



Table 1. Key Statistics 2017, France

Total (net) installed wind power capacity	13.5 GW
Total offshore capacity	0 GW
New wind power capacity installed	1.6 GW
Decommissioned capacity (in 2017)	---
Total electrical energy output from wind	22.6 TWh
Wind-generated electricity as percent of national electricity demand	8.4%
Average national capacity factor	21.8% (estimate)
Target	2018 wind power capacity: 15 GW land-based; 0.5 GW fixed offshore

OVERVIEW

Wind power is an increasingly significant source of renewable electricity production in France, accounting for nearly 28% of all installed renewable power capacity. France set a new record for wind power industry development in 2017, with over 1.6 GW of newly installed wind power capacity. These installations bring the country's total land-based installed wind power capacity to approximately 13.5 GW.

The record installation rates are the continued result of simplified administrative procedures and better visibility in terms of regulatory changes. The annual electrical energy output from wind was 22.6 TWh, a significant increase from 2016. This increase is the result of higher installed power

capacity, with an unchanged capacity factor with respect to the year before. Wind and all renewables covered 4.7% and 18.4% of national electricity demand, respectively.

The first call for tender of 500 MW of onshore wind power and some initiatives to facilitate wind deployment also occurred in 2017. Concerning offshore wind, the first phase of a competitive dialogue for a third tender in the Dunkerque area took place, as well as preparation of a new tender in the Oléron area. The start of studies for a commercial call for tenders for floating wind farms was also announced in 2017, following the ongoing wind farm pilot projects.

MARKET DEVELOPMENT

National Targets & Policies Supporting Development

Along with the Paris Agreement during COP21, France defined new trajectories for renewables after adopting the Energy Transition for Green Growth Act in 2015. This law defines long-term objectives for the transition to a low-carbon economy and energy system, and also defines new policy tools. It addresses several aspects including energy efficiency, renewables deployment, and the future of nuclear energy.

The Pluriannual Energy Program (Programmation Pluriannuelle de l'Énergie, PPE) was updated during 2015 and 2016 to set renewable energy targets for 2018 and 2023. New trajectories for each renewable energy source are defined in the PPE, leading to the following targets for installed renewable power capacity by the end of 2018:

- 15 GW land-based wind power capacity
- 0.5 GW fixed offshore wind power capacity
- 10.2 GW solar energy
- 25.3 GW hydroelectricity

Additionally, the following targets are set for the end of 2023:

- 21.8-26 GW land-based wind power capacity
- 3 GW fixed offshore wind, with between 0.5-6.0 GW of ongoing projects, depending on the outcome of the first projects and price levels
- 18.2-20.2 GW solar energy
- 25.8-26.05 GW hydroelectricity
- 100 MW of installed tidal floating wind and wave power capacity, with between 200-2,000 MW of ongoing projects, depending on the outcome of the first pilot farm projects and price levels
- The PPE is currently being revised and submitted to a public debate that will run up to 2018 and will define new objectives for the periods to come.

Progress & Operational Details

During 2017, France broke its 2016 record by connecting over 1,650 MW of new wind-power capacity, leading to a total of 13.5 GW of installed capacity. With a capacity factor almost equal to 2016, wind-generated electricity production increased 13% since 2016, totaling 22.6 TWh. The percentage of electricity demand met by wind energy increased to 4.7%. Should this high installation rate continue, the target set by the PPE will be reached by the end of 2018. The installation rate should, however, further increase to meet the 2023 target.

Offshore projects are making progress with the third call for tender for the area offshore of Dunkerque following a competitive dialogue phase. A call for tender is being prepared for the area offshore of Oléron for fixed wind, while some studies have been launched to identify locations for commercial floating wind farms.

Annual wind-generated electricity production increased in 2017 as the result of a very active year for installations. The average capacity factor is estimated at 21.8%, which is significantly lower than the 2015 value of 24.3%.

The average wind turbine nameplate capacity is currently 2.3 MW with a nacelle height of 80-90 m [1]. However, there is a trend toward higher nacelle heights (typically 100-110 m) with an increased swept area, which can be used to improve economics in areas with lower average wind speeds. For the standard wind turbine type, the average levelized cost of energy ranges from 54-108 EUR/MWh (65-130 USD/MWh), but can decrease to 50-94 EUR/MWh (60-113 USD/MWh) [1].

