



Report 2022

France

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In 2022, France installed around 1.4 GW of new wind capacity onshore and 0.5 GW of capacity offshore, raising the country's total wind power capacity to 20.9 GW [1].

Although the newly installed 1.4 GW of onshore wind power capacity surpassed the capacity installed in 2021, an additional 3.7 GW is still needed to reach the target of 24.1 GW set for next year. Regarding offshore wind power capacity, 1.9 GW in additional capacity is needed to achieve the goal of 2.4 GW set for 2023.

Wind and solar power capacities jointly represented 56% of France's renewable power capacity. Wind

power alone represented one-third of total renewable electricity production and 8.3% of national electricity demand. The total annual wind power energy output was 37.9 TWh, indicating a moderate increase of 3% from 2021. Due to unfavourable meteorological conditions, the capacity factor in 2022 was 21.6% [2], the lowest recorded in the last ten years.

In September 2022, the French government presented a draft law

Table 1. Key National Statistics 2022: France

Total (net) installed wind power capacity	20.9 GW
Total offshore capacity	0.5 GW
New wind power capacity installed	1.9 GW
Decommissioned capacity (in 2022)	N/A
Total electrical energy output from wind	37.9 TWh
Wind-generated electricity as percent of national electricity demand	8.3%
Average national capacity factor	21.6%
Target set for 2023	24.1 GW onshore and 2.4 GW offshore
National wind energy R&D budget	15 M EUR in 2020

to accelerate renewable energy development, aiming to foster faster deployment of renewable projects. The law was enacted in March 2023.

In November 2022, the first commercial bottom-fixed offshore wind farm, Saint-Nazaire, began producing electricity.

Highlight(s)

- The first commercial bottom-fixed offshore wind farm (Saint-Nazaire) began producing electricity in 2022.
- Newly installed onshore wind capacity (1.4 GW) must double in 2023 to reach the 24.1 GW total capacity target.
- Five bottom-fixed offshore wind farm projects have reached the construction phase, two of which should be commissioned in 2023.
- The total capacity of the projects under examination reached 13.8 GW in 2022, including 10.7 GW of onshore and 3.1 GW of offshore wind projects [1].

Market Development

Targets and Policy

The Pluriannual Energy Programme (Programmation Pluriannuelle de l'Énergie, PPE) requires renewable energy sources to contribute more than 33% of gross energy consumption in 2030 [3]. By this date, renewable energies must represent the following:

- 40% of electricity production.
- 38% of final heat consumption.
- 15% of final fuel consumption.
- 10% of gas consumption.

These national objectives are consistent with the goal of achieving carbon neutrality by 2050.

The policy enacting the PPE was published on the 21st of April, 2020, alongside updated wind power capacity targets for 2023 and 2028. For 2023, targets of 24.1 GW for onshore wind power capacity and 2.4 GW in fixed-bottom offshore wind power are set. To reach these targets, 3.2 GW of new onshore capacity and 1.9 GW of new offshore capacity must be installed in 2023.

The PPE also sets targets for 2028, ranging from 33.2 to 34.7 GW for onshore wind power capacity and

between 5.2 and 6.2 GW for offshore wind power capacity.

Finally, the PPE includes a schedule for deploying offshore bottom-fixed and floating wind tenders, as shown in the Table 2.

Progress and Operational Details

Total renewable power capacity reached 65 GW at the end of 2022, of which wind energy provided approximately 32% of France's overall installed renewable power capacity. Wind and solar jointly represent 56% of the total capacity, where wind represents the second largest renewable energy source after hydroelectricity, accounting for 26 GW.

The total renewable electricity produced was 117 TWh, representing around 26% of the total consumption in 2022. Wind contributed 31% of total renewable energy production, equalling 8.3% of total electricity consumption.

