France Energie Eolienne | Capgemini invent

WIND OBSERVATORY 2023

Analysis of the French wind power industry:
market, jobs and challenges

Op-ed

The period spanning 2022 and the initial months of 2023 witnessed an unprecedented energy crisis, prompting emergency responses such as the implementation of energy price caps. This period underscored the imperative of implementing a robust energy policy founded on principles of energy sobriety, efficiency, the expansion of renewables, and maintaining an adequate level of carbon-free dispatchable generation resources.

Getting through the winter of 2022–2023 without any power cuts was only made possible thanks to an ambitious energy conservation strategy plan and emergency measures to bolster the growth of renewable electricity, particularly wind power.

A collective understanding has now emerged that extends beyond short-term emergency management, however. There is a recognition that we must anticipate an annual increase in electricity consumption of approximately 15 TWh per year until 2035 – a surge driven by the electrification of end uses in transportation and mobility, industrial sectors, as well as residential and commercial real estate.

Over this period, renewable electricity generation from onshore and offshore wind, as well as solar PV, stand as the sole available technologies capable of ensuring the required growth in electricity consumption to achieve a 55% reduction in greenhouse gas emissions by 2030 compared to 1990 levels and to attain carbon neutrality by 2050.

In numerical terms, achieving these goals will require escalating renewable electricity generation from approximately 120 TWh in 2020 to 230 or even 250 TWh by 2030, amounting to a twofold increase in the annual generation of renewable electricity in France in under seven years.

Op-ed

In order to achieve this reduction in fossil fuel consumption through the electrification of end uses – effectively constituting a second wave of electrification for the country given its scale –, four prerequisites must be fulfiled:

- **Consolidating a legal and regulatory framework** that will streamline project implementation timeframes and make them align with European standards (3 to 4 years for an onshore wind farm or ground-mounted solar installations, and 6 to 7 years for an offshore wind farm), which is the focus of France's Renewable Energy Acceleration Act passed in March 2023.

- **Enhancing clarity and ambition in outlining development goals for both 2030 and 2035**, which is the focus of the forthcoming Loi de Programmation Energie et Climat (LPEC) legislation.

- **Ensuring a stable economic environment for renewables** capable of effectively responding to shifting economic circumstances (such as shocks in commodity prices and spiking interest rates) to maintain a conducive environment for industrial businesses, which is the focus of the Green Industry Bill, upcoming finance bills, and the budget part of the LPEC bill.

- **Fostering an enabling approach** between the renewables industry, government agencies and local authorities with a view to elevating project quality and reaching consensus on topics including the intersection between renewables and biodiversity, landscapes, land use, positive local impacts, all within a spirit of open dialogue.

Progress has been initiated towards meeting these four prerequisites. The effectiveness of the collaborative efforts between the French state, elected officials, and the industry, as well as the resolutions reached on these various issues between the end of the summer recess 2023 and the summer of 2024, will determine France's ability to achieve EU policy goals, particularly those set for 2030.

From my standpoint, there are two opposing forces at play. On one hand is the inclination or convenience of maintaining the status quo, on the other the sense of responsibility that should guide the future of our country. The challenges that lie ahead of us, particularly around the LPEC energy and climate bill, must unequivocally demonstrate that France doesn't stand for inertia. We shall continue our ongoing efforts, outreach initiatives and proposals, so that common sense can prevail over resignation.

Anne-Catherine de Tourtier – Head of France Énergie Éolienne

Executive summary

Key figures of the wind energy sector in 2022

The French wind power market

2nd largest renewable energy in France's electricity generation mix [1]

21.1 GW of installed onshore and offshore wind as at 31 December 2022[1] (+11% compared to 2021)

38.1 TWh of electricity generated in 2022[1]

9% of France's electricity consumption in 2022[1]

1st French offshore wind farm commissioned in Saint-Nazaire in 2022

Jobs in the wind sector

No.1 employer among renewable electricity sources in France[2]

28,266 direct and indirect jobs in wind power at the end of 2022[3] (+11% compared to 2021)

Costs and revenues

€76.33 per MWh,[4] average price of onshore wind electricity in the 2022 and 2023 calls for tender

€6.3 billion in net revenue for the French state in 2022 and 2023, generated thanks to renewable energies[5]

Sources:
[1] Electricity report for 2022, RTE
[2] Latribune.fr
[3] FEE data, processed by Capgemini Invent
[4] CRE, average price of the last 3 onshore wind tenders
[5] CRE deliberation, July 2023. CSPE onshore wind sector

Key figures of the wind energy sector in 2022

2.1 GW[2]
in wind power capacity installed and connected to the grid in 2022 (1.6 GW onshore and 0.48 GW offshore)

38.1 TWh[2] of electricity produced from wind energy

642 wind turbines[1] installed in 2022

2.6 million households could be supplied in electricity derived from wind power

Key figures

- Almost **9,500 wind turbines** in France at the end of 2022, spread over nearly **2,262 wind farms**[3] (2 of which were offshore wind farms).
- Installed wind capacity in 2022 has **increased compared to 2021**, which saw the installation of 1.2 GW in new capacity. **1.3 GW additional wind power** should have been installed in 2022 in order to meet the PPE objectives. France is thus the only European country that is lagging on its annual renewable energy and heat recovery development objectives.
- The year 2022 was marked by the opening of the first offshore wind farm off the coast of Saint-Nazaire, with a capacity of 480 MW.
- Wind power is the **second-largest source of renewable electrical power** after hydropower, and the fourth largest electrical power source in France.

