European Commission/ WindEurope

Table 1. Key Statistics 2017, EU	
Total (net) installed wind power capacity	168.7 GW
Total offshore capacity	15.8 GW
New wind power capacity installed	15.6 GW
Decommissioned capacity (in 2017)	0.6 GW
Total electrical energy output from wind	336 TWh
Wind-generated electricity as percent of national electricity demand	11.6%
Average national capacity factor	21.8% (land-based)
Target	20% RES by 2020

OVERVIEW

The Renewable Energy Directive is the main policy driver for wind energy in the European Union (EU) to 2020, and H2020 is the main instrument to support R&D at the EU level.

In 2017, the EU connected 15.6 GW of new wind energy capacity—an increase of 25% compared to 2016 (Figure 2). Of the new capacity, land-based installations accounted for 12.4 GW and offshore installations accounted for 3.2 GW. The total cumulative wind capacity grew 9.7% during the year, reaching 168.7 GW by the end of 2017. Wind power generated almost 336 TWh in 2017, covering 11.6% of the EU's electricity demand [1, 2].

Although the European Commission (EC) decreased its total funding specifically dedicated to wind energy R&D to 33 million EUR (40 million USD) in 2017, it increased its support for storage and the development of a flexible energy system, which is important for large scale wind energy penetration.

MARKET DEVELOPMENT

National Targets & Policies Supporting Development

The Renewable Energy Directive established the overall legal framework for the production and promotion of renewable energy sources (RES) [3]. It set a target of 20% share of renewable energy in final energy consumption by 2020. The legislation required all EU countries to adopt national renewable energy action plans (NREAPs), which include specific targets for wind energy.

Within the 28 EU member states, ten countries were above their general 2020 RES targets at the end of 2015. According to the EC energy model PRIMES, 16 other states are on track to reach their targets but will need to continue their current efforts to reach them by 2020. The remaining three EU member states—France, Luxembourg, and the Netherlands—must increase their action to meet their RES targets. Current State Aid Guidelines for environmental protection and energy encourage EU member states to shift their wind energy regulatory framework toward schemes that will ensure higher market compatibility [4]. For many countries, 2017 was a transitional year as they moved toward new support schemes and tender mechanisms. A large number of projects were rushed to connect while feed-in-tariffs (FIT) still applied.

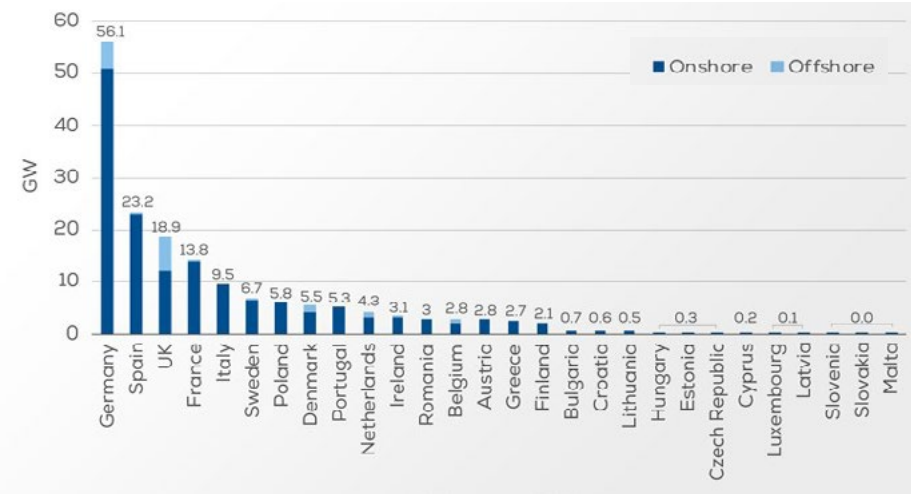


Figure 1. Cumulative installations land-based and offshore wind energy (Source: WindEurope)

