European Commission & WindEurope

Table 1. Key Statistics 2018, EU	
Total (net) installed wind power capacity	179 GW
Total offshore capacity	18.5 GW
New wind power capacity installed	10.1 GW
Decommissioned capacity (in 2017)	0.42 GW
Total electrical energy output from wind	363 TWh
Wind-generated electricity as percent of national electricity demand	13.7%
Average national capacity factor	23.8%
National wind energy R&D budget	72.4 mil EUR; 82.9 mil USD
Target	32% RES by 2030

OVERVIEW

The European Union has a fixed target to generate at least 32% of its energy from renewable sources by 2030. Furthermore, it has adopted a long-term vision of climate neutrality by 2050. Together, these goals represent a powerful driving force for renewables, particularly wind energy.

While the road ahead seems exciting, it will not be without shortcomings. In 2018, the market experienced a 36% reduction in new installed capacity. There are good reasons to believe that regulatory changes account for that deceptive figure, and that the pace of new installations will accelerate again in the future. For example, corporations are increasingly procuring green energy directly from wind farms. Furthermore, costs remain subdued, with CAPEX reductions of 43% for land-based wind and 76% for offshore wind since 2015. These reductions can be credited to technological developments and the auctioning of wind energy capacity. By the end of 2018, 179 GW of wind power was connected to the grid, which represented 14% of the EU's electricity demand, 2 percentage points more than in 2017.

In the research domain, 2018 saw 72.4 million EUR (82.9 million USD) supporting new wind energy projects – mostly on offshore technology and maintenance and monitoring. Floating wind has been gaining particular traction as of late, with more than 63 million EUR (72.2 million USD) granted by the EU for research and innovation (R&I) since 2009. Last year, the EU also completed several projects. ELICAN and TELWIND, for example, showed how an innovative, self-installing telescopic tower could reduce floating offshore installation costs, while Aeolus4Future addressed the critical need for training highly-skilled researchers on wind energy systems.

MARKET DEVELOPMENT

National Targets & Policies Supporting Development

By 2030, the EU will have to generate 32% of its energy from renewable sources. Two other climate and energy framework headline targets also need to be reached by 2030: at least 40% cuts in greenhouse gas emissions (from 1990 levels), and at least 32.5% improvement in energy efficiency.

As a part of the framework, the regulation on the governance of the Energy Union and Climate Action has set out planning, reporting and monitoring mechanisms to achieve those targets. In response, Member States have drafted national energy and climate plans, which include measures to ensure the non-discriminatory participation of renewable energy, demand response, and storage in all energy markets.

In November 2018, The European Commission published the Communication "A Clean Planet for All," a strategic long-term vision for climate neutrality by 2050. The strategy is consistent with the Paris Agreement objective to keep temperature increases well below 2°C—and pursue efforts to limit it to 1.5°C—and shows how such ambitious goals can be attained by investing into technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance, and research.

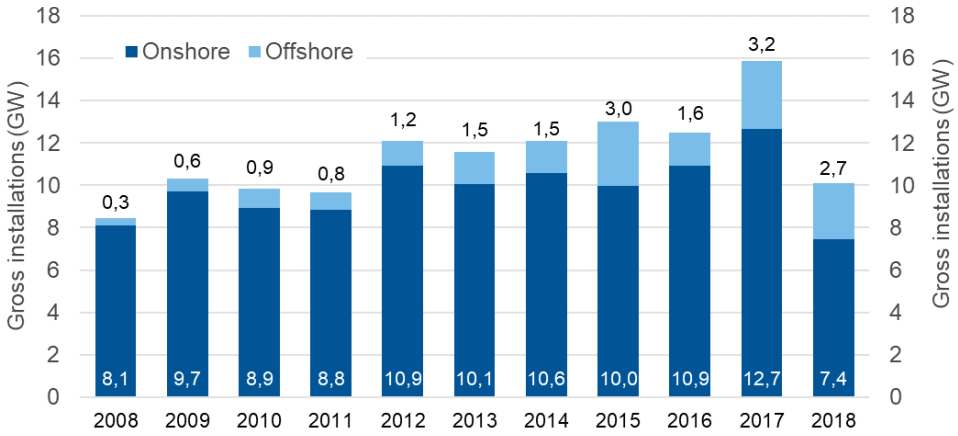


Figure 1. Gross annual and offshore wind installations in the EU [11] (Source: WindEurope)

Progress & Operational Details

In 2018, 10.1 GW of wind power capacity was installed across the European Union, a 36% decrease from 2017 (Figure 1). This significant drop was related to regulatory changes Member States instituted to comply with the revised EU State aid guidelines for environmental protection and energy (see further details below). Offshore wind represented 26% (2.65 GW) of the total new wind installations, while decommissioning stood at 421 MW. France, Germany, and the UK together accounted for 60% of the new capacity [11].

