



Report 2023

# France

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**In 2023, around 1.6 GW of new onshore and 1 GW of new offshore wind power capacities were built in France, raising the country's total wind power capacity to 23.5 GW [1].**

The newly installed 1.6 GW onshore wind power capacity was higher than in 2022, however an increase of 3.7 GW was needed to reach the target of 24.1 GW set for this year. The 1 GW increase of offshore wind power capacity, did not allow the achievement of the objective of 2.4 GW set for 2023.

In 2023, wind and solar power capacities jointly represented 60% of France's renewable installed power

capacity. The year was characterised by record output for both wind energy (50.7 TWh) and solar energy (21.5 TWh). Wind power alone represented 10.2% of the French electricity production. Wind power electricity output stands ahead of gas, and close to hydroelectric power production.

Total annual onshore wind power energy output was 48.7 TWh, constituting a strong increase (more than 25%) from 2022, due to new wind power

**Table 1. Key National Statistics 2023: France.**

Total (net) installed wind power capacity	23.5 GW
Total offshore capacity	1.5 GW
New wind power capacity installed	2.5 GW
Total electrical energy output from wind	50.7 TWh
Wind-generated electricity as percent of national electricity demand	10.2%
Average national capacity factor	25.8%
Target set for 2023	24.1 GW onshore and 2.4 GW offshore
Target set for 2028	Between 33.2 and 34.7 GW onshore Between 5.2 and 6.2 GW offshore

capacities and to favourable meteorological conditions. The capacity factor for onshore wind was 25.8% in 2023, compared to 21.6% in 2022 [2]. Offshore wind power energy output was around 1.9 TWh.

The law aiming to accelerate the renewable energy production development in France, and to foster a faster deployment of renewable projects was enacted in March 2023. This law makes territorial planning for renewable energies a priority [3]. For offshore wind, a “seafronts planification” will be implemented.

Two new commercial bottom-fixed offshore wind farms (Saint-Brieuc [4] and Fécamp [5]) began producing electricity in 2023.

### Highlight(s)

- The total capacity of projects under planning reached 14.9 GW at the end of 2023, including 11.7 GW of onshore and 3.2 GW of offshore wind projects [1].
- Two new commercial bottom-fixed offshore wind farms (Saint-Brieuc and Fécamp), each with 0.5 GW, began producing electricity in 2023.
- Three floating wind turbines of Provence Grand Large were

successfully installed at sea, 17 km off the coast of Port-Saint-Louis-du-Rhône.

- Record high new installed capacity of 2.5 GW brought the total to 22 GW for onshore and 1.5 GW for offshore wind. This was however not enough to reach the targets set for 2023 of 24.1 GW and 2.4 GW.
- 54 new projects were selected from calls for tenders, for a total power capacity of 931 MW and average price of 86.94 EUR/MWh.

## Market Development

### Targets and Policy

The Pluriannual Energy Program (PPE) sets the target share of renewable energies at more than 33% of gross final energy consumption by 2030. By this date, renewable energies must represent:

- 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 path necessary to achieve carbon neutrality by 2050.

The decree enacting the PPE was published on the 21st of April, 2020, with updated wind power capacity targets for 2023. Targets were set at 24.1 GW for onshore wind power capacity and 2.4 GW for bottom-fixed offshore wind power. To reach the 2023 targets, an additional 3.2 GW of new onshore capacity and 1.9 GW of new offshore installed capacity would have been necessary.

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. To reach these targets, 2.3 GW of capacity onshore and 750 MW offshore needs to be installed each year until 2028.

Finally, the PPE includes a schedule for deploying offshore bottom-fixed and floating wind tenders, as shown in the following table [6].

Table 2

Windfarm or tender name	Tender	Award year/ Lauch year	Capacity (MW)	Type	Beginning of construction	Comissioning year
Saint Nazaire	A01	Awarded in 2012	480.00	Bottom-fixed	2020	2022
Saint Brieuc			496.00		2021	2023
Fécamp			497.00		2020	
Courseulles-sur-mer			448.00		2021	2025
Îles d'Yeu et de Noirmoutier	A02	Awarded in 2014	496.00		2022	
Dieppe-Le Tréport						
Dunkerque	A03	Awarded in 2019	600.00		2024	
Centre Manche 1	A04	Awarded in 2023	1,000.00		2027	2031
Sud Bretagne	A05	Launched in 2021	250.00	Floating	2025	2030
Méditerranée (2 farms)	A06		500.00	Floating (2x250 MW)	2027	2031
Sud Atlantique	A07		1,000.00	Bottom-fixed		2030
Centre Manche 2	A08		1,500.00		2031	

(Total of capacities to be awarded by these tenders: 7.8 GW)

## Progress and Operational Details

The total renewable power capacity reached 70 GW at the end of 2023, of which wind energy provided approximately 33%. Wind and solar jointly represent 60% of the total capacity, wind being the second largest renewable energy source after hydroelectricity (26 GW).