Sources:
[1] FEE data
[2] Electricity report for 2022, FEE study
[3] Transition-energetique.eco and The Wind Power

The contributions of the wind industry in France in 2022

Economic contributions benefiting everyone

€6.3 billion in wind revenue for **the State** in 2022 and 2023[1]

€165 million in local tax revenue in France in **2022**[2]

On average, IFER tax benefits from a wind farm **fund 21% of the operating budget** of its host municipality[3]

A sector that contributes to France's reindustrialisation

€7 billion in turnover in 2021 (+23% compared to 2020)[4]

€777 million in equipment and engineering exports[3]

4 out of 12 European units involved in the production of offshore wind equipment **are located in France**[5]

Massive buy-in by French citizens

73% of the French[6] have a positive image of wind power

€11.4 million collected through crowdfunding to fund renewable energies in 2021[7]

The French government is working on a roadmap aiming to mainstream the principle of shared governance (civic participation).

Major benefits for the community

5 million tonnes of avoided CO_2 emissions thanks to the development of solar and wind power in France[8]

The installation of wind farms allows rural municipalities to improve various **public services**, such as:

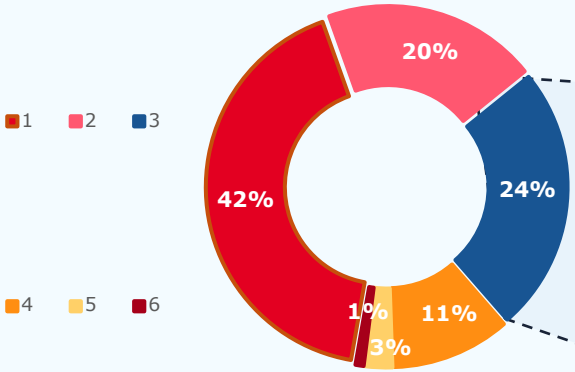
- Road rehabilitation
- Building/renovating cultural and tourist sites
- Deploying fibre-optic networks
- Renovating public lighting systems

[1] Excluding tax revenue. CRE newsletter, July 2023
[2] Estimate based on an average of
[3] €7,820 per MW installed (IFER average)
IFER application at 50% (€7,820) for a 24 MW park, AMRF
[4] Baromètre 2022 des Énergies renouvelables électriques (2022 Renewable Electricity Barometer)
[5] Not including the Chantiers de l'Atlantique foundation production plant in Saint-Nazaire.
[6] Harris Interactive study for the Ministry of Ecological Transition, August 2021
[6] Crowdfunding: 185 M€ pour la transition énergétique [€185 million for the energy transition], GreenUnivers, 12 May 2022
[8] Note : précisions sur les bilans CO_2 [clarifications on CO_2 assessments], RTE

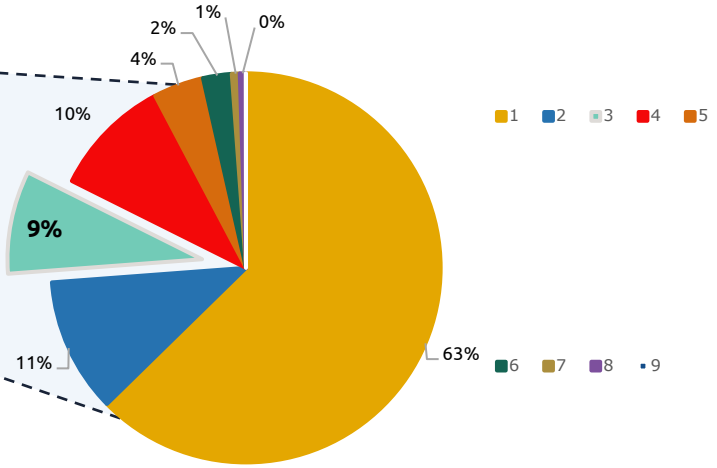
The place of wind power in the French energy mix in 2022

Electricity accounts for **24%** of France's energy use.
In 2022, wind power accounted for **9%** of France's electricity production.