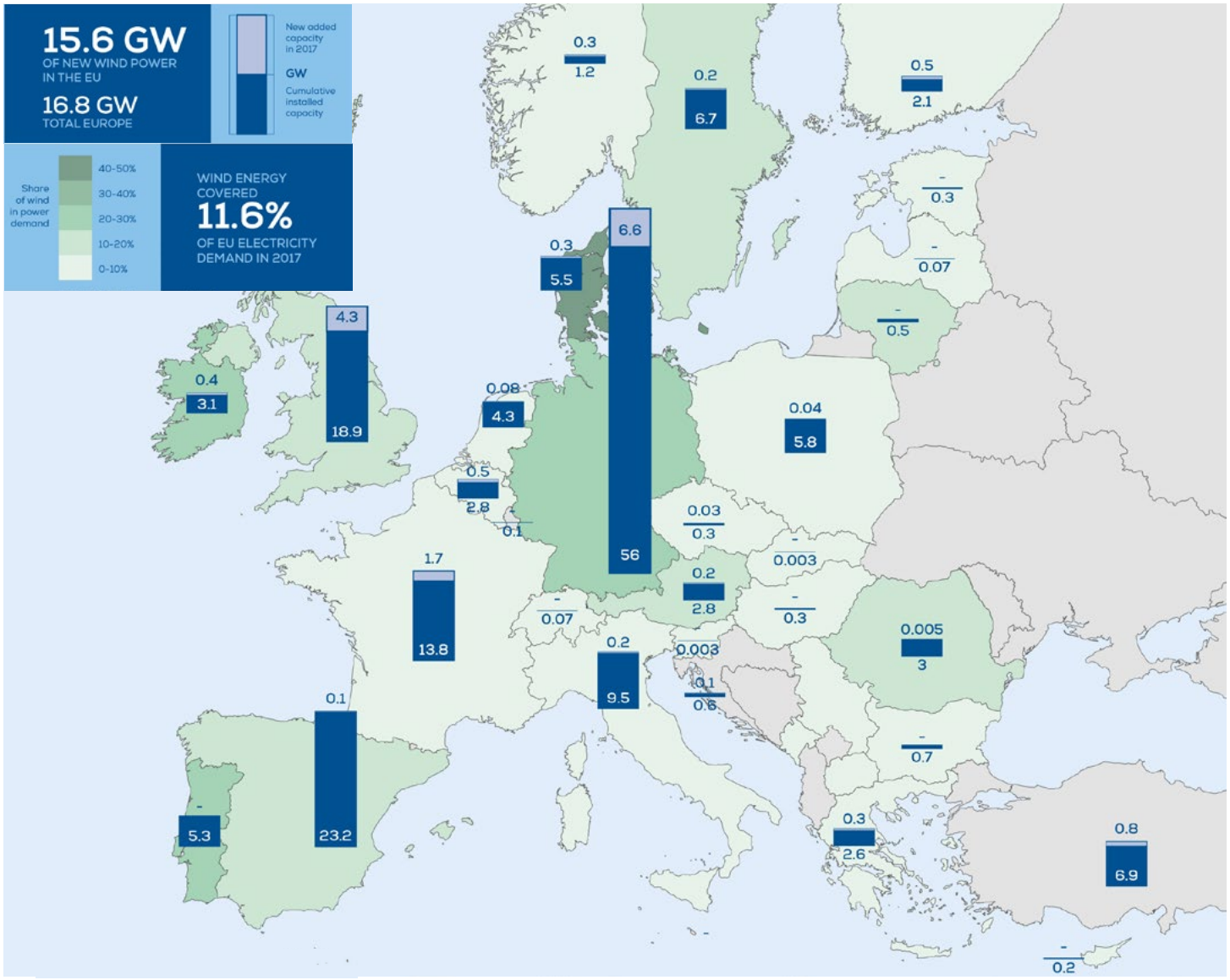


Figure 2. Gross and cumulative installed capacity in the EU in 2017 (Source: WindEurope)

While some projects continue accessing FiT (Belgium, France, and Germany) and Green Certificates persist in Sweden, Europe entered in an auction world in 2017. The first onshore wind tenders took place in France, Germany, and Spain. The U.K. ended its Renewable Obligation Certificates (ROCs).

Progress & Operational Details

During 2017, 15.6 GW of new wind power capacity was installed and grid-connected in the EU, 25% more than in 2016 (Figure 1). Land-based installations accounted for 12,484 MW, while offshore installations made up 3,154 MW. Cumulatively, 168.7 GW are now installed in the EU (a growth of 9.7% over 2016). By the end of 2017, the total installed wind power capacity in the EU was 79% of the 2020 target.

