the end of the year and thereby add some tens of megawatts to the UK base. Other wind turbine demonstration projects that were decommissioned during 2016 include Portugal's Windfloat floating project (2 MW) and Germany's Hooksiel project (Bard 5.0 MW).
In 2016, only three new offshore wind farms were fully installed and connected **(table 3bis)**. The biggest is the Gemini Wind Farm (600 MW), 85 km off the Dutch North Sea coast (and thus invisible from the coast). It is the world's second biggest offshore wind farm (coming just after London Array with 630 MW), and should provide about 2.6 TWh of electricity every year (i.e. 2.5% of the country's electricity output). The Gemini Wind Farm required an investment of 2.8 billion euros and will cover the electricity requirements of 785 000 Dutch households (1.5 million people) and reduce carbon dioxide emissions by 1.25 million tonnes per annum. The two other wind farms are Gode Wind 1 (330 MW) and Gode Wind 2 (252 MW), which are also in the North Sea, 40 km off the coasts of Germany. According to Dong Energy, which has invested 2.2 billion euros in these two projects, they will supply enough power for 600 000 erman households. Many of Germany's Sandbank Wind Farm turbines (288 MW) were connected at the end of 2016 but the wind farm will only be totally on-grid at the beginning of 2017.
In the light of the projects under way, we can confidently announce a clear recovery in the installation pace for 2017 and 2018. After a break in 2015, explained by delays on a number of 3rd Crown Estate tender projects, the UK will be in the spotlight again with construction in progress on the Dudgeon East, Galloper, Race Bank and Rampion Wind Farms. German market growth will continue with construction on the Nordergründe, Nordee One, Veja Mate, Wikinger Wind Farms and Belgium with the NobelWind project. The WindEurope Association claims that at the start of 2017 construction was underway on no fewer than 4.8 GW worth of projects, 24.2 GW having obtained construction permits and 7 GW waiting for their applications to go through. A further total of 65.6 GW of projects are in the design phase. WindEurope reckons that investments in offshore continued to increase strongly in 2016, as 11 new projects obtained a final investment decision for a combined amount of 18.2 billion euros, which is 39% more than in 2015.

It should be noted that these statistics do not include the nearshore wind farms because their characteristics are more akin to onshore wind farms than those installed several kilometres out to sea. For example (and after checking with Statistics Netherlands) the Dutch nearshore wind farm, Westermeerwind (144 MW) which was entirely hooked up to the grid in 2016 is officially included in the onshore wind farm statistics.

Tabl. n° 3

Offshore wind power capacity connected to the grid in the EU at the end of 2016 (MW)

	2 015	2 016
United Kingdom	5 103.5	5 093.5*
Germany	3 284.0	4 108.3
Denmark	1 271.1	1 271.1
Netherlands	357.0	957.0
Belgium	712.2	712.2
Sweden	201.7	201.7
Finland	32.0	32.0
Ireland	25.2	25.2
Espagne	5.0	5.0
Portugal	2.0	0.0
Total EU 28	10 993.7	12 406.0

** For the UK, data refers to first 3 quarters of 2016.* ***Source: EurObserv'ER 2017.***

THE WEATHER IS THWARTING PRODUCTION

The year 2016 will hardly go down as a history making year for European Union electricity production. Initial EurObserv'ER estimates suggest that output will have increased only slightly (by 0.3%) to give a total of 302.7 TWh, which is low if we bear in mind the increase in generating capacities **(table 4)**. In contrast with last year, the weather conditions were disastrous for wind power generating from Northern Europe to the UK while they were mediocre in Germany and France. Southern Europe enjoyed slightly better wind conditions than in 2015.
According to the Danish energy agency, its output receded by about 10% (12.8 TWh), while in Sweden the drop recorded was as much as 12.7% according to Svenks Vindenergi estimates (14.2 TWh). Despite the German market's momentum, output will be hard put to exceed 80 TWh, which is barely up on its 2015 level. On 16 December 2016, the AGEB (AG Energiebilanzen) put the year's output at 79.8 TWh with 66.8 TWh from the onshore segment (70.9 TWh in 2015) and 13 TWh from the offshore segment (8.3 TWh in 2015). By mid-February, the BEIS data for the UK was still incomplete. It suggested a 486 GWh

Tabl. n° 3 bis

List of the offshore wind farms entirely connected to the grid during 2016 in the EU.