Breakdown of **final energy** consumption in France



Electricity generation sources in France

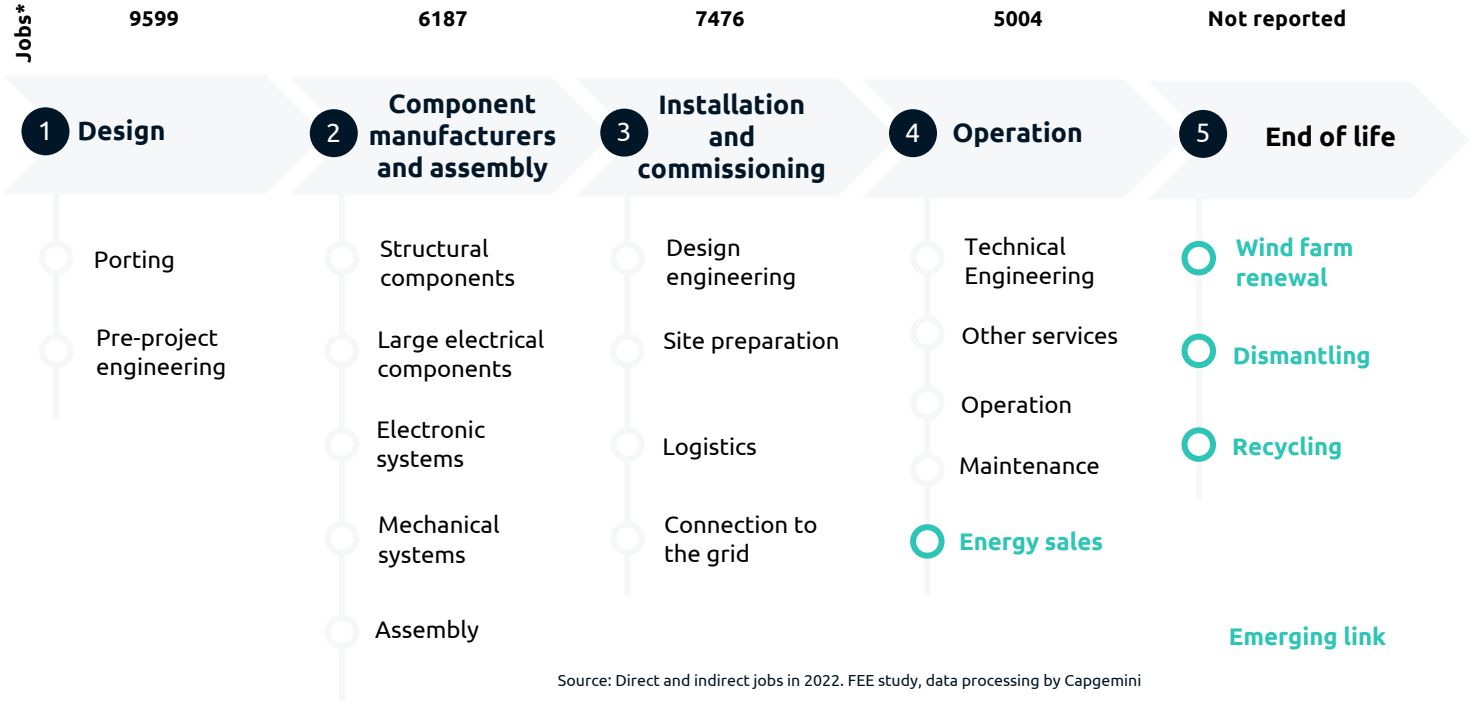


Total electricity generation
445.2 TWh

Wind
38.1 TWh

Sources: RTE's 2022 Electricity report and Key energy figures 2022, French Ministry of Ecological Transition

The value chain is changing with the emergence of new nodes including energy sales and recycling.



Source: Direct and indirect jobs in 2022. FEE study, data processing by Capgemini

Key facts and figures

28,266 FTEs
in wind power at the end of 2022

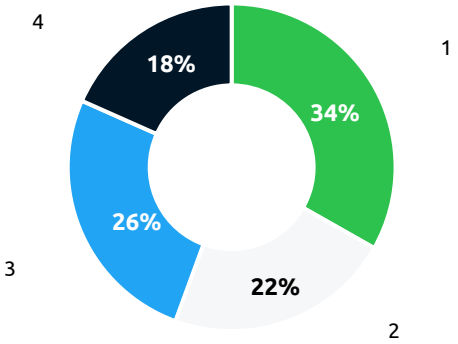
11%
increase in jobs in 2021

In 2022, **wind power jobs have continued to increase at a significant pace**, with a growth rate of 11% and a total of 28,266 direct and indirect jobs in France as at 31 December 2022.

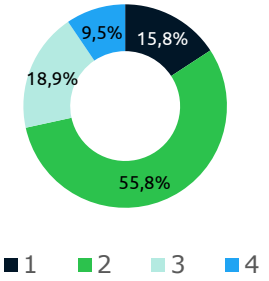
These winds jobs are primarily created in the Normandy and Pays de la Loire regions. This reflects the strong presence of the offshore wind sector.