Over 1.4 GW [1] of new onshore wind power capacity was deployed in 2022. While this slightly exceeds the 2021 figure (see Figure 1), it falls below the average of 1.5 GW, which has been observed from 2016 to

Table 2

Award year	2020	2021	2022	2023	2024
Bottom fixed (MW)	1000 Manche Est Mer du Nord (60€/MWh) (63.63 \$/MWh)	500-1000 MW Sud Atlantique (60€/MWh)		1000 (50 €/MWh) (53 \$/MWh)	1000 MW/year (bottom -fixed and/or floating)
Floating (MW)		250 Bretagne (120 €/MWh) (127 \$/MWh)	2X250 Med. (110 €/MWh) (116.65 \$/MWh)		

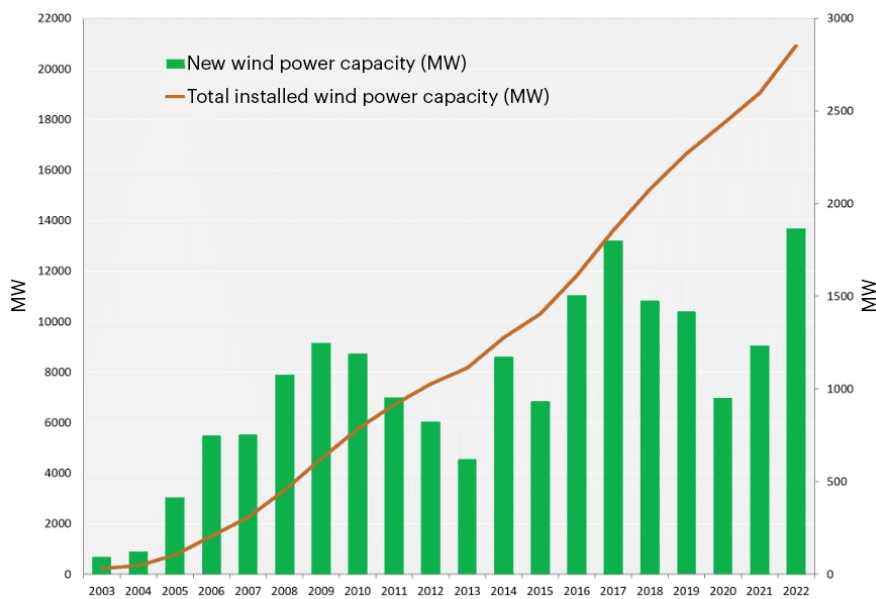


Figure 1: New and total installed wind power capacity (onshore and offshore).

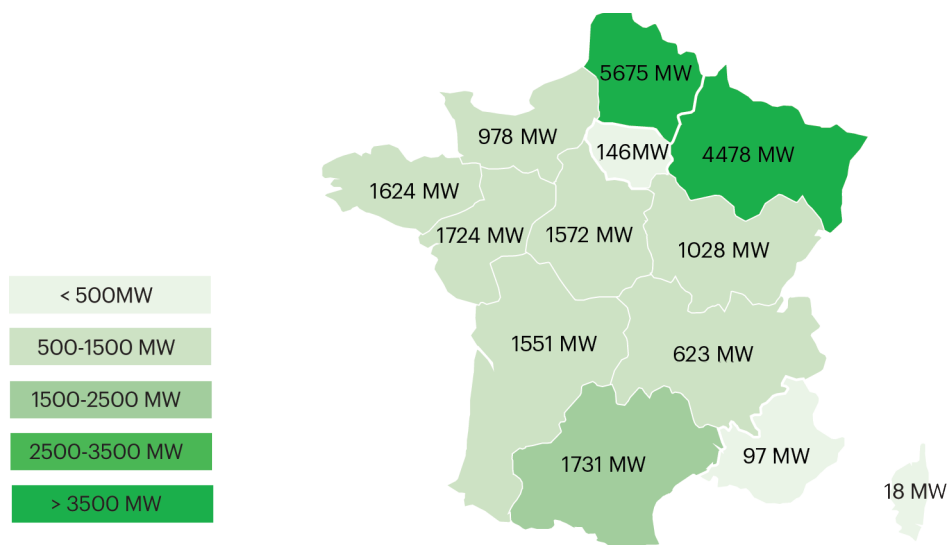


Figure 2: Total installed wind power capacity (onshore and offshore) in the different administrative regions.