Renewable electricity amounted to 131 TWh, representing around 26% of total consumption in 2023. Wind contributed to 39% of the total renewable energy production.

Over 1.6 GW [1] of new onshore wind power capacity was built, slightly exceeding the 2022 figure (see Figure 1). The total capacity for onshore wind reached 22 GW on the 31st of December, 2023, mainly located in the North and the East of the country (see Figure 2). The installed offshore

wind power capacity, located in Brittany and Normandy, reached 1.5 GW.

In 2023, favourable weather conditions enabled a capacity factor for onshore wind of 25.8%, which fell below the record high of 26.5% that was reached in 2020, but higher than in 2021 and 2022. Thus, this high-capacity factor combined with newly installed capacities, created a total (onshore and offshore) wind power energy output of 50.7 TWh, representing an increase of 33% compared to 2022. Wind power production accordingly accounted for 10.2% of electricity consumption (excluding overseas territories).

Concerning onshore wind power, call for tenders began in 2021, and is comprised of ten periods, running until 2026. In 2023, 54 new projects were selected at the end of November, for a total power capacity of 931 MW. The average price of the

winning projects is 86.94 EUR/MWh. This was the second fully subscribed call for tenders of the year 2023, in addition to the first call for tenders in June which led to 73 projects being selected with a total power capacity of 1,182.36 MW and an average price of 84.76 EUR/MWh.

Substantial progress was made regarding offshore wind power, as the commercial bottom-fixed offshore wind farms of Saint-Brieuc and Fécamp (about 0.5 GW each) began producing electricity in July 2023 and should be fully commissioned at the end of March 2024 (see Figure 3).

The other awarded wind farm from the 2012 tender, Courseulles sur Mer, is still in the construction phase and should be commissioned in 2025.

The two farms awarded during the 2014 tender (Dieppe-Le Tréport et Yeu-Noirmoutiers) should be

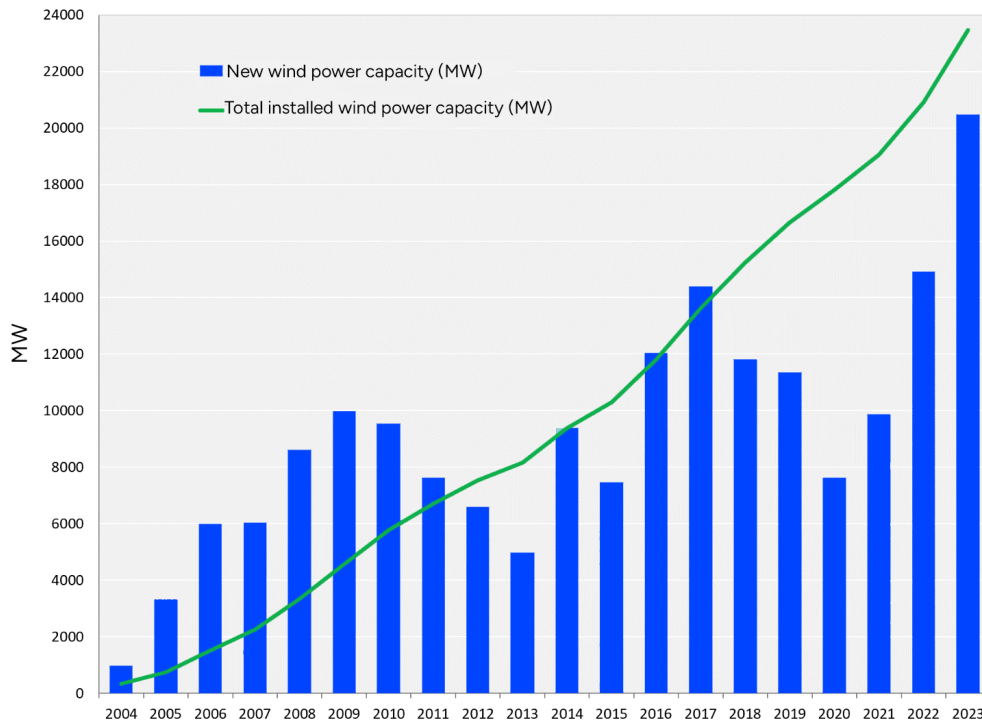


Figure 1: New and total installed wind power capacity (onshore and offshore). Author: IFPEN, Source: SDES [1].