34% are female[2]

Distribution of FTEs on the value chain



Breakdown based on company size[2]

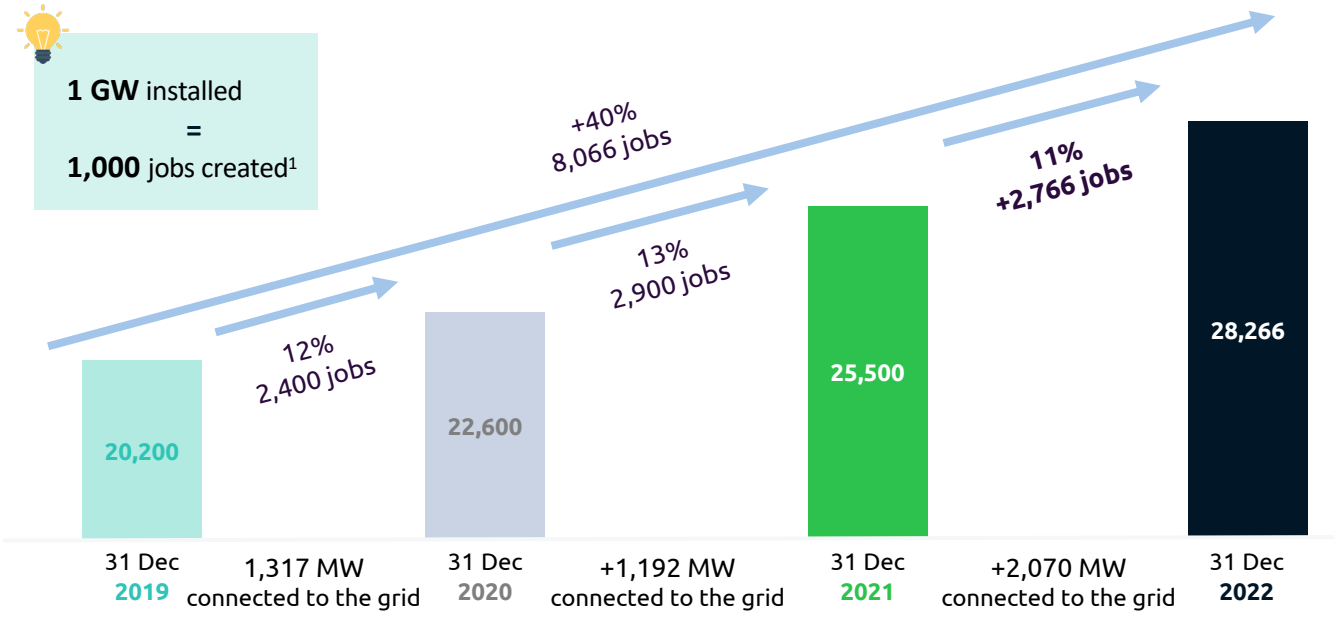


Sources: [1] Observatory for marine energies 2022
[2] Based on jobs recorded in 2022

Job growth in wind power in France in 2022

The number of wind jobs is continuing to increase

Employment trends in wind power from 2019 to 2022

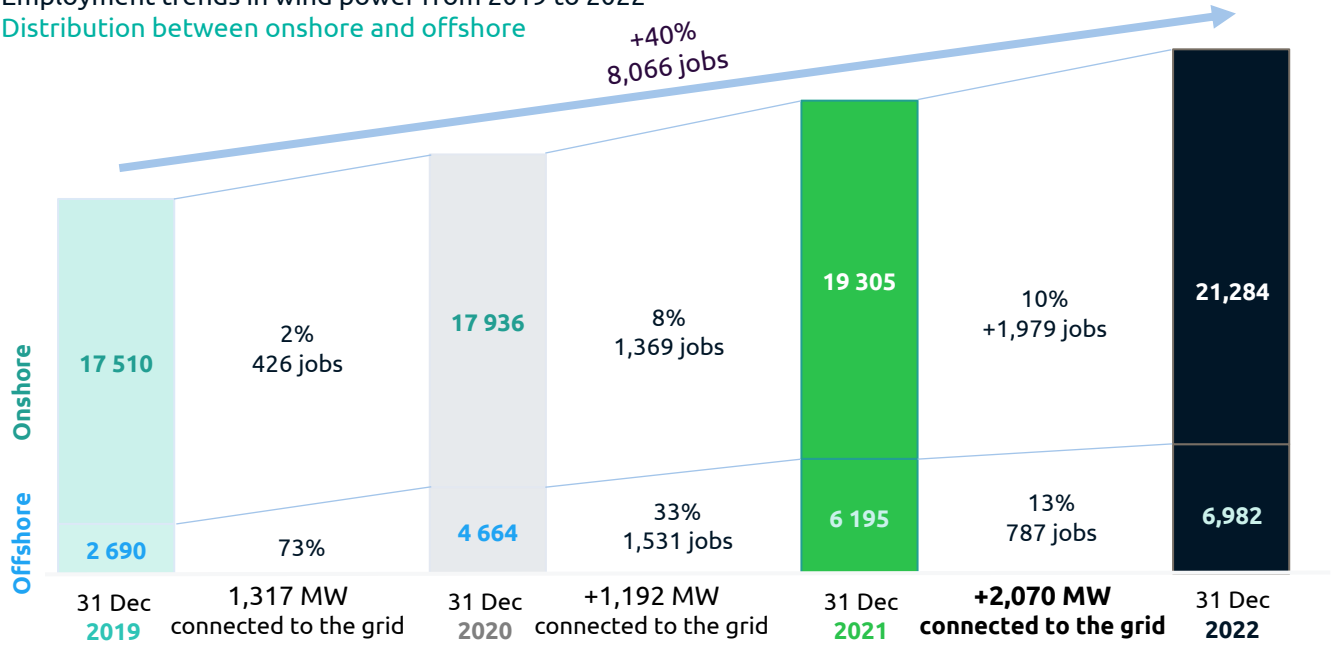


Source: 2023 FEE study, data processing by Capgemini Invent. [1] See page 46

Job growth in wind power in France in 2022

The number of wind jobs is continuing to increase both in offshore and onshore wind