Name	Country	Capacity (MW)	Number of turbines	Type of turbines	Developer
Gemini	Netherlands (North sea)	600	150	Siemens SWT 4.0-130	Northland Power
Gode Wind 1	Germany (North sea)	330	55	Siemens SWT 6.0-154	DONG Energy
Gode Wind 2	Germany (North sea)	252	42	Siemens SWT 6.0-154	DONG Energy

Source: EurObserv'ER 2017.

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Siemens' wind service operation vessel for the Gemini wind farm.

SIEMENS

drop in output for the first three quarters of 2016. The data that was available for the fourth quarter only covered the Major Power Producers and pointed to a serious fall in output – namely 20% less than in Q4 2015. By our calculations, that would take the UK's output to 37.3 TWh or 3 TWh less than in 2015.

The provisional data for France published in the "Panorama de l'électricité renouvelables en 2016", produced in conjunction with the grid operator (RTE) and the French Renewable Energy Association (SER), indicates the figure of 20.7 TWh, which slipped because of poorer weather conditions. Nonetheless and despite less constructive market dynamics, growth was generally positive in Southern Europe. Referring to the monthly report for December published by Terna, the Italian grid operator, output increased by 18.7% between 2015 and 2016 to 17.5 TWh (14.7 TWh in 2015).

NEWS FROM EUROPE'S TWO MAIN MARKETS

Germany plans to keep its market in check

The German market performed well in 2016. Data released by Deutsche WindGuard GmbH shows that the country installed as much as 4 625 MW of onshore wind turbine capacity. If we bear in mind 366 MW of decommissioned capacity and 679 MW of repowering, namely capacity increase to existing wind turbines, it added 4 259 MW of net capacity. Grid connection of 156 offshore turbines adding 818 MW of capacity to the onshore facilities, took the German installed capacity base past the 50 GW (50 019 MW) threshold at the end of 2016.

The legal framework for setting the remuneration for wind power projects has been completely revamped in line with the latest renewable energy act reform (EEG 2017 dated 8 July 2016) and the new European Commission guidelines. Since 1 January 2017, the tender system for all new wind power projects of >750 kW has come into force. From now on the sole selection criterion will be the bidder's price for the tender. The volumes for tender have been set at 2 800 MW for 2017–2019 (the first tranche of 800 MW will be sent out on 1 May 2017) followed by 2 900 MW from 2020 onwards.

If we factor in the capacity of the projects approved by the Federal Grid Agency earlier (i.e. 6 128 MW) that still fall under the former legislation's terms (compulsory direct sale system with market premium), the volumes due for installation over the next two years will be significant as they will supplement those that are open for tender. BWE, the German Wind Energy Association, is thus expecting a 2017 for onshore installation level of 4 500–5 000 MW and of 3 000–3 500 MW in 2018. From 2019, when all the projects covered by the former legislation have been installed, the tendering system alone will constrain the market size. The EEG 2017 Act also adopts the commitment from the previous act to open up tenders, of up to 5% of annual installation capacities, to facilities located in other European Union countries. The Act provides for establishing a mechanism to convert excess renewably-sourced electricity into heat in view of the delays to electricity grid development. Development will be limited in regions where the electricity grid is already under severe strain. Newly installed capacity in these regions, primarily in Northern Germany, will not be allowed to exceed 58% of the mean annual volume installed from 2013 to 2015.

Germany intends to promote public wind energy projects by introducing purpose-designed simplified tendering procedures. A citizen energy project (Bürgerenergiegesellschaft) must be led by at least 10 people with a majority of locally presented votes. No member may have more than 10% of the votes, while local communities may participate up to 10%. The size of these projects is restricted to 6 wind turbines for a maximum combined capacity of 18 MW. The simplification measures for these citizens' projects include: no need for authorisation from the BImSchG (Bundesimmissionsschutzgesetz) for protection from environmental nuisances, proof of land reservation and a certified wind analysis will suffice. The demand for financial guarantee will also be limited to 50%. Moreover these projects will benefit from an extension to the completion time of up to two years.