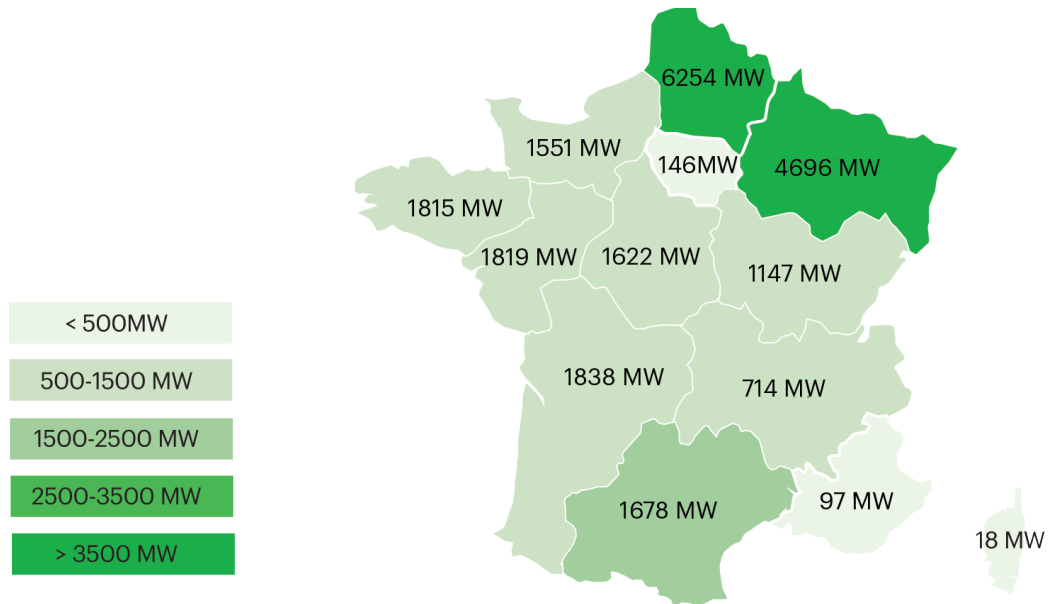
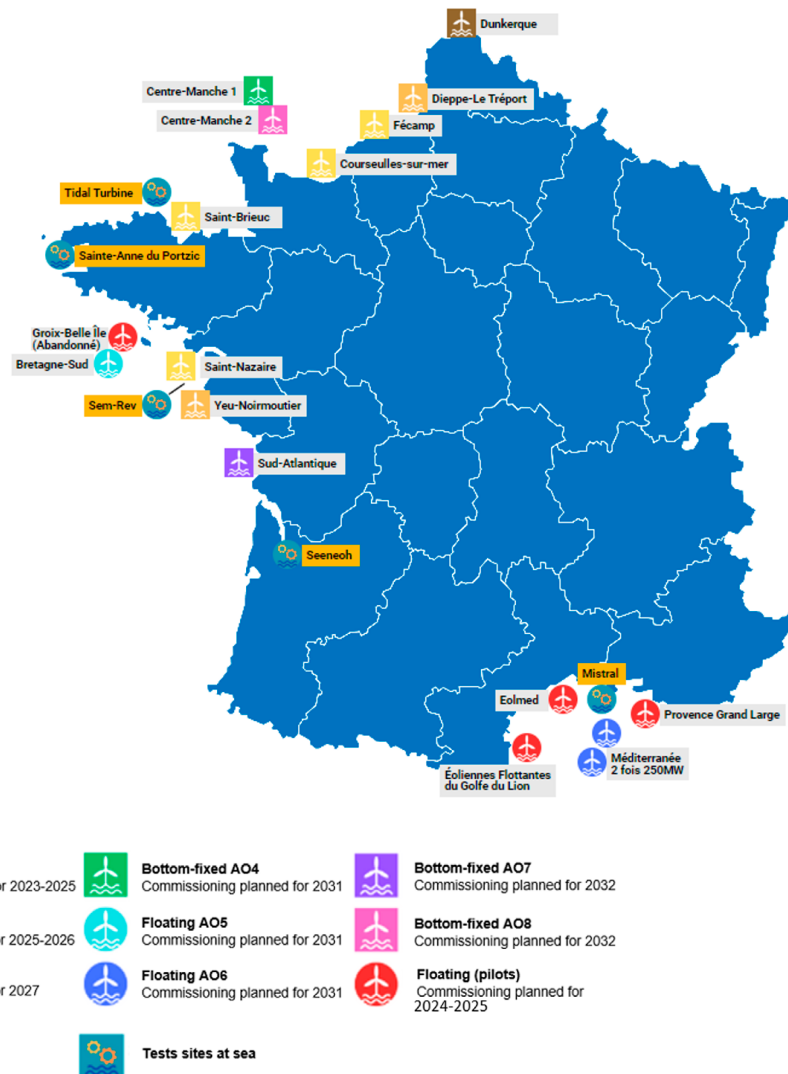