Employment trends in wind power from 2019 to 2022
Distribution between onshore and offshore



Source: FEE 2023 study, Marine energy observatory 2023 and data processing by Capgemini Invent

France: centrepiece of the wind industry in Europe

France: **Shares first place** with 4 of Europe's manufacturing plants for the production of offshore wind turbine blades and nacelles

Company*	Generation	Country	City
LM Wind Power (GE)	Blades		Cherbourg
GE Renewable Energy	Nacelles		Saint-Nazaire
Siemens Gamesa	Nacelles		Le Havre
Siemens Gamesa	Blades		Le Havre
Siemens Gamesa	Blades		Aalborg
Siemens Gamesa	Nacelles		Brande
Vestas	Blades		Nakskov
Vestas	Nacelles		Lindo
Vestas	Blades		Isle of Wight
Siemens Gamesa	Blades		Hull
Siemens Gamesa	Nacelles		Cuxhaven
LM Wind Power (GE)	Blades		Castellón

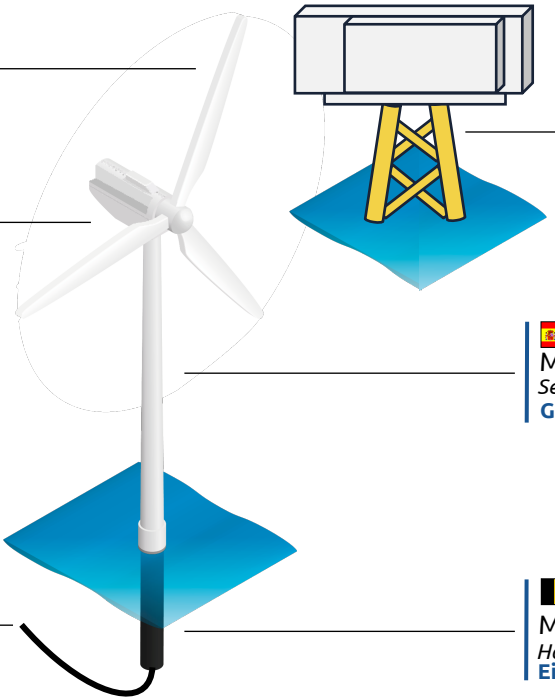
*Sorted by country

A rapidly growing market
The turnover of the wind energy sector is undergoing continuous growth and amounted to approximately **€7 billion** in 2021, a **23%** year-on-year increase.[1]

Sources: [1] Observ'ER 2022 Barometer of Renewable Electric Energy in France – this figure relates to both onshore and offshore wind power
[2] Observ'ER 2021 Renewable Energy Barometer

Industrial achievements

An emerging European industry – the example of an offshore wind turbine*



Blades
Cherbourg factory (Manche département)
LM Wind Power

Nacelle
Montoir-de-Bretagne factory (Loire-Atlantique)
General Electric

Inter-array power cables
Montereau-Fault-Yonne (Seine-et-Marne) and Gron (Yonne) factories
Prysmian

Electrical substation
Saint-Nazaire factory
Chantiers de l'Atlantique

Mast
Sevilla factory
GRI Renewable Industries

Monopile foundation
Hoboken factory
Eiffage

* Example of a Haliade 150-6 MW turbine from the Saint-Nazaire offshore wind farm / only the main manufacturers are mentioned

Sources: Wind Europe, Saint Nazaire.fr offshore wind farm, Eiffage, General Electric, Ouest France, Chantiers de l'Atlantique

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Overview and prospects

Appendixes

1

The wind industry

A positive backdrop

Wind power serves as a solution for both industrial sovereignty and to successfully advance the energy transition

The current international environment makes it necessary for France to build sovereign industrial capabilities and rise up to the challenges of the energy transition

ACHIEVING SOVEREIGNTY

The Covid crisis has highlighted **dependencies** as well as **weaknesses in the supply chain** . Wind energy appears as an effective solution as it offers a **source of domestic energy** that bolsters France's energy security.

AN ENERGY TRANSITION CHALLENGE

France's 2015 Energy Transition for Green Growth Act set a target of **40% renewable energy** in its electricity mix by 2030 and achieving carbon neutrality in 2050. Wind power is an effective means of meeting the country's twofold challenge of **electrification** and **decarbonization** .