As for the offshore segment, the Federal government plans to restrict its tenders to 1.7 GW in 2017 and to 1.4 GW in 2018 (compared to two tenders initially scheduled in 2017 for total capacity of 2.92 GW). In the longer term, the installation of offshore wind farms will be limited to 3.1 GW between 2021 and 2025 giving preference to Baltic Sea where there are more connection capacities. The installation of only 500 MW is planned for in the Baltic in 2021, followed by 500 MW in the North Sea and the Baltic Sea in 2022, followed by 700 MW per annum between 2023 and 2025, and 840 MW annually from 2026 onwards. The offshore target for 2030 is 15 GW. The purpose of these (offshore and onshore) limitations is to keep renewable energy development in pace with electricity grid development.

The French market wakes up

France may be relaunching its market at the best time, by taking full advantage of the sector's latest technological innovations and falling production costs. Data published in "Panorama de l'électricité renouvelables en 2016" shows that it was a record year for the wind energy sector. At least 1 345 MW of capacity was connected over the year, which is an increase on the 1 200 MW connected in 2009. The French base has an installed capacity of 11 670 MW in mainland France and Corsica. It is the 4th biggest wind turbine base in the European Union by capacity but is still only in 16th place by per capita capacity **(graph 3)**, behind Lithuania and Cyprus. Despite this new installation record, the connection pace is below what is needed to achieve the 2018 targets of the Multi-year plan on renewable energy that aims for installation of 15 GW (calling for 1 665 MW of connection in 2017 and in 2018). However implementation of simplification measures in recent years has made for a faster installation pace. "Panorama de l'électricité renouvelables" claims that at the start of 2017, the projects in the pipeline amounted to a volume of 11 397 MW, which is a 693 MW increase over the previous twelve months. From 1 January 2017 onwards, top-up remuneration (namely remuneration on the wholesale market, topped up by a State premium) will be applied to wind farms retained as successful bids. A multi-year tender for a total of 3 000 MW is planned for the first quarter of 2017, for an annual volume of 1 000 MW spread over two sessions. Wind farms with fewer than 6 wind turbines will also be eligible for top-up remuneration through an "open window" system, which will let them opt out of the rules for tendering. Under this system, the electricity will be sold on the wholesale market, but the income to the producers will be secured through a State-fixed reference tariff. The top-up remuneration mechanism aims to make

Tabl. n° 4

Electricity production from wind power in the European Union in 2015 et 2016* (TWh)

	2015	2016
Germany	79.206	79.800
Spain	49.325	50.157
United Kingdom	40.310	37.251
France**	21.249	20.700
Italy	14.844	17.455
Sweden	16.268	14.200
Denmark	14.133	12.782
Portugal	11.608	12.560
Poland	10.858	11.623
Netherlands	7.591	8.343
Romania	7.045	6.725
Ireland	6.573	6.115
Austria	4.840	5.700
Belgium	5.574	5.200
Greece	4.621	5.096
Finland	2.327	3.068
Bulgaria	1.454	1.460
Lithuania	0.807	1.131
Croatia	0.796	1.013
Hungary	0.693	0.700
Estonia	0.715	0.589
Czech Republic	0.573	0.497
Cyprus	0.221	0.226
Latvia	0.147	0.150
Luxembourg	0.102	0.108
Slovakia	0.006	0.006
Slovenia	0.006	0.006
Malta	0.000	0.000
UE 28	301.893	302.661

Estimate. **Overseas department not included.* ***Source: EurObserv'ER 2017.*

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The Chemin d'Ablis wind farm in the Eure et Loir department