Fleet-wise, the most powerful land-based wind turbines were installed in Germany and Austria (average rating of 3.2 MW). The average newly installed offshore turbine was rated 6.8 MW—15% larger than in 2017. The largest turbine in the world was installed in the UK: the V164-8.8 MW from MHI Vestas Offshore Wind, with a rotor diameter of 164 m [1].

Higher-rated power translates into a decreased capital expenditure (CAPEX) per MW. While in 2015 around 2 million EUR (2.3 million USD) were required for each MW of installed land-based wind, in 2018 investment needs fell 43%, to an average of 1.4 million EUR (1.6 million USD) per MW. Offshore wind has seen an even more dramatic decrease: from almost 4.5 million EUR (5.2 million USD) per MW in 2015 to just under 2.5 million EUR (2.9 million USD) per MW in 2018, equivalent to a 76% fall [11].

These positive figures make wind energy an increasingly relevant electricity source. In 2018, it met 14% of the EU's electricity demand—2 percentage points higher than in 2017. The highest shares were achieved in Denmark (41%), followed by Ireland (28%) and Portugal (24%) [11].

Matters Affecting Growth & Work to Remove Barriers

Although the Energy Union does result in a certain degree of regulatory convergence among Member States (particularly regarding market design), a lack of harmonization between countries persists in areas like spatial planning and permitting. For example, there are no common guidelines regarding site selection and the impacts on the environment and local communities, which prevents authorities from switching from a precautionary principle to an evidence-based approach [2].

Restrictions related to the aviation sector also conflict with wind deployment, mostly due to interference with surveillance equipment or with low flight and training zones. The offshore sector faces specific challenges regarding spatial planning.

Although Denmark and the UK may allow the multi-purpose use of the marine space occupied by wind farms, this is not yet the case in most EU countries. This exacerbates conflicts between industries, as competition grows between offshore wind and aquaculture and fisheries.

Another issue of concern is that of import tariffs. In July 2018, The European Commission applied a 25% duty fee on steel imports whenever the EU exceeds a conservative, predefined import volume. Since February 2019, import volumes will increase by 5% every year until 2021. Although the intention is to shield the European steel industry from aggressive steel production incentives in the United States and China, EU manufacturers relying on cheaper imported steel have estimated a 18% turbine production cost headwind, as steel makes up over half the material they require. Eventually, this may put European turbine manufacturers at a disadvantage compared to overseas competitors [10].

Offshore and land-based wind tenders: The shift from feed-in-tariffs to tender-based support schemes promoted by the State aid guidelines prompted increasingly competitive prices for wind energy. For example, more than 3.1 GW of offshore wind have been allocated under zero-subsidy bids in Germany and the Netherlands, while bid prices decreased by 65% in tenders held in Denmark from 2010-2016 and in the United Kingdom from 2013-2017 (Figure 2) [4].

Similar trends have been observed for land-based wind. For example, Spain allocated more than 4.6 subsidy-free GW in three tender rounds held in 2016 and 2017. In Germany, the winning bid price decreased by 33% in three technology-specific auctions in 2017. Italy saw the average winning price drop by 44% in four rounds from 2013 to 2016, while the capacity allocated nearly doubled [4].

Power-purchase agreements: Increasingly competitive renewable electricity prices, in relation to wholesale market prices, are stimulating industrial consumers to procure their energy needs directly with the producers of renewable power (particularly wind energy) through power purchase agreements (PPAs). Asset owners also benefit from PPAs by reducing their merchant risk exposure and ensuring a predictable income flow. In Europe, the majority of the corporate wind-PPA capacity is found in the Netherlands, Norway, Sweden, and the United Kingdom. So far, the high-tech sector is the main buyer of these agreements. In total, 4.8 GW of wind-PPAs have been signed since 2000, with deals above 1 GW annually for the last three years [1].