Figure 2: Total installed wind power capacity (onshore and offshore) in the administrative regions. Author: IFPEN, Source: SDES [1].



**Figure 3:** Offshore wind power farms commissioning plan 2023 [6]. NB: «AO» stands for «Appel d’Offres», which mean «call for tender».

commissioned in 2025.

The 1 GW “AO 4 Centre Manche” bottom-fixed project in Normandy and the first floating wind tender for 250 MW in South Brittany (“AO5”) were still in a phase of competitive dialogue in 2023. Competitive dialogue is also ongoing for two other floating wind projects in the Mediterranean Sea (“AO6”).

At the end of November 2023, President Emmanuel Macron announced that the government will launch a large call for tenders in 2025 for new offshore wind farms, adding 10 GW of installed power in 2035 [10]. Considering that 8 GW of offshore wind projects are already under construc-

tion or examination, the target of 18 GW in 2035, set in the “offshore wind pact” from March 2022, would thus be reached.

### Matters Affecting Growth and Work to Remove Barriers

The law aiming to accelerate the renewable energy production development and to foster a faster deployment of projects was enacted in March 2023. It is based on the four following principles: Planning of renewable energy projects, simplification of procedures, mobilisation of land for solar and wind power, better sharing of the value of renewable energies.

This law makes territorial planning for renewable energies a priority. Because of this law, municipalities can after public debate, define acceleration zones where they primarily wish to see implemented renewable energy projects [3].

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

For offshore wind, a “seafronts planification” has been implemented. France is divided into four large seafronts: The East Channel – North Sea seafront, North Atlantic - West Channel seafront, South Atlantic seafront and Mediterranean seafront. A major public debate on the future of

offshore wind power is taking place in the territories of the four seafronts from November 2023 to the end of April 2024.

All citizens can accordingly participate in the choices regarding the future of offshore wind power, which will be decided in 2024.

## RD&D Activities

### National RD&D Priorities and Budget

- 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 TRLs; and industrial projects funded by subsidies, refundable aids, and possibly equity.
- Created in 1996, the France Energie Eolienne (FEE) association promoting the French wind industry became France Renouvelables in 2023. France Renouvelables, which is a stakeholder group acting as a spokesperson for the industry, is now dedicated to wind and photovoltaic energies and has more than 360 members across all value chains.
- The national “Advanced Technologies for Energy Systems” (TASE) strategy was announced in February 2022. Nearly 1 billion euros in support has been allocated to developing innovative solutions in the field of photovoltaics, floating wind power and energy networks, and to accelerate the industrialisation of renewable energies. Three calls for projects were made by ADEME which were open until October 2023. Among the selected topics, floating wind technology was prioritised.
- The CORIMER (Orientation Council for Research and Innovation in Sea Industries)

also makes periodical calls for proposals with public funding. In collaboration with representatives of the maritime industrial sector (shipbuilding, equipment manufacturers, oil services, energy companies, renewable energies, nautical industry), the R&D Committee of the sector, and the public authorities, it acts as a trusted third party. Its calls for expressions of interest are based on the sector’s technological roadmaps, with a purpose of structuring public aid and support for sector projects.

### National Research Initiatives and Results

- Several projects funded by the ANR (National Research Agency) are in progress, such as MOMENTA (farM rOtor ModEl accouNting aTmospheric wAke turbulence), ePARADISE (Evaluation des Perturbations Aérodynamiques sur les pales pour l’Amélioration de la Durabilité et de l’Impact Sonore des Eoliennes), CREATIF (Floating wind turbines control and grid integration), MISTERY (modelling and estimation of unsteady aerodynamic flows), RIBEOlh (impacts of wind turbines noise on humans).
- France Energies Marines (Institute for energy transition) coordinates and finances many research projects in the offshore wind sector, such as BIODHYL (biofouling impact), DIMPACT (design of floating wind turbines), CASSIOWPE (Characterisation of atmosphere - sea surface interactions in the Gulf of Lion), MONAMoor (polyamide anchor lines monitoring). Since the beginning of 2020, the activities of the Institute have been carried out by a “simplified joint-stock company” (SAS). Created in 2012, following a national reflection on the interest of building a national technological platform for offshore renewable

energies, the original structure brought together a broad partnership with the main players in the sector.