Marc Didier/EDF

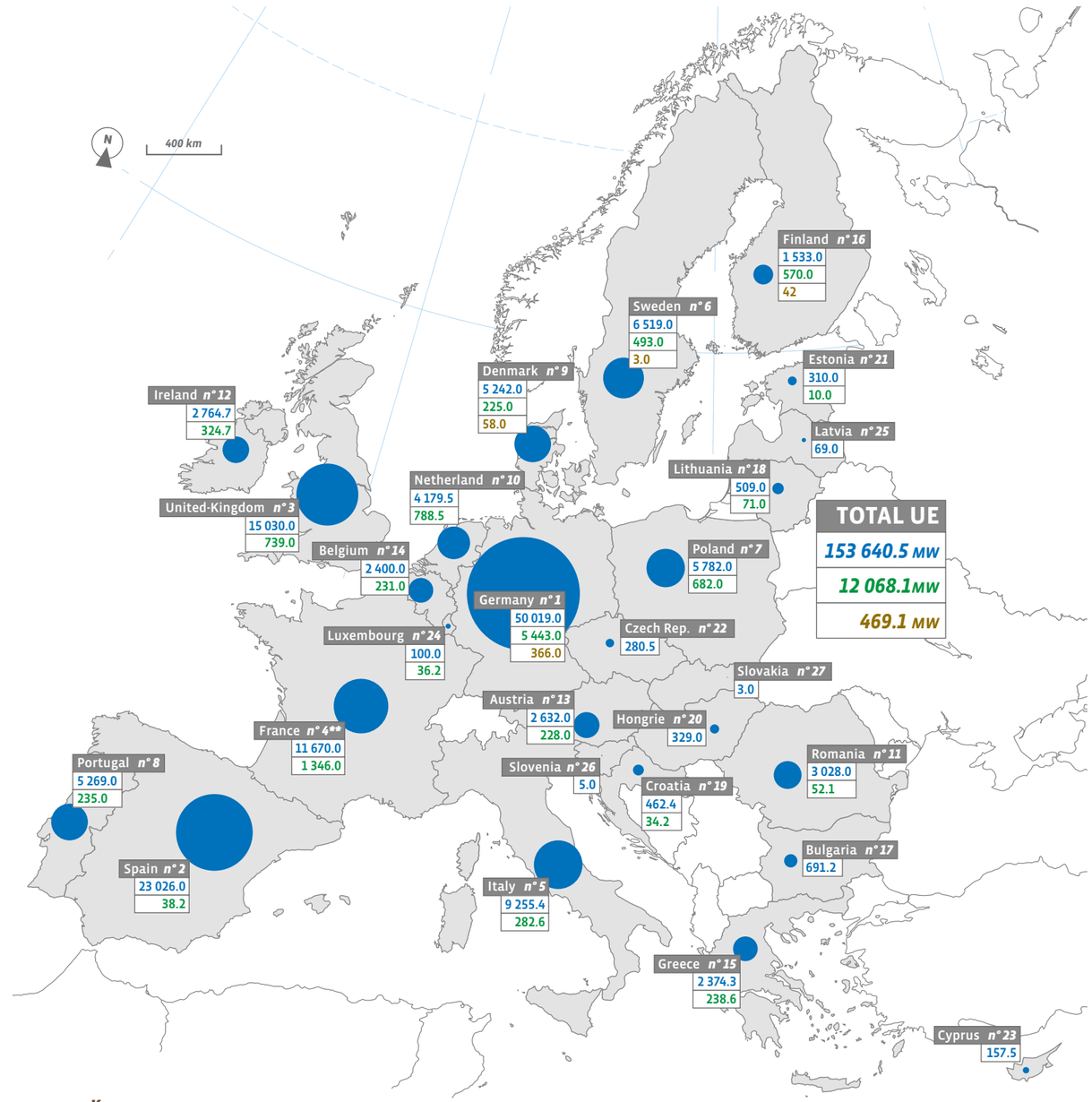
up the difference between the wholesale market price and this equivalent tariff. The Higher Council for Energy plans to set the reference tariff with top-up remuneration at € 72/MWh, and supplement it with a management premium of € 2.8/MWh.
Any projects that made full purchase contract or remuneration contract demands in 2016, will benefit from the new tariff order of 13 December 2016, which the European Commission approved the day before. The order ends the uncertainty that undermined the validity of the 17 June 2014 tariff order following the reform of the electricity public service tax (CSPE). Project leaders will be able to convert their full purchase contract demands into full top-up remuneration demands and retain the current purchase obligation rate of € 82€/MWh. On 12 December 2016 the first dialogue phase was launched for the 3rd tender for offshore wind turbines off the Dunkirk coast. This bidder preselection phase, which is open until 28 February 2017, will cover a volume of 250–750 MW. On 3 November 2016, the Minister announced that commercial tenders for floating wind and tidal stream energy were under preparation.