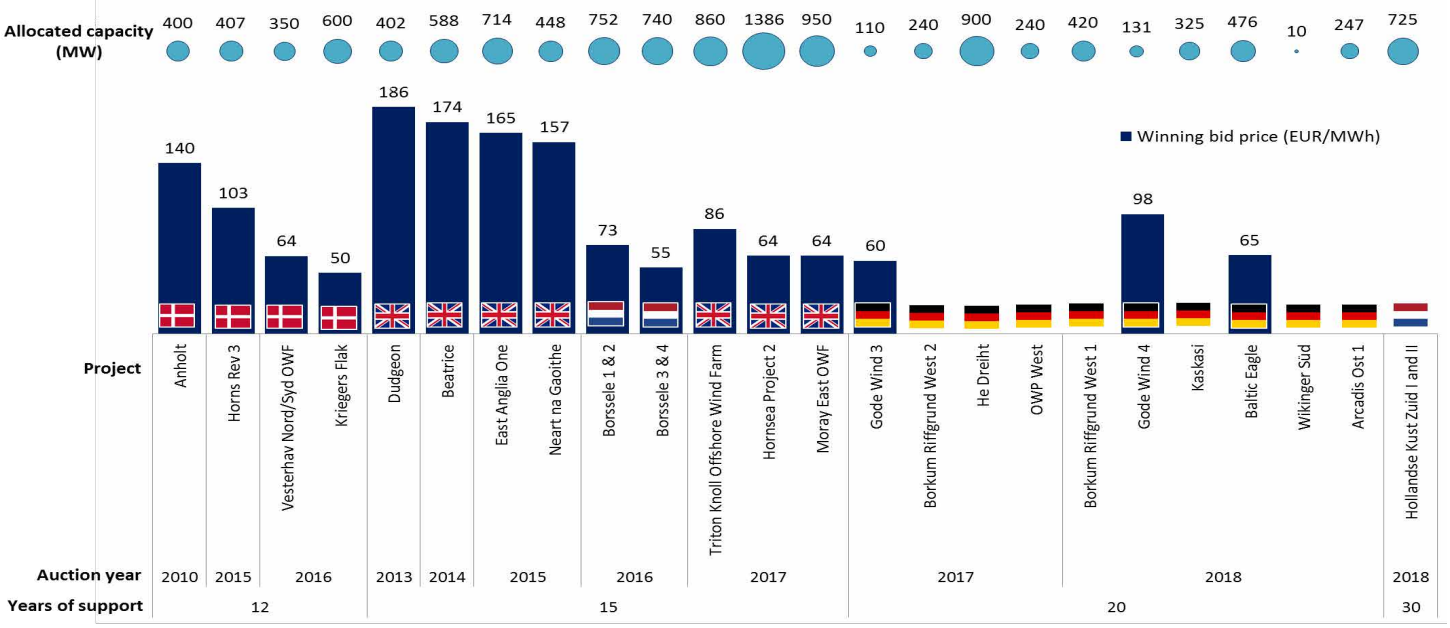


Figure 2. Results of offshore wind tenders in EU Member States (2010-2018) [4]

R,D&D ACTIVITIES

National R,D&D Priorities & Budget

Horizon 2020 (H2020) is the main funding instrument for energy R&I at the EU level, with a budget of about 6.0 billion EUR (6.9 billion USD) for the period 2014-2020. In 2018, 65 million EUR (74.5 million USD) were allocated to projects specifically focused on wind energy, but the figure increases to 72.4 million EUR (82.9 million USD) if other projects where wind is a significant component are included (Table 2) [4].

Figure 3 depicts how funding has been distributed across main priorities since 2009 under the previous and current R&I framework programs. A large part of the EU R&I funding (almost 70% for projects starting in 2018) has been devoted to offshore wind technology in order to develop next-generation offshore wind turbines, reduce costs, and move towards the commercialization of floating turbines [4].

Floating technologies have been gaining traction, particularly since FP7 (e.g. with the FLOATGEN and DEMOWFLOAT projects, which demonstrated different floating concepts at pre-commercial scale). Together with the 11 projects financed so far under H2020, this brings total EU support to floating offshore wind to more than 63 million EUR (72.2 million USD) since 2009.

National Research Initiatives & Results

The EU achieved significant research results in 2018, as 20 wind energy projects came to an end during the year. We have highlighted a few below [4]:

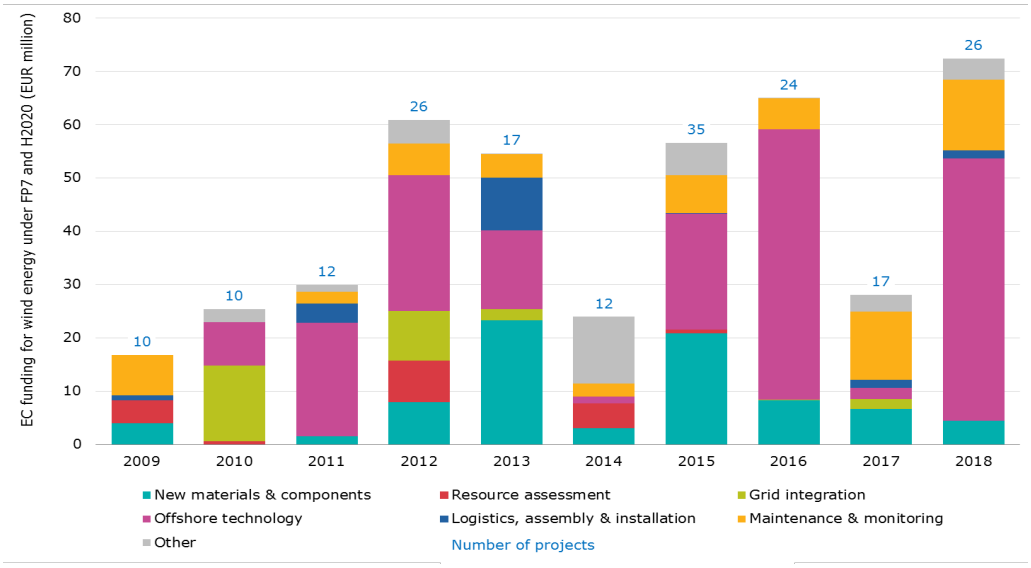
- TELWIND tested a novel, low-cost floating substructure integrated with a self-installing telescopic tower in a lab environment for further use with +10-MW offshore wind turbines. EU support: 3.5 million EUR (4.0 million USD).
- ELICAN followed-up on TELWIND and demonstrated the technology through a 5-MW prototype installed off the coast of Las Palmas, in the Canary Islands (Spain). EU support: 11 million EUR (12.6 million USD).
- VirtuWind demonstrated the technical and economic benefits of introducing open, modular and secure control infrastructure for the wind energy industry. EU support: 4.9 million EUR (5.6 million USD).
- Aeolus4Future created a training network with ten institutions across seven countries to provide researchers with a technical background in wind energy systems. EU support: 3.8 million EUR (4.4 million USD).

Table 2. Wind Energy-Specific Funding Under Horizon 2020 Granted to Projects Starting in 2018

H2020-Funded Projects	Total Project Cost mil EUR (mil USD)	EC Contribution mil EUR (mil USD)	Number of Projects
Wind energy projects	84.12 (96.36)	65.04 (74.51)	20
Projects with a significant wind energy component[1]	9.01 (10.32)	7.35 (8.42)	6
Total funding for wind energy	93.13 (106.69)	72.4 (82.94)	26

[1] Non-wind specific projects include projects on grid integration of renewables, projects developing materials for extreme conditions (cold climates, offshore applications), or projects developing common platforms/components (e.g., with wave/tidal energy)

Figure 3. Evolution of EU R&I funding priorities on wind energy under FP7 (2009-2013) and Horizon 2020 (2014 2018) [4]. Projects specifically on wind energy and those with a significant wind energy component are accounted for (see Table 2). The number of projects funded is shown at the top of each bar. Note: The item "other" includes projects that cannot be classified in other categories. Some examples include projects on emerging technologies such as airborne wind energy systems, social acceptance, and critical rare earth elements.



A high number of SME projects were also completed in 2018:

- On new floating concepts: X1 Wind (a self-orientated platform with a single point mooring system and a downwind structural design that removes the active yaw system, the ballast system, and the tower) and WTSS (a floating support structure with no mooring lines and a single point anchoring, which optimizes assembly, installation, and decommissioning)
- On novel wind turbines designed to work under low speed and turbulent wind profiles (e.g. urban environments): WindiBox, EOLI FPS and INNOWIND
- Other areas: Skypull (demonstration of a 100 KW airborne wind energy system), Ventura Habitat (a novel blade maintenance system), and YURAKAN (a high power rated novel cyclone converter generator for land-based wind turbines)

New R&I projects

- ReaLCoE aims to develop the next generation +12-MW offshore wind turbine with a modular design that is easily customized. It will also investigate business models to optimize investment and lower financial risks and will propose digitalization at every stage of the process. EU support: 24.8 million EUR (28.4 million USD)
- i4Offshore proposes a full-scale demonstration of a highly innovative offshore system solution at a challenging deep-water site, featuring a next-generation direct drive wind turbine, a hybrid-material gravity jacket foundation optimized for low-cost manufacturing, and new very-low-cost array cable-in-pipe solution. EU support: 19.8 million EUR (22.7 million USD)
- TotalControl aims to develop and validate advanced integrated wind power plant and wind turbine control schemes. All essential interactions between the wind turbines shall be accounted for, including production and load aspects. EU support: 4.9 million EUR (5.6 million USD).