Germany is the EU country with the largest installed capacity (56.1 GW), followed by Spain (23.2 GW), the UK (18.9 GW), France (13.8 GW), and Italy (9.5 GW). Four other EU countries (Sweden, Poland, Denmark, and Portugal) have more than 5 GW installed. Seven additional EU countries have over 1 GW of installed capacity: the Netherlands, Ireland, Romania, Belgium, Austria, Greece, and Finland (Figure 1).

In 2017, wind-generated electricity met 11.6% of the EU-28's total electricity demand. Denmark achieved the highest penetration rate (44%), followed by Portugal (24%), and Ireland (24%). Ten out of the 28 member states had a wind penetration rate over 10% (Figure 3).

In 2017, the EU land-based wind capacity factor averaged 21.7%. Offshore capacity factor averaged 41.1%. The size and type of wind turbines installed in the EU in 2017 varied between member states. For example, the wind turbines in Denmark and Finland had an average power rating of 3.4 MW, while the turbines installed in Spain had an average rating below 2 MW. Regulatory restrictions on tip height, project duration, and wind regimes (low-speed or high-speed) account for some of the variation in wind turbine ratings in the different member states.

Offshore wind turbines in the UK and Germany had an average power rating of 6.0 and 5.6 MW, respectively. By contrast, all the turbines installed in Belgium use older turbine models (3.3 MW), as they belong to a project that started in 2009. In France, the relatively low rating (2 MW) is due to the type of project (demo floating wind turbine). In 2017, the world's first floating 30-MW wind farm, Hywind, started delivering electricity to the Scottish grid.

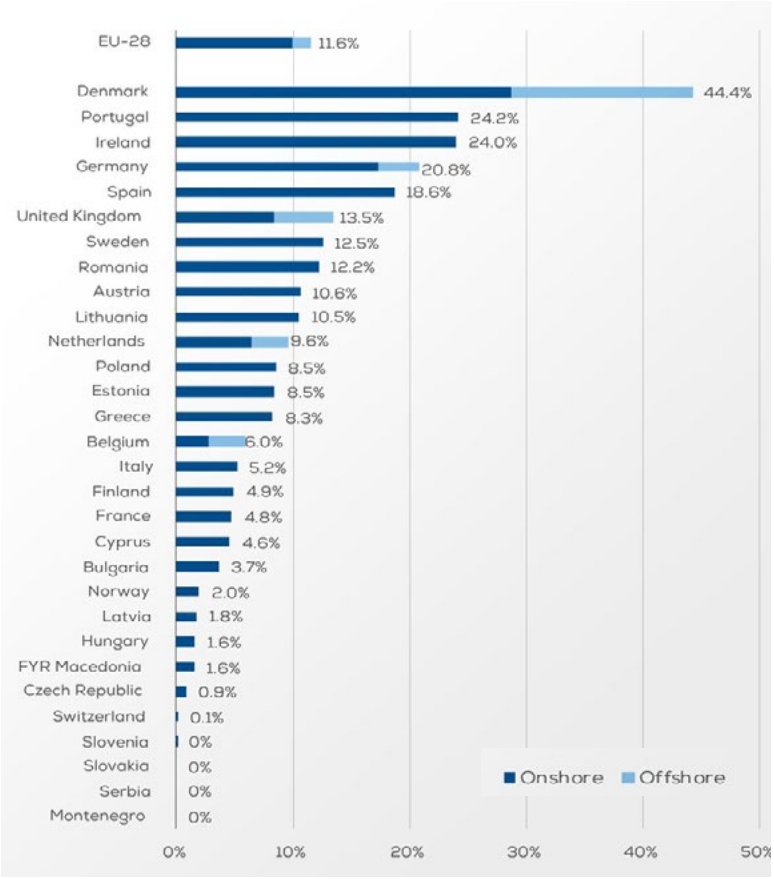


Figure 3. Wind power penetration rates in Europe (Source: WindEurope)

Matters Affecting Growth & Work to Remove Barriers

Long-term visibility and stable regulatory frameworks remain crucial for wind deployment beyond 2020. However, only eight member states have post-2020 renewable energy plans.