OFFSHORE WIND ENERGY HAS THE INDUSTRY SHIFTING

THE WIND ENERGY GIANTS ARE MANUFACTURING GIANT WIND TURBINES

Wind energy is making rapid progress in both its offshore and onshore segments, which has led to constant changes in the sector's competitive environment. Offshore, which is the more recent of the two, is having a major impact on the market's structure.
The market has been living with consolidation for a number of years, with bigger and bigger groups emerging to take up position in the offshore segment. It began in 2013 and initially took the form of groups creating common subsidiaries; this was followed by mergers-absorptions in 2015–2016. The major players started by creating alliances and common subsidiaries to gain a toe-hold in the market and test the water. The subsequent absorption demonstrates that the groups felt that the offshore segment was sufficiently promising to pitch for a 100% hold on a sector. So in 2013, Vestas and Mitsubishi formed a common subsidiary, MHI Vestas Offshore Wind Energy. In 2014, Gamesa and Areva created the Adwen subsidiary. The merger-absorption wave started in 2015 when General Electric bought out Alstom that was developing wind turbines. Then, in 2016, the wind energy universe saw its biggest change when Siemens acquired Gamesa. The merger created the world's largest

Installed wind power capacity in the European Union at the end of 2016* (MW)



Key

153 640.5 Installed capacity to date in the countries of the European Union at the end of 2016 (MW)

12 068.1 Capacity installed in the countries of the European Union 2016 (MW)

469.1 Capacitiy decommissioned during 2016 (MW)

Estimate. ** Overseas departments not included for France.* ***Source: EurObserv'ER 2017.*

wind energy group in terms of installed capacity. In June 2016 the merger was announced and then left in abeyance for a few months between the future Adwen, the Areva and Gamesa subsidiary. After an initial proposal from General Electric that was rejected, Gamesa bought out the remaining 50% of Adwen.

This general trend to concentrate is echoed in the onshore segment. As we recall, in 2015, Germany's Nordex and Spain's Acciona merged. At the start of 2016, Vestas announced it was acquiring Availon, a German wind energy provider. In October, General Electric acquired the blade manufacturer LM Wind Power and in November Senvion took control of blade manufacturer Euros Group.

As the sector's groups grow, so do the wind turbines. Offshore wind turbines are becoming more and more powerful and efficient, reaching 7 or 8 megawatts. Vestas is developing its 8 MW V164 model with a diameter of 164 metres. Siemens is selling a 7 MW SWT 7.0 that is 154 metres in diameter and has announced a forthcoming 8-MW model. Another race to build the biggest wind turbine is being run in the onshore segment. For example, Enercon is selling a 4.2 MW Enercon E 141 model with a diameter of 141 metres.

2016... OFFSHORE ESTABLISHED THREE ECONOMIC RECORDS IN A ROW

The second common theme in wind energy is the constant fall in the sales price for the electricity produced. Once again, it is offshore that is particularly dynamic, for three price records marked 2016.

In July, Dong made the successful bid for the Dutch Borssele 2 project with a sales price of € 72.70/MWh for 15 years followed by the market price. In September, Vattenfall successfully bid for the Danish Vesterhav project with a sales price of € 63.80/MWh. Then in November Vattenfall clinched another tender for the Danish Kriegers Flak project with a sales price of € 49.90/MWh. It should be noted that the Danish government will provide 470 million euros of support for the Kriegers Flak project. In less than two years the sales price has been halved from the February 2015 record price of € 103.10/MWh.

This has only been made possible by reducing the LCOE. The global cost is determined by six factors: total electricity output, the project service life, operating costs, capital cost, debt cost and lastly the investment schedule. As we saw before, wind turbines are increasingly powerful, which increases the overall production of electricity. The phenomenon is amplified by the improvement in wind turbine load factor, which is the ratio between the energy produced and the energy that could have been produced at its peak. Naturally, major economies of scale can be achieved by huge projects. For instance, Borssele (1 and 2 won by Dong), Vesterhav and Kriegers Flak are for 720, 350 and 600 MW respectively, which offers the bidders greater negotiating power with suppliers and thus room for slashing purchase costs. In addition, the companies acquire more experience in cost reduction negotiation and the learning curve improves, which contributes to reducing operating costs further. Lastly, the creation of major groups with diverse markets and sound balance sheets reassures the financial markets. Hence equity providers and lenders feel confident and can lower their interest rates, thereby improving capital and debt costs.

The growth in load factor is the most important of all these market improvements because it changes the wind energy market paradigm. The "Annual Offshore statistics" report by WindEurope claims that in 2016, the average national annual load factor of the five main European offshore segments ranged from 33.1% to 42.9%. What is more to the point is that in the winter months (November–February) these load factors are more than 50% with the UK peaking at 68.2%.