Matters Affecting Growth & Work to Remove Barriers

The Energy Transition for Green Growth Act confirmed in 2015 an already ongoing trend toward simplification of the permitting and licensing process. During 2017, several measures were adopted, including:

- Application of a single environmental authorization process to the whole territory (“one stop shop” approach)
- The reduction of deadlines for appeals within this single authorization process
- The implementation of incentives for residents to acquire shareholdings in limited companies involved in local renewable energy projects
- The full application of the “Complément de remunération” funding mechanism

The creation of a work group at the Ministry level also led to several propositions, including the following important measures:

- The suppression of one level of jurisdiction regulating litigations
- The revision of the IFER tax (imposition forfaitaire pour les entreprises de réseaux) to redistribute this tax more locally

The first tender for 500 MW of onshore wind-power installations took place in 2017. Five new 500-MW tenders are expected to be launched through May 2020.

Finally, the so-called “Hydrocarbon” law included some measures for the development of offshore wind, including the obligation for RTE (French TSO) to build connections to the grid for offshore projects.

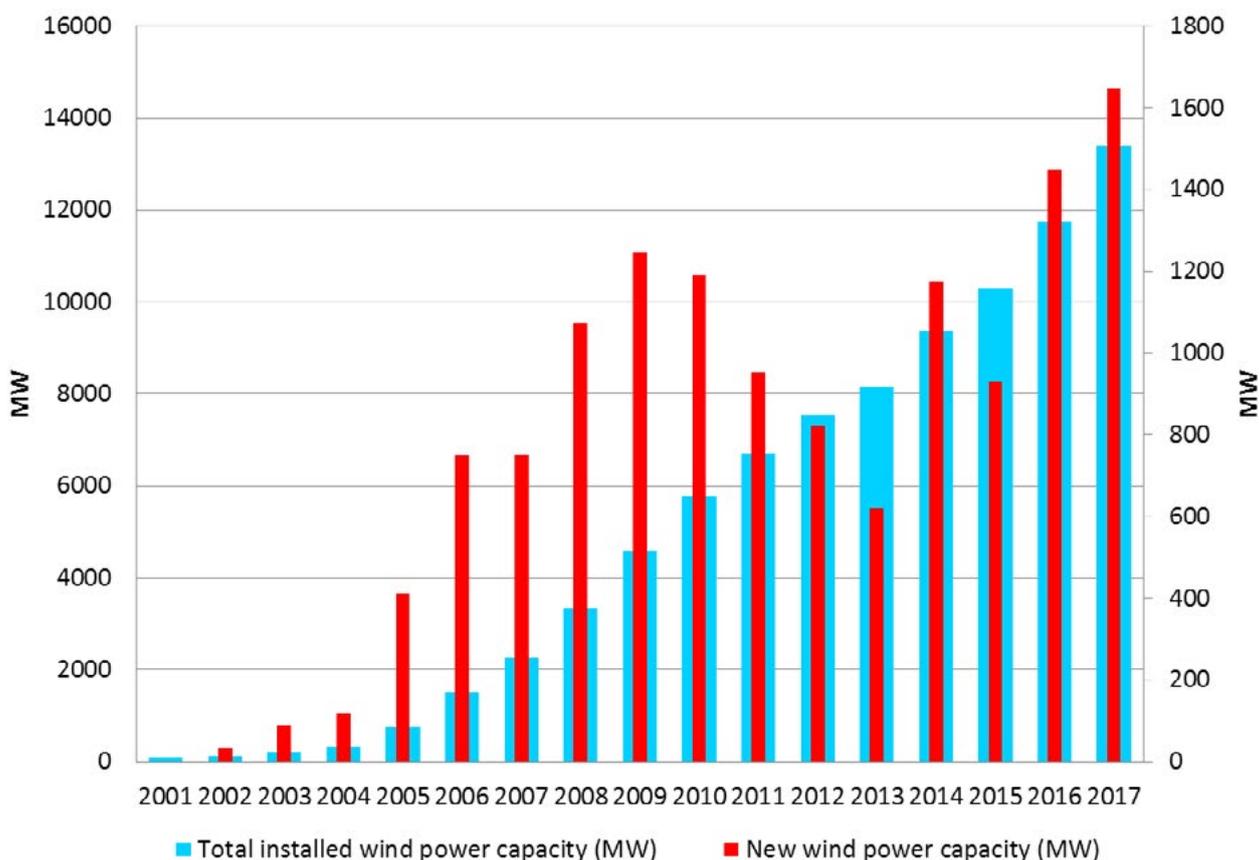


Figure 1. New and total wind power capacity in France (2001-2017) [2]