From an industry standpoint, other barriers to deployment include varying legislation between different European countries regarding spatial planning and the relatively slow rate of repowering—a result of asset life extension in mature markets. In some countries, such as France, Poland, Sweden, the UK, and the Baltic countries, regulations are tightening (e.g., set back distances, noise limitations, or wind turbine interference regulations for civil aviation and military radars).

Around 50% of the current cumulative installed capacity in the EU will reach the end of its operational life by 2030. The uptake of a repowering market will be determined by the implementation of fast-track administrative procedures. Finally, the rate of build out and reinforcement of the grid system to host the increasing wind energy capacity while minimizing curtailment (both land-based and offshore) is a crucial point for keeping a high pace of wind energy deployment in Europe.

R,D&D ACTIVITIES

National R,D&D Priorities & Budget

Horizon 2020 (H2020) is the main funding instrument for energy research and development at the EU level, with a budget of about 6.0 billion EUR (7.2 billion USD). In 2017, 17 projects started with total funding of about 28 million EUR (34 million USD) (Table 2).

The EU's R,D&D priorities include all aspects related to reducing wind energy costs, such as:

- New turbine materials and components
- Resource assessment
- Grid integration
- Offshore technology
- Logistics, assembly, testing, and installation
- Maintenance and condition-monitoring systems

Increasingly, the EU is supporting projects that focus on grid integration and energy storage projects, which will allow the energy system to accommodate higher shares of wind energy and other variable RES. The total EC funding from H2020 dedicated to wind-specific projects was about 25 million EUR (30 million USD) for projects starting in 2017. The average EC funding per wind energy project has remained relatively stable since 2009, with around 1.7 million EUR (2.0 million USD) per project.

Figure 4 shows how research and innovation (R&I) priorities have translated into actual projects since 2009 under H2020 and its predecessor FP7. The item "other" includes projects exploring emerging technologies such as kites or social acceptance.

Table 2. Wind Energy-Specific Funding Under H2020 for Projects Starting in 2017

H2020-Funded Projects	Total Project Cost million EUR (million USD)	EC Contribution million EUR (million USD)	Number of Projects
Wind-specific projects	34.89 (41.87)	25.13 (30.16)	13
Non-wind specific projects[1]	2.96 (3.55)	2.94 (3.53)	4
Total funding for wind energy	37.85 (45.42)	28.07 (33.69)	17

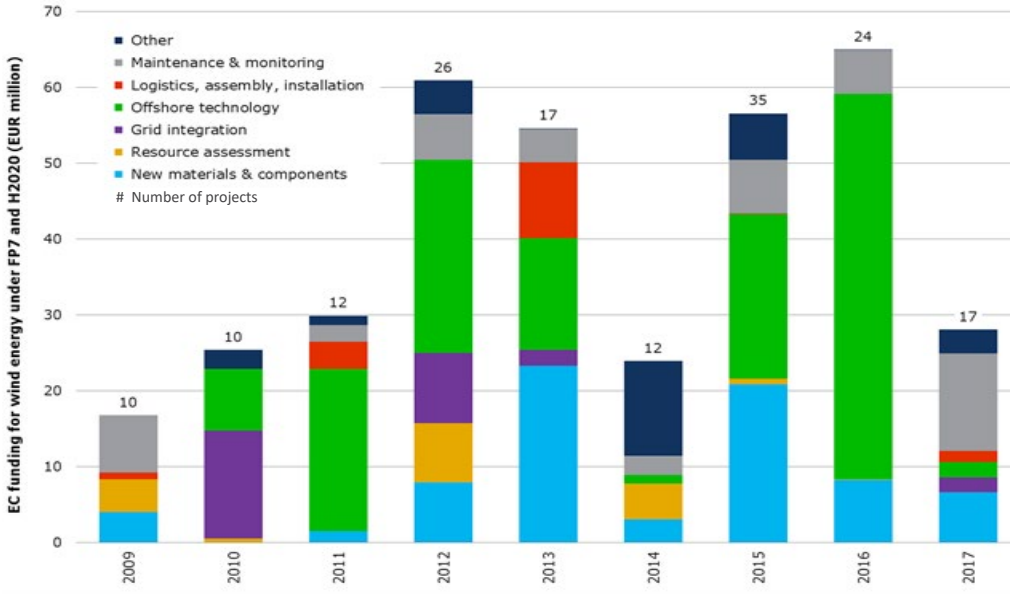
[1] Non-wind specific projects include projects on grid integration of renewables, projects developing materials for extreme conditions (cold climates, offshore applications), or projects developing common platforms/components (e.g., with wave/tidal energy)