THE COMPETITIVE ENVIRONMENT OF WIND ENERGY

From 2015 to 2016, the onshore wind energy market balance hardly moved. However, some major trends should be borne in mind. China is the leading global market for the sector, yet it is the preserve of its national companies. The biggest company worldwide for installed capacity is Goldwind. Other big Chinese companies such as Ming Yang, Envision and Dongfang can attribute their success to domestic demand. Yet these companies export very little and wield no influence on competitive equilibrium elsewhere.

In the rest of the world the wind energy giants are already well established in the onshore segment and the level of competition leaves very little room for new entrants. While Vestas has been in the lead in terms of installed capacity (China excluded), this equilibrium could be undermined by the Siemens-Gamesa merger. In this context, technological innovation in wind turbine unit capacity, which nowadays tends to approach 4 MW, in particular, is a key success factor. Another example of Vestas' technological prowess is that it has developed a multi-rotor wind turbine model comprising a tower and four rotors distributed either side of it. This 900 kW model, which enables the size of the wind turbine to be limited for the capacity developed, is currently in the test phase. Technological breakthroughs like these will have their role to play when national repowering strategies begin.

Recent offshore developments enable us to sketch the competitive structuring of this new market. Today's players are major groups with huge expertise that enables them to offer low wind energy prices and contribute to keeping would-be players at bay. Furthermore, as a result of the consolidations, the number of companies on the ground is relatively low. Therefore it is hard to know whether the competitive equilibrium will be strong enough to continue to drive down prices. Thanks to the success of projects conducted in Northern Europe, other countries could be enticed into gambling on offshore, which would provide a whole raft of new outlets for the existing manufacturers. A global market appears to be shaping up for the few players that were bold enough to be the offshore pioneers.

2030... ELECTRIFICATION OF THE HEATING AND TRANSPORT SECTORS IS ON THE CARDS

With less than four years to go before the deadline for the 2009 Renewable Energy Directive targets is up, the wind energy sector's trajectory is becoming clear. In

Frank Boutrup Schmidt/Vestas

Tabl. n° 5

Main European wind farm developers and operators 2016

Name of company	Country	Wind capacity developed or operated (in MW including offshore) 2016 [1]	Annual turnover 2016 (in M€)	Employees 2016
Iberdrola Renovables	Spain	14 336	2 400[2]	n.a.
EDP Renovàveis	Portugal	10 408	1 651	1 083
EDF Energies Nouvelles	France	8 499	1 358	3 108
E.ON Climate Renewables	Germany	8 174	n.a	1 660[3]
Gamesa	Spain	7 450	4 612	7 271[3]
Enel Green Power	Italy	7 264	3 011[3]	4 309[3]
Acciona Energy	Spain	7 257	1360[4]	n.a
RWE Innogy	Germany	4 106	813	890[3]
WPD AG	Germany	3 308	n.a	860
Dong Energy	Denmark	3 000	2 219	2 351
Vattenfall	Sweden	3 000	458	706
Juwi AG	Germany	2 000	575[3]	1 000

Large energy companies are well represented in this ranking because of their size and their ability to raise capital, but besides this 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 have also chosen to develop projects with their own machines.
1) Worldwide figure. 2) Turnover for all renewables technologies. 3) 2015 figure. 4) Jan. to Sept. 2016 figure. ***Source: EurObserv'ER 2017.***

Frank Boutrup Schmidt/Vestas

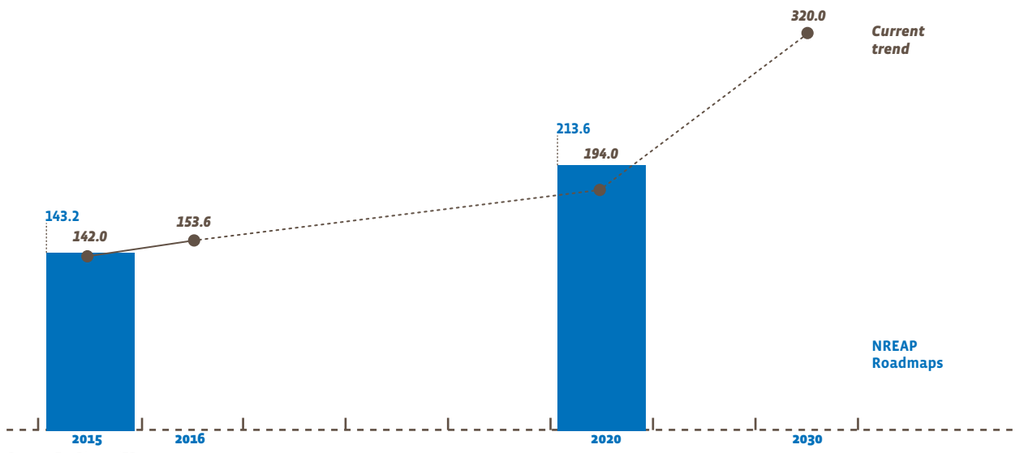
Vestas' multi-rotor turbine.