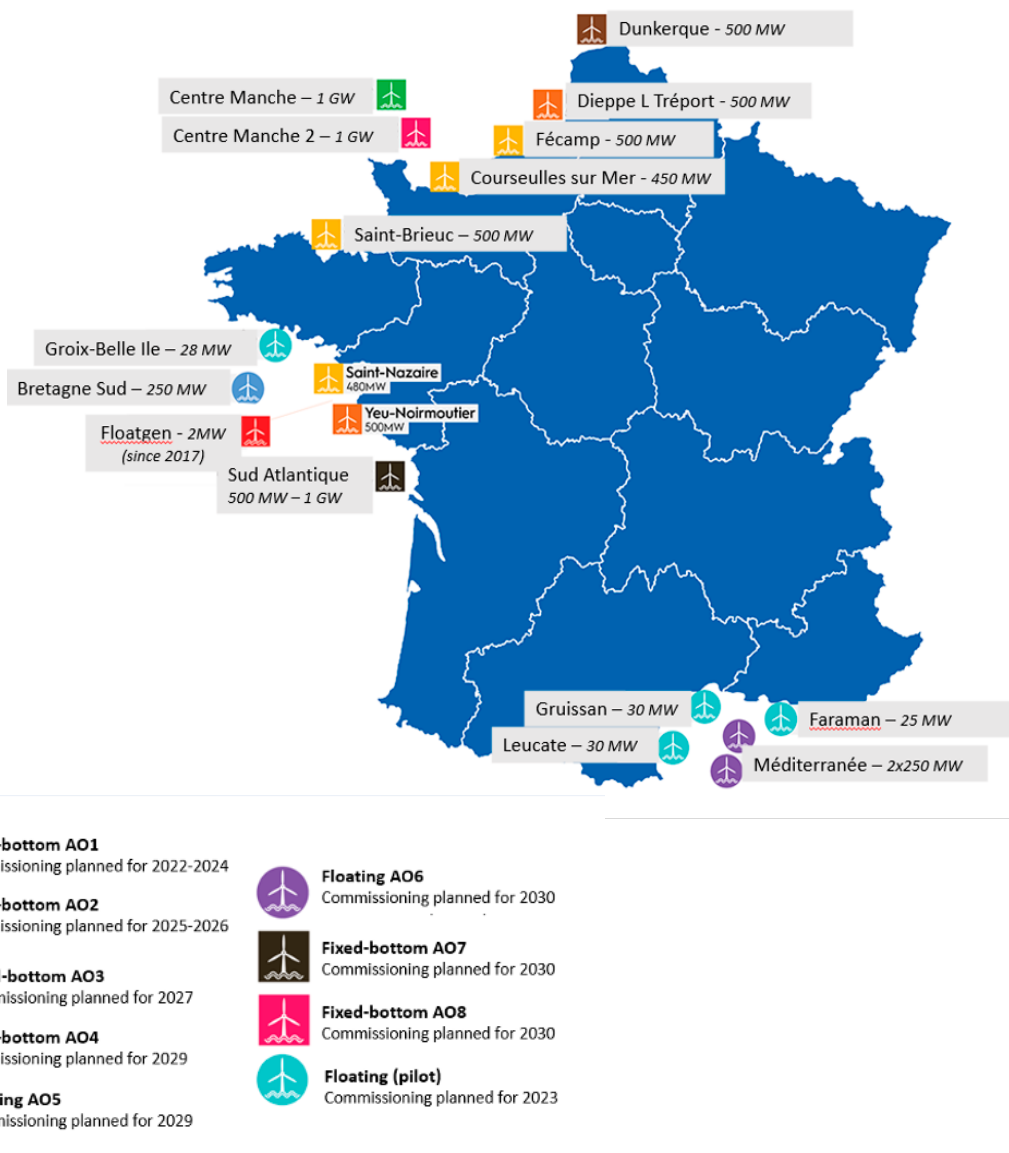


Figure 3: Offshore wind power farms and projects [6].

2019. On the 31st of December, 2022, the total capacity reached 20.9 GW, including 480 MW of offshore wind power capacity, mainly located in northeastern areas (see Figure 2).

In 2022, the capacity factor was 21.5%, well below the record high of 26.5% reached in 2020 and the lowest over the last ten years. The reason for the decline is attributed to unfavourable weather conditions. However, due to the newly installed capacities, the total wind energy output reached 37.9 TWh, representing an increase of 3% compared to 2021. Accordingly, wind power production accounted for 8.3% of electricity de-

mand, excluding overseas territories.