- A call for projects was launched in June 2023 by the French Biodiversity Office (OFB, public institution dedicated to the protection and restoration of biodiversity in France, under the supervision of the Ecology ministry and Agriculture & Food ministry). The call aims to promote and support research work to acquire new knowledge on the interactions between offshore wind turbines and the marine environment and solutions to avoid, reduce or compensate their impacts. Three projects were selected and will receive a budget of 2 million euros.

### Test Facilities and Demonstration Projects

- In the Mediterranean Sea, the Provence Grand Large floating wind project is ongoing. This project implements an innovative floating system developed by SBM Offshore and IFPEN. In October 2023 the three floating wind turbines were successfully installed at sea, 17 kilometres off the coast of Port-Saint-Louis-du-Rhône. The farm is expected to be operating for at least 20 years.
- Also in the Mediterranean Sea, the EoldMed project and Eoliennes Flottantes du Golfe du Lion project are in progress. For both, commissioning is scheduled for the third quarter of 2024.
- The Open-C foundation, created in 2022, is coordinating all the French test facilities. The facilities are (see figure 3):
  - \*The SEMREV test site on the Atlantic Coast, managed by Ecole Centrale de Nantes and 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 Seeneoh (located on the Garonne downstream from Bordeaux) for the wave, currents, and tidal energy.

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

France is currently involved in Task 25 Energy Systems with Large Amounts of Variable Generation, 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. The new Task 56 OC7 and Task 57 Joint Assessment of Models are also being considered.

## Economic Benefits and Industry Development

- According to Wind Observatory 2023 [8], wind energy represented a total of 28,300 full-time equivalent jobs at the end of 2022 (a 11% increase from 2021), with steady growth over the last two years. 34% of the employees are working in planning and design, 22% in component manufacturing, 26% in engineering and construction, and 18% in operation and maintenance.
- The wind power sector is well developed in France, with many companies located throughout the territory, in all segments of the value chain (planning and design, component manufacturing, engineering and construction and operation and maintenance).

## 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,

## Impact of Wind Energy

### Environmental Impact

- Many research projects studying the impact of wind turbines are ongoing, such as MIGRATLANE (Complementary methods to characterise the use of the North-East Atlantic Arc by birds and bats), MAPE (Reduction of Avian Mortality in Operating Wind Farms), SEMMACAPE (Monitoring and study of marine megafauna in wind farms by automatic characterisation), ECOSYSM-EOF (Prefiguration of an observatory of marine ecosystems in interaction with floating offshore wind farms in the Gulf of Lion) and ORNIT-EOF (Prefiguration of an observatory of the Gulf of Lion birdlife in interaction with floating offshore wind farms).
- A study commissioned by the French Biodiversity Observatory identified 80 levers developed internationally for action to better integrate biodiversity into renewable energy projects. These levers may be classified in economic, techno-legal and socio-cognitive categories [7].

- 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 also include component manufacturers, such as NTN for bearings, Prysmian and Nexans for connection cables, and Hutchinson and Mersen. Engineering and construction companies are also well represented.
- Many SMEs and startups are present in the study and design segment.

## Next Term

The law on the acceleration of renewable energy production, enacted in March 2023, will foster wind energy development. A new PPE (pluriannual energy program) should be implemented in 2024 for the period 2024-2035. In November 2023, the government made its energy and climate strategy (SFEC) public, which

stipulates that France will eradicate fossil fuels by 2050 [8]. The rapid development of renewable energies until 2035 will be essential to achieve this objective.

Regarding onshore wind, a periodical tender (AO PPE2) is ongoing, with a total of 9 GW in new capacity. The tender began in 2021 and is comprised of ten periods, running until 2026. Until now, 4 GW were awarded on six periods. Four periods still remain (i.e. around 4 GW) to be awarded.

Regarding offshore wind, there is a steady pipeline from the previous call for tenders with 8 GW under construction or planning. The government will launch a large call for tenders in 2025 for new offshore wind farms, adding 10 GW of installed power in 2035. This will enable France to reach its target of 18 GW by 2035 set in the “offshore wind pact” dated March 2022.

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