National R,D&D Priorities & Budget

The development of offshore wind and large wind turbine technology has been a priority in the recent years. The French Environment and Energy Management Agency (ADEME) is the driving funding agency for applied R,D&D projects in this area. ADEME funds and administers three kinds of projects: PhD theses; R&D projects for intermediate technology readiness levels (TRL); and the Programme des Investissements d'Avenir, which is dedicated to industrial projects, and funded by subsidies, reimbursable aids, and possibly equity.

After a call for proposals in 2009 on ocean energies, which included floating wind technologies, another call was launched in 2013 and four industrial demonstration projects were awarded by ADEME (see the IEA Wind TCP 2015 Annual Report).

Among the selected topics, floating wind technology was identified as a strategic area. France has a favorable situation for floating wind, local harbor facilities, and a local naval and offshore oil and gas industry capable of addressing this market. A dedicated call for tender for floating wind farm pilot projects highlighted the focus on floating wind.

Even though no national statistics are emitted on the R&D budget, 2017 remains a very active year, with the support to the four floating-wind pilot farm projects.

National Research Initiatives & Results

The DGE (drone générateur éolien) project was launched with the support of ADEME. Led by the start-up BladeTips Energy, the project aims to develop an airborne wind energy device and has already produced several small-size prototypes. As a first step, it targets a 20-kW power system.

The Helice project, led by Leosphere and supported by ADEME, aims to develop a new lidar technology to specifically address the control market with drastically reduced costs.

The ePenon project, also supported by ADEME and led by the Mer Agitée Company, develops dedicated wind speed sensors that can be installed in the tips of wind turbines to better control them based on real-time measurements.

Test Facilities & Demonstration Projects

The four pilot projects awarded in 2016 for floating wind farms have progressed on permitting and engineering work. These projects are targeting installation in 2020 and 2021 and include the following consortia:

- **The Faraman project** (near Fos sur Mer, in the Mediterranean), led by EDF Energies nouvelles, which comprises three Siemens 8-MW wind turbines on a floater developed by SBM Offshore and IFP Energies nouvelles
- **The Groix and Belle-Ile project** (on the Atlantic coast), led by EOLFI and CGN Europe, which features four GE Haliade 6-MW wind turbines on a floater developed by DCNS
- **The EoldMed project** (near Gruissan, in the Mediterranean), which will use four Servion 6.15-MW wind turbines on a floating foundation developed by IDEOL
- **The Eoliennes Flottantes du Golfe du Lion project**, led by Engie, Caisse des depots, EDPR and Eiffage (near Leucate in the Mediterranean), which will host three GE Haliade 6-MW wind turbines on a floater designed by Principle Power and built by Eiffage

In 2017, a 2-MW demonstrator was inaugurated and tested along the quay of Saint-Nazaire. The installation, hook-up, and commissioning will be finalized in 2018. This will be the first offshore wind turbine installed in France.

Collaborative Research

Since joining IEA Wind TCP in 2014, nearly 15 French organizations, including private companies, Regional Transmission Organizations (RTOs), Small to Medium Enterprises (SMEs), and laboratories, have expressed interest in collaborative research. France has contributed to the following IEA Wind TCP Tasks with positive results:

- Task 25 Design and Operation of Power Systems with Large Amounts of Wind Power
- Task 29 Analysis of Wind Tunnel Measurements and Improvement of Aerodynamic Models
- Task 30 Offshore Code Comparison Collaboration, Continued, with Correlation (OC5)
- Task 31 WAKEBENCH: Benchmarking of Wind Farm Flow Models
- Task 32 Lidar Systems for Wind Energy Deployment
- Task 33 Reliability Data: Standardizing Data Collection for Wind Turbine Reliability, Operation, and Maintenance Analyses
- Task 34 Working Together to Resolve Environmental Effects of Wind Energy (WREN)

Participation in Task 36 Forecasting for Wind Energy is also being considered.