Regarding onshore wind power, a tender of around 1 GW was launched in April 2022 (AO-PPE2 – 2nd period). Only 17 projects were awarded in September 2022, totalling 295 MW and an average price of 67.5 €/MWh (71.53 \$/MWh). Another tender was launched in December 2022, with a very low award of 54 MW (compared to the expected 1 GW) and an average price of 76.4 €/MWh (80.96 \$/MWh).

Substantial progress was made regarding offshore wind power. As of November 2022, the first com-

mercial bottom-fixed offshore wind farm, Saint-Nazaire, began producing electricity (see Figure 3).

The three additional awarded wind farms from the 2012 tender are still under construction. Saint-Brieuc and Fécamp are projected to be commissioned at the end of 2023, and Courseulles sur Mer in 2025.

The two farms awarded during the 2014 tender, Dieppe-Le Tréport et Yeu-Noirmoutiers, aim to be commissioned in 2025.

The 1 GW “AO 4 Centre Manche” bottom-fixed project in Normandy

and the first floating wind tender of 250 MW in South Brittany (“AO5”) were still in a phase of competitive dialogue in 2022. Competitive dialogue is also ongoing for another two floating wind projects in the Mediterranean Sea (“AO6”).

Matters Affecting Growth and Work to Remove Barriers

In September 2022, the French government presented a draft law to accelerate the deployment of projects and, thereby, renewable energy production. The law was enacted in March 2023 and covers the four following project pillars: Planning of renewable energy projects, simplification of procedures, mobilisation of land for solar and wind power, and improved sharing of the value of renewable energies.

Regarding wind energy, a target of 40 GW of installed offshore wind capacity by 2050 has been set.

RD&D Activities

National RD&D Priorities and Budget

- Developing offshore wind and large wind turbine technology has recently been a priority.
- The French Agency for Ecological Transition (ADEME) is the driving funding agency for applied RD&D projects in this area. ADEME finances and administers three kinds of projects: Ph.D theses, R&D projects for intermediate technology readiness levels (TRL), and industrial projects funded by subsidies, refundable aids, and possibly equity.
- As part of the France 2030 investment plan, jointly implemented by ADEME, the National Research Agency (ANR), Bpifrance and the Banque des Territoires, the national

“Advanced Technologies for Energy Systems” (TASE) strategy was announced in February 2022. Support of nearly 1 billion euros aims to foster innovative solutions in the field of photovoltaics, floating wind power and energy networks. Furthermore, accelerating the industrialisation of renewable energies is planned. Three calls for projects were made by ADEME in 2022 and are open until October 2023. Among the selected topics, floating wind technology is prioritised.

- The CORIMER (Orientation Council for Research and Innovation in Sea Industries) also makes periodical calls for proposals. In 2022, several projects relating to offshore wind have been selected.
- Although several national public organisations coordinate R&D from their own budget, a dedicated R&D budget for 2020 is 15 million EUR (15.9 million USD), which is the third largest, after solar and biomass.

National Research Initiatives and Results

- The Momenta (farM rOtor ModEl accouNting aTmospheric wAke turbulence) project, funded by the ANR, is ongoing. Partners include the LA, LHEEA, PRISME labs, IFPEN and VALEMO. The objective is to study atmospheric and wake turbulence influence on wind turbine loads.
- The ePARADISE project (Evaluation des Perturbations Aérodynamiques sur les pales pour l’Amélioration de la Durabilité et de l’Impact Sonore des Eoliennes) also continues. It aims to develop a sensor to measure the airflow near wind turbine blades, optimising their operations and minimising acoustic emissions.

- Additional projects funded by the ANR are also in progress, such as the CREATIF project (Floating wind turbines control and grid integration), the MISTERY project (modeling and estimation of unsteady aerodynamic flows), the RIBEolh project (impacts of wind turbines noise on humans).
- France Energies Marines coordinates and finances many research projects in the offshore wind sector, such as BIODHYL (biofouling impact), DIMPACT (design of floating wind turbines), CASSIO-WPE (Characterisation of atmosphere - sea surface interactions in the Gulf of Lion), MONAMOOR (polyamide anchor lines monitoring).