Source: French government / FEE

A positive backdrop

France's legal framework encourages companies operating in the wind sector to invest and produce in the country and in Europe

	Green Industry Draft Bill *(ongoing)*	**Make France the European leader in green industry** . This law will provide support for green technologies including wind power.	Financial support Industry-specific training Industrial opportunities
	Renewable Energy Acceleration Act *(2023)*	**Reduce the appraisal time for offshore wind projects by 2 years**, supported by careful maritime spatial planning	Efficiency gains Industrial opportunities Increased investments
	Critical Raw Materials Act *(2023)*	**Secure Europe's supply of raw materials** in order to defend its sovereignty	Relocate part of the supply chain / Industrial opportunities and job creation
	Net Zero Industry Act *(2023)*	Boost clean energy technology manufacturing in Europe, for instance wind turbines, in order to cover 40% of EU needs by 2030	Industrial opportunities Increased investments
	The North Sea Summit in Ostende *(2023)*	**Accelerate the deployment of wind power in the North Sea** . Objective of 300 GW by 2050 (including 40 GW in France)	Industrial opportunities Increased investments

Green Deal Industrial Plan

Source: French government / Public Sénat / Elysee.fr / European Commission

A positive backdrop

Leveraging wind power to make France Europe's green industry leader

Objectives of the Green Industry Bill:

Acknowledging the lag in industrial development, France, through its Green Industry Bill, is determined to equip itself with the means to realize its ambition of **securing European leadership in the green industry**. Five sectors will receive special support – heat pumps, **wind turbines**, solar panels, green hydrogen and electric batteries.

4 priorities

- Facilitate and accelerate the establishment of industrial sites in France
- Securing funding for the green industry by mobilizing both public and private funds
- Champion businesses that contribute to regional economic development and align with environmentally sustainable practices through all government interventions
- Providing training for careers in the green industry

This proposed legislation complements the "**France 2030**" plan, one of the objectives of which is to advance cutting-edge renewable energy technologies.

40,000
Direct jobs created by 2030

9 months
Actual time for setting up factories halved

€23 billion
of investments made by 2030

-

41 million
tonnes of CO2

Source: French government/ Public Sénat / Ecologie.gouv

A positive backdrop

The offshore wind pact signed between the government and the industry in March 2022 helps brings industrial projects to fruition.

FRENCH GOVERNMENT

1. Aim for a minimum of 2 GW per year in offshore wind attributed through call for tenders from 2025 onwards
2. Aim for 20 GW allocated by 2030, with a capacity of 18 GW in service by 2035 and 40 GW by 2050
3. As part of the development of the PPE, carry out planning work to enable these objectives to be achieved.

THE WIND INDUSTRY

1. Aim for a fourfold increase in wind jobs to get to at least 20,000 jobs (both direct and indirect) across the country by 2035
2. Commit more than €40 billion in investments to carry out projects over the next 15 years
3. By 2035, achieve 50% of local content, calculated on all project costs at the time of commissioning, for every offshore wind project
4. Execute projects that are exemplary in terms of harmonious integration with both the human and natural environment within which they are situated.

Source: French government – Pacte éolien en mer [Offshore wind pact]

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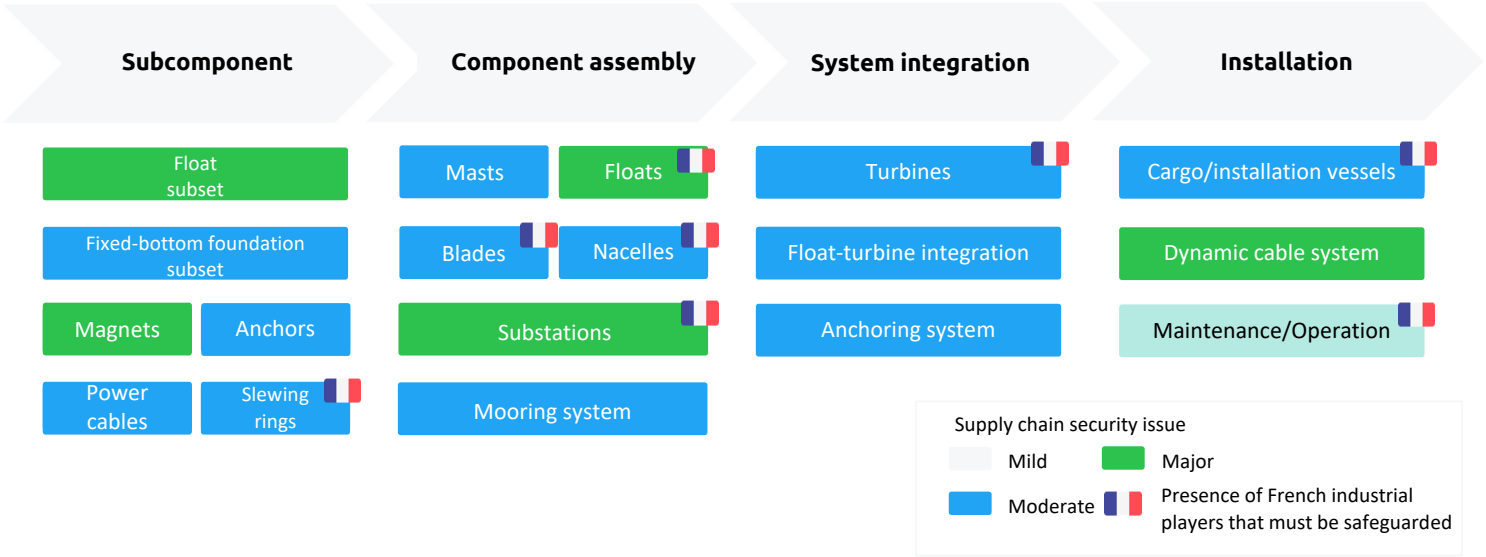
[2] Observ'ER 2021 Renewable Energy Barometer