National Research Initiatives & Results

Several FP7 funded projects were completed in 2017:

- **INNWIND.EU** (www.innwind.eu) was a project with 28 partners and a budget of nearly 20 million EUR (24 million USD). Its objectives included the conceptual design of beyond-state-of-the-art 10-20 MW offshore wind turbines and hardware demonstrations of their critical components.
- **The AVATAR project** (www.eera-avatar.eu) was about the development and validation of advanced aerodynamic models used in integral design codes for the next generation of large scale wind turbines (up to 20 MW).

Figure 4. Evolution of EC R&I funding under FP7 and H2020 for wind and number of projects, 2009-2017



- **LEANWIND** (www.leanwind.eu) provided cost reductions across the offshore wind farm lifecycle and supply chain through the application of lean principles and the development of state-of-the-art technologies and tools.

In 2017, many smaller H2020 projects, led by Small and Medium-sized Enterprises (SME), were also completed:

- **ELISA** focused on a full-scale prototype of a substructure system for offshore wind turbines.
- **EK200-AWESOME** developed an integrated 100-kW, container-based airborne wind energy (AWE) converter and storage solution.
- **ABLE (Air Blade Life Extension)** focused on a technology to extend the lifespan of a wind turbine blade.
- **IRWES (Integrated Roof Wind Energy System)** investigated a roof-mounted structure with a more efficient internal turbine than existing urban windmills.

Specific information on EU projects can be found in the CORDIS projects and results database [5].

Test Facilities & Demonstration Projects

Of the 17 projects under the H2020 program that started in 2017, seven are funded under the Small and Medium-sized Enterprises (SME) instrument. In most cases, these projects received an EC contribution of 50,000 EUR (60,000 USD).

Key EU-funded projects (non-SME) are as follows:

- **The ROMEO project** aims to develop and demonstrate an O&M information management platform, enabling improved decision-making processes to reduce O&M costs, improve reliability, and extend the lifetime of off-shore wind turbines and wind farms.
- **NEOHIRE** wants to reduce the use of rare earth elements cobalt and gallium in wind turbine generators by developing a new concept of bonded NdFeB magnets and new recycling techniques, using critical raw materials from current and future wastes.
- **WinWind** enhances the environmentally sound and socially inclusive wind energy market uptake by increasing social acceptance in 'wind energy scarce regions' (WESR).
- **SmartAnswer and InnoDC** are two projects under the Marie-Curie Innovation Training Network, respectively,1.) Smart mitigation of flow-induced acoustic radiation and transmission for reduced aircraft, surface transport, workplaces and wind energy noise; 2.) development of innovative tools for offshore wind and DC grids.

Collaborative Research

Projects funded by the EC foster international cooperation, and most require international collaboration between industry and research organizations. The Joint Research Centre of the European Commission has been and will continue to participate in the IEA Wind TCP Task 26 Cost of Wind Energy.

IMPACT OF WIND ENERGY

Economic Benefits & Industry Development

Europe invested a total of 22.3 billion EUR (26.8 billion USD) in wind energy in 2017—a 19% decrease from 2016. This is largely due to lower investments in offshore wind and cost reductions in both land-based and offshore wind CAPEX. There were 11.5 GW of new wind capacity financed in 2017. Wind energy investments accounted for 52% of new clean energy finance in 2017, compared to 85% in 2016. Offshore wind projects accounted for 35% of the investment activity in the renewable energy sector.

At the end of 2016 the wind energy industry accounted–both directly and indirectly–for about 260,000 jobs in the EU. It contributed 36.1 billion EUR (43.3 billion USD) to the EU's Gross Domestic Product, or 0.26% of the overall EU GDP [6]. The industry remains a global net exporter with a 2.4 billion EUR (2.9 billion USD) positive trade balance in products and services. This includes exports of 7.8 billion EUR (9.4 billion USD) and imports of 5.4 billion EUR (6.5 billion USD).