Test Facilities and Demonstration Projects

- In the Mediterranean Sea, the Provence Grand Large floating wind project reached important milestones in 2022. This project implements an innovative floating system developed by SBM Offshore and IFPEN. The commissioning of the pilot farm is scheduled for 2023, for an operating period of at least 20 years.
- Also in the Mediterranean Sea, the EoldMed project and Eoliennes Flottantes du Golfe du Lion project are in progress. Commissioning is scheduled for both projects for the third quarter of 2024.
- Shell-Eolfi decided to stop the Groix and Belle-Ile floating wind project located on the Atlantic coast. The project was initially issued from a call for projects launched in 2015.

- The Open-C foundation is now coordinating all French test facilities. The creation of the foundation was decided in 2022 [4]. The facilities include:

*The SEMREV test site on the Atlantic Coast, managed by Ecole Centrale de Nantes, involves many academic and industrial partners.

*The Mistral floating wind test site on the Mediterranean coast, developed by Valeco/ EnBW in cooperation with France Energies Marines.

*The Saint-Anne du Portzic test site located near Brest is dedicated to floating wind turbines (Eolink, Windquest) and wave energy systems (PH4S, Dikwe).

*Other sites are Paimpol-Bréhat (Brittany) and See-neoh (located on the Garonne downstream from Bordeaux) for the wave, currents, and tidal energy.

Collaborative Research

Since joining IEA Wind TCP in 2014, nearly 15 French organisations, including private companies, regional transmission organisations (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 and unCertainty (OC6).

- Task 31 WAKEBENCH: Benchmarking of Wind Farm Flow Models.
- Task 32 Lidar Systems for Wind Energy Deployment.
- Task 33 Reliability Data: Standardising Data Collection for Wind Turbine Reliability, Operation, and Maintenance Analyses.
- Task 34 Working Together to Resolve Environmental Effects of Wind Energy (WREN).
- Task 36 Development of Forecasting Models and Risk Assessment of Wind Power.

Other Tasks, including Task 44 Farm Flow Control, Task 45 Recycling of Wind Turbines Blades, Task 49 Integrated Design on Floating Wind Arrays (IDeA) and Task 52 Large-Scale Deployment of Wind Lidar are also being considered.

Impact of Wind Energy

Environmental Impact

- Regarding biodiversity, a report from France Energie Eolienne was published in October 2022 [7], showing that “the wind power industry is fully aware of its impacts on biodiversity” and that “wind companies are already applying their resources towards mitigating their impacts”. On the other hand, many research projects studying the impact of wind turbines are ongoing, such as MIGRATLANE, MAPE, SEM-MACAPE, ECOSYSM-EOF and ORNIT-EOF.

Economic Benefits and Industry Development

- According to Wind Observatory 2022 [5], wind energy represented a total of 25,500 full-time equivalent jobs at the end of 2021 (a 12.8% increase

from 2020), with steady growth over the last two years. 33% of the employees are working in planning and design, 22% in component manufacturing, 28% in engineering and construction, and 17% in operation and maintenance.

- The wind power sector is well developed in France, with many companies located throughout the territory at all levels of the value chain (planning and design, component manufacturing, engineering and construction and operation and maintenance).
- Most international wind turbine manufacturers contribute to the French wind industry, with facilities from large wind turbine suppliers such as GE, Siemens-Gamesa, and an LM Windpower blade factory.
- Large international groups include component manufacturers, such as NTN for bearings, Prysmian and Nexans for connection cables, Hutchinson and Mersen. Engineering and construction companies are also well represented.
- Many SMEs are present in the study and design segment. Among them, Vensolair has extensive experience in onshore projects. Several startups are also beginning to develop in engineering studies and digital, such as Eoltech, Epsiline, Morphosense and Sereema.

Next Term

In 2023, two new offshore wind power plants in France will be constructed. Others will follow in 2025. The law to accelerate renewable energy production, enacted in March 2023, will foster wind energy development. Onshore wind capacity needs to increase and ongoing periodical tenders will potentially enable 9 GW by 2026.

In February 2022, the President of the Republic, Emmanuel Macron, presented the new energy policy and its objectives for 2050. It expects a tenfold increase in the production of solar energy, aiming to exceed 100 gigawatts (GW), the deployment of 50 new offshore wind farms aiming to reach 40 GW, and the doubling of the production of onshore wind turbines to reach 40 GW.

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