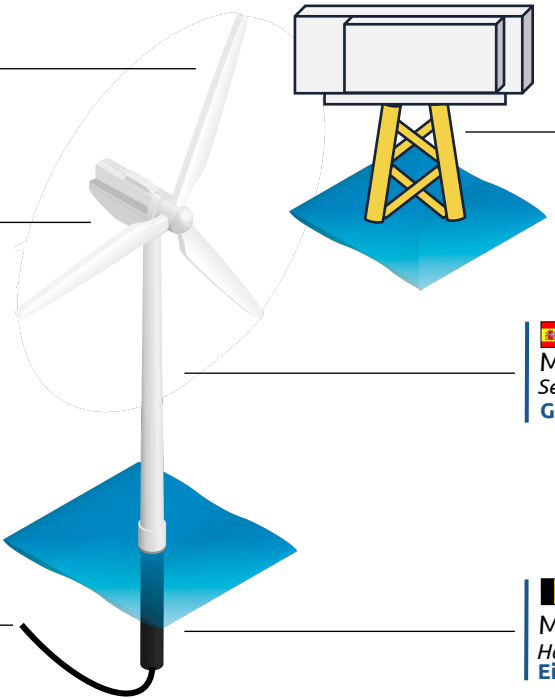
A value chain that is becoming increasingly structured on a national scale to secure supply chains



Sources: FEE and Capgemini study; inspired by a document/the work of the DGE

Industrial achievements

An emerging European industry – the example of an offshore wind turbine*



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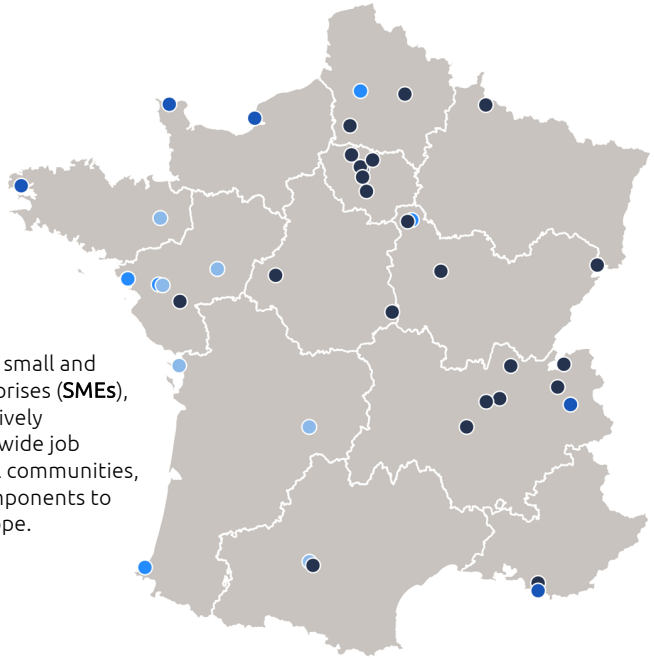
* Example of a Haliade 150-6 MW turbine from the Saint-Nazaire offshore wind farm / only the main manufacturers are mentioned

Sources: Wind Europe, Saint Nazaire.fr offshore wind farm, Eiffage, General Electric, Ouest France, Chantiers de l'Atlantique

Industrial achievements

With numerous factories located across its territory, catering to both the onshore and offshore wind power sectors, France boasts a robust industrial infrastructure that generates a substantial number of jobs.



Primarily comprising small and medium-sized enterprises (**SMEs**), these companies actively contribute to nationwide job creation, enrich local communities, and export their components to various parts of Europe.