IMPACT OF WIND ENERGY

Environmental Impact

In order to analyze the environmental impact of wind energy within the EU energy system, the JRC-TIMES model analyzed three different scenarios [6]. *Diversified* and *ProRES* reach the CO_2 emission reduction target for 2050 (80% as compared to 1990 levels) but *Diversified* allows for new nuclear capacity while *ProRES* doesn't. *Zero Carbon* is even more ambitious and aims for net zero emissions by 2050. Carbon capture and storage is possible under *Diversified* but not under the two other scenarios.

The power and the transport sectors experience the strongest emission reductions until 2050 (from 2,400 Mt/year in 2010 to 850 Mt/year or 330 Mt/year in 2050 in the *ProRES* and the *Zero Carbon* scenarios, respectively) [6]. In scenarios that exclude the usage of CCS (*ProRES* and *Zero Carbon*), transport becomes the main consumer of electricity by 2050, as this vector is used directly in electric vehicles and in the production of hydrogen and derived synfuels.

Consequently, the power sector undergoes a substantial transformation towards increased low-carbon generation capacity, which reaches 5,700 GW by 2050 in the *Zero Carbon* scenario. Solar and wind power will account for most of the change, with 540-1,500 GW of wind capacity in the 80% CO_2 reduction scenarios, and up to 1800 GW in Zero Carbon (Figure 3) [6].

Similarly, the modeling projections based on the EU long-term strategy 2050 ("A clean planet for all") suggest that wind capacity will increase to 700-1,200 GW by 2050, representing more than half of the power generation in 2050 [2].

Economic Benefits & Industry Development

In 2018, new asset financing for European wind power projects stood at 26.7 billion EUR (30.5 billion USD)—a 20% increase from 2017 and over 60% of all in new power capacity investments in the region [9].

In terms of jobs, the wind energy industry directly and indirectly employed about 260,000 persons in the EU in 2016. It contributed 36.1 billion EUR (41.4 billion USD), or 0.26%, to the EU's GDP [7]. The industry remains a global net exporter with a 2.4 billion EUR (2.7 billion USD) positive trade balance in products and services.

Over 80% of European wind energy companies have a commercial presence (including manufacturing sites) in more than 80 countries outside Europe. Five of the ten biggest wind turbine manufacturers in the world are EU-based [7].

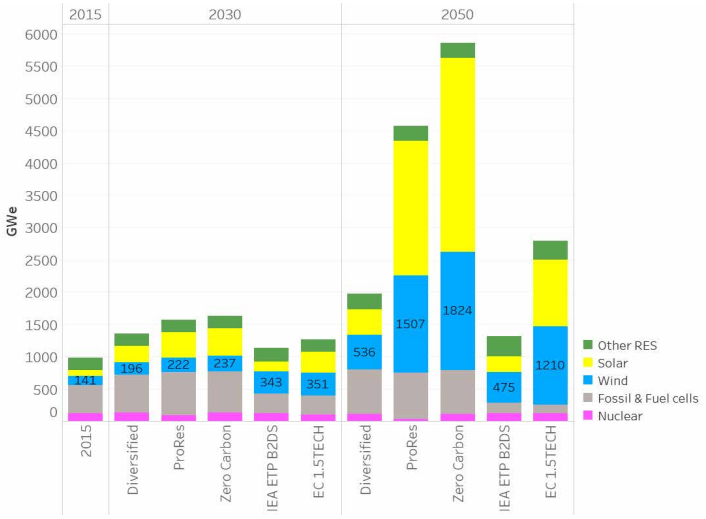


Figure 4. Installed generation capacities in the EU by 2050 for different decarbonization scenarios of the JRC-EU-TIMES model, as well as for the IEA ETP B2DS and EC 1.5TECH scenarios [2-4, 6]

NEXT TERM

The EU will continue to invest in a diversified portfolio of wind energy R&I projects in Horizon 2020. Offshore technologies, particularly floating, will likely be prioritized. After 2021, Horizon Europe, the next R&I framework program, will be in place.

The main building blocks are already known: a mission-oriented approach, the continuation of the European Research Council, the creation of the European Innovation Council, and the new generation of European Partnerships as well as an increased collaboration with other EU programmes. Broad mission areas have been defined (including one on carbon-neutral and smart cities), but additional details on the programming will be fleshed out during the upcoming strategic planning phase.

Repowering and decommissioning are becoming a key concern for the wind energy market in the EU. Today, about 4 GW of installed capacity is more than 20 years old, plus an additional 18 GW within the next 5 years. By 2030, that number could increase to 40-60 GW [11]. This raises the question how many of these wind farms can be repowered, and how administrative and regulatory procedures will facilitate the challenge.

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Opening photo courtesy of Pixabay/Distel2610

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