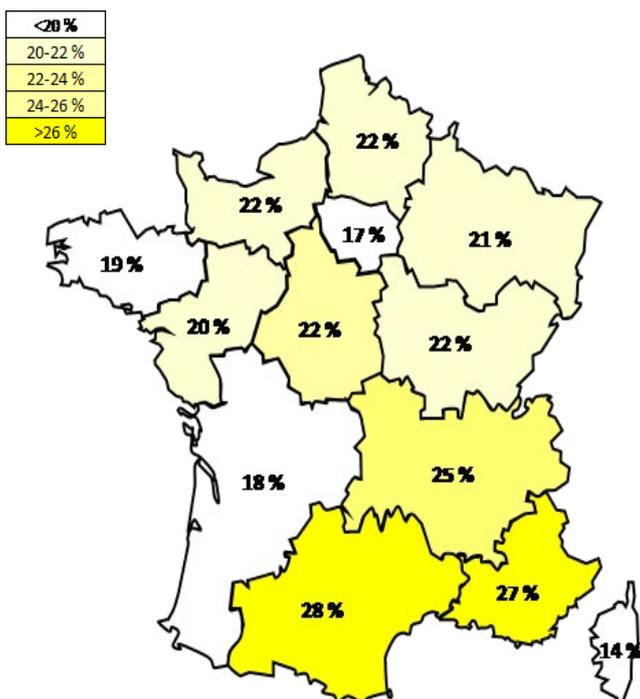


Figure 2. Capacity factors by region in France during 2017 [4]

IMPACT OF WIND ENERGY

Environmental Impact

Wind energy provided approximately 28% of the overall installed renewable power capacity in France, which amounted to 48.7 GW at the end of 2017. This constituted the second largest source after hydroelectricity. In terms of electricity production, wind contributed to 25% of the total renewable energy production.

Economic Benefits & Industry Development

Wind energy provided 10,000-11,000 full time equivalent direct jobs and nearly 8,000 indirect jobs [3]. Manufacturing of wind turbines and components account for an estimated 6,700 employees. Though there is no major national wind turbine manufacturer in France, several players such as DDIS, Vergnet, and, more recently, Poma Leitwind, contribute to the French economy. The wind industry in France also includes facilities from several large wind turbine suppliers such as GE, Siemens/Gamesa, and an LM Windpower blade factory that is being installed.

NEXT TERM

In 2018, the new revision of the PPE should be finalized and set new targets for wind power capacities. Several of the aforementioned measures aiming at facilitating the installation of wind turbines should become operational in the coming term.

Finally, the SmartEole project—focusing on wind turbine control at blade, turbine, and farm levels—will be finalized and results will be presented during a dedicated international workshop.

A variety of suppliers already exist, such as STX for offshore foundations, Nexans for the electric cables, Leroy-Somer for generators, and Rollix for blade and yaw bearings. Several SMEs are also providing advanced technologies; for example, LeoSphere is a leading lidar provider, while METEODYN and METEOPOLE provide service and software for wind resource assessment. This situation is currently evolving quickly, along with the development of a local offshore industry.

The national land-based wind market is valued at 1.8 billion EUR/yr (2.2 billion USD). Of this total, 1.3 billion EUR (1.6 billion USD) are devoted to investment in new parks, and 5.0 million EUR (6.0 million USD) are intended for the operation and maintenance of existing wind turbines

References

Opening photo: Coyecques wind park, France (Photo credit to Maia Eolis-Engie Green)

[1] Ministère de l'environnement, de l'énergie et de la Mer, en charge des relations internationales sur le climat. ADEME. December 2016. Coûts des énergies renouvelables en France. Edition 2016. ADEME editions.

[2] Ministère de l'environnement, de l'énergie et de la Mer, en charge des relations internationales sur le climat. February 2018. Tableau de bord: éolien. Quatrième trimestre 2018. Download from: www.statistiques.developpement-durable.gouv.fr

[3] ADEME, 2017. Etude sur la filière éolienne française: bilan, prospective et stratégie. Rapport final.

[4] RTE, SER, Enedis, ADEEF 2018 Panorama de l'électricité renouvelable en 2017.

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