2017, the European Union market should remain above the 12 GW threshold, with a potential new installation record to be made. This is because Germany and the Nordic countries should again provide the EU market with a sound base. It will be boosted by the British market which should come back in strength with the construction of almost 2 GW offshore at the end of 2016. New momentum from France that has now been released from most of its administrative constraints will consolidate sales.

For the next three years, the European Union market contours will be somewhat blurred with the UK's probable exit before the 2020 timeline. If we look at the current situation (the European Union and the UK), it should be affected by the gradual decline of the German market which is likely to be offset only partly by the strengthening or return to business of a few key markets (Spain). A little less than 30 GW could be installed between 2018 and 2020 which would take the capacity of the European Union and the UK's bases close to the 194 GW threshold by the end of 2020. This projection is slightly higher than the "central" scenario that the EWEA (now WindEurope) provided in 2015, which foresaw 192.5 GW by 2020.

Graph. n° 4

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



Source: EurObserv'ER 2017.

In the longer term, by the 2030 timeline, the European Commission reckons that the renewable energy share could be as much as 50% of electricity output and that wind energy could well capture the lion's share of it. WindEurope forecasts that wind energy could alone cover 24–28% of the electricity demand (about 778 TWh), in the case of a "central" scenario of 320 GW.

There are nagging uncertainties because wind energy's deployment capacities will largely depend on unwavering European energy policy and the implementation of new electricity market operating rules.

According to the sector players, several key points would expedite wind energy deployment. These include, raising the renewable energy targets in final gross energy consumption to 30% in 2030 as opposed to the currently envisaged 27%. They think it is essential for the new European renewable energy directive, which will remain the main political instrument for renewable energy deployment in Europe, to set up control mechanisms to enable the Member States to contribute equitably to the common target and clearly define the measures to be taken in the event of failure to meet commitments. The players also consider that in view of the importance taken by the renewable electricity production sectors in the electricity system, the instruments that foster their integration need to be geared more towards market mechanisms, which are in a better position to reflect short term market needs and encourage competition between the sectors. Given the specificities of highly capital-intensive renewable energy investments (high fixed costs and lower variables costs); the system requires earnings stabilisation mechanisms to reassure investors and reduce project financing costs. One of the ways to mitigate these long-term financial risks is already commonly used in the USA, project financing, is developed by concluding power purchasing agreements (PPA) between producers and suppliers. Another vital point that will ease deployment is to make adequate investments in grid infrastructures and electricity supply management systems, which in certain countries or regions are already curbing development. They also think it is time to break the mould of low European electricity growth by implementing new policies to promote the electrification of other energy sectors such as heating, refrigeration and transport and do so with a view to decarbonising the energy market. The gradual conversion of these sectors to renewable electricity production would open up new horizons to the sector, without long-term development limits. □

Sources T2 and T4 : Deutsche Windguard (Germany), AGEB (Germany), AEE (Spain), Red Electrica (Spain) BEIS (United Kingdom), RTE (France), SER (France), Svensk Vindenergi (Sweden), DGEG (Portugal), HOPS (Croatia), ANEV (Italy), Terna (Italy), ENS (Denmark), Ministry of Industry and Trade (Czech Republic), windstats.nl (Netherlands), IWEA (Ireland Republic), Eirgrid (Ireland Republic), IG Windkraft (Austria), Tuuleenergia (Estonia), Litgrid (Lithuania), VTT (Finland), CERA (Cyprus), HWEA (Greece), Apere (Belgium), STATEC (Luxembourg), PESE (Poland), AEE (Spain), Svensk Vindenergi (Sweden), INSEE (Romania), Tuuleenergia (Estonia), WindEurope

The topic of the next barometer will be photovoltaics

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