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

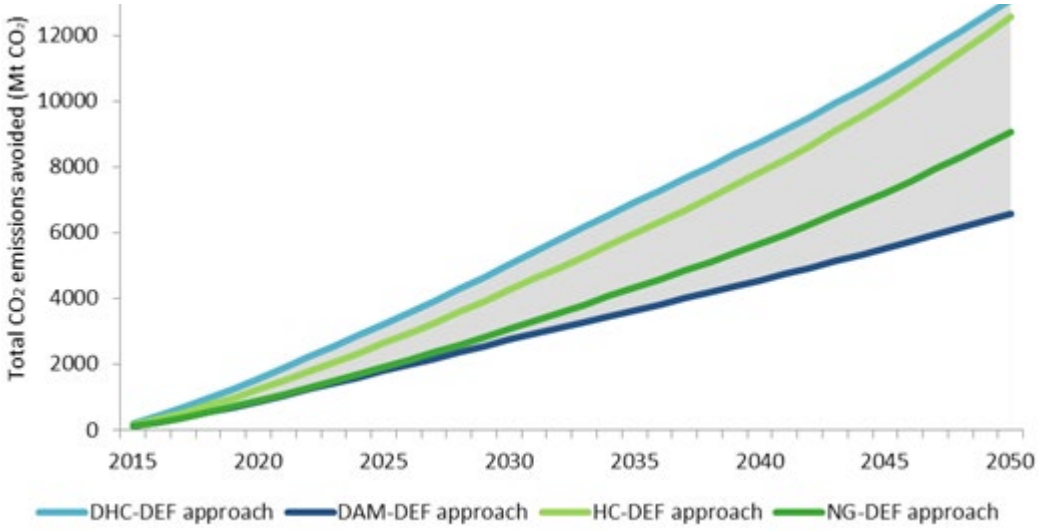


Figure 5. Total CO_2 emissions avoided by wind energy generation over the period 2015-2050 under different approaches Note: DHC-DEF (Dynamic high-carbon displacement emission factor), DAM-DEF (Dynamic all mix energy displacement emission factor), HC-DEF (High-carbon displacement emission factor), NG-DEF (Natural gas displacement emission factor)

Environmental Impact

The total CO_2 emissions avoided by wind energy in the European Union range from 6,600 to 13,100 Mt CO_2 over the period 2015-2050, representing around 5-10% of the cumulative emissions under the EU's reference scenario [7]. These values represent the upper and lower limits of wind energy's effect on the decarbonization of the European energy system.

Emissions are calculated based on two displacement factors. The first factor considers that wind energy will replace future high-carbon generation, providing an upper limit of potential avoided CO_2 emissions. The second factor considers that wind energy will displace high-carbon and other less-competitive renewable generation in the long run, resulting in a lower limit. These factors are dynamically computed on an annual basis, based on the evolution of the future energy mix.

NEXT TERM

The year 2018 will continue to be a transition year for the wind energy sector, as support schemes are changing. Land-based wind is expected to follow its current 12 GW/year level, but it may decrease from 2019 onwards. There is a strong pipeline of offshore projects, which should reach at least 24 GW of cumulative installed capacity by 2020.

The European Commission has proposed a recast Renewable Energy Directive together with a target of at least 27% renewables in the final energy consumption by 2030 [8]. The European Parliament reviewed this proposal in early 2018 and voted for a 35% renewables target. Over the next 12-18 months, member states, the European Parliament, and the European Commission will negotiate the target level and the adoption of the corresponding legislation.

The EC will continue to fund wind energy research and innovation via the Horizon 2020 program and financial instruments like the European Fund for Strategic Investments (EFSI) and InnovFin Energy Demo Projects (InnovFin EDP), implemented via the European Investment Bank.

To follow Horizon 2020 (2014-2020), in 2018 the Commission will propose Horizon Europe, a new Framework Programme for Research and Technology Development (FP9) for the 2021-2027 timeframe.

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Opening photo courtesy of Pixabay/Distel2610

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