Industrial production sites

- Components, cables and materials
- Nacelles, blades, foundations and assembly
- R&D, services and logistics
- Other

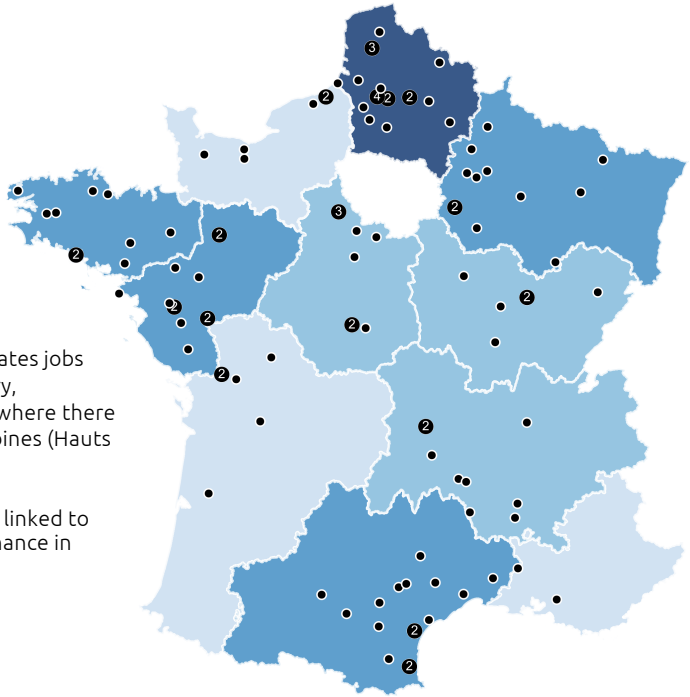
Sources: FEE study

Industrial achievements

The numerous wind maintenance and prevention bases serve as crucial drivers of industrial activity

Wind maintenance creates jobs throughout the country, particularly in regions where there are more installed turbines (Hauts de France, Occitanie)

There were **5,004 jobs** linked to operation and maintenance in France in 2022.



- Maintenance bases
- **x** Number of maintenance bases per municipality

Number of jobs (FTEs) linked to wind maintenance activities

- < 50
- 50 - 100
- 100 - 250
- > 250

Sources: FEE study

Industrial achievements

The industrialization of the offshore wind industry contributes to massive investments in certain French ports

Examples		
Port of Brest	€220 million	Creation of a 40-hectare polder dedicated to MREs
Port-la-Nouvelle	€252 million	Construction of floats / assembly of masts and turbines
Port of Saint-Nazaire	€120 million	Projet Éole: development of floating wind power

Work in progress for the construction of a polder in the port of Brest aimed at attracting activities related to marine energies

Winners of the Ports de France 2030 call for expressions of interest

- Ports of Normandy
- Grand Port Fluvio-Maritime de l'Axe Seine
- GPM of La Rochelle, GPM of Bordeaux, Port of Bayonne, Port of Charente-Atlantique
- GPM of Nantes Saint-Nazaire
- Ports of Brest and Lorient
- GPM of Marseille
- Occitanie Region
- Port-la-Nouvelle

Source: FEE Capgemini study, 2023 Marine Observatory, ADEME

- **Become a key player in the energy transition (Grand Port Maritime strategy)**
- **Construction of the Saint-Nazaire (operational – 480 MW) and Yeu Noirmoutier (under construction – 496 MW) wind farms**
- **EOLE project: an industrial base for the integration of fixed-bottom and floating wind power (operational in 2028)**
- **Manufacturing (GE factory), design, export**

Industrial achievements

Port of Saint-Nazaire

NANTES SAINT-NAZAIRE PORT

> **With wind power, we are starting to see a national inter-port subsidiary emerge, as exemplified by our flagship industrial project, EOLE.**
>
> *Oliver Tretout – General Manager of the Nantes Saint-Nazaire Port*

The Port of Saint-Nazaire, which boasts **28,500 jobs** in port-related activities, marked a milestone with the inauguration of the country's **first offshore wind farm** in 2022. This port hosts a myriad of industrial activities, including cabling, nacelle manufacturing, and wind turbine installation.

Industrial achievements

The port of Port-La Nouvelle

Becoming the hub for MREs in the Mediterranean

2 floating wind farm pilot projects: EolMed & EFLG

250 jobs
×4 for future commercial projects

Anchorage logistics, assembly and launching of floats, turbine integration, maritime storage of floats

The Port of Port-la-Nouvelle is contributing to the REPOS (positive-energy region) strategy of the Occitanie region, which aims to make it the first positive energy region in Europe by 2050.

"The objective is to develop infrastructures capable of accommodating entire floating wind projects, from float assembly to turbine integration, thus addressing the challenges of decarbonization and national energy sovereignty."

Yann Wickers - CEO of SEMOP Port-la-Nouvelle

Industry challenges

The supply of critical materials is key for the industrialization of the wind industry

All sectors in the wind industry are grappling with escalating raw material prices.

Critical Raw Materials Act

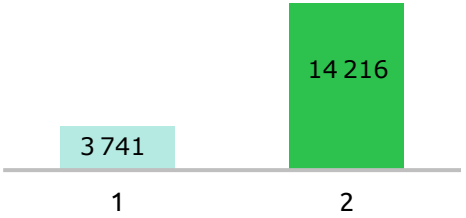
By 2030, the EU must have the ability to

- carry out the following activities in Europe: **10%** of extraction, **40%** of transformation, **15%** of recycling.
- Not to rely on any given single country for more than **65%** of its imports

NB: as a % of the EU's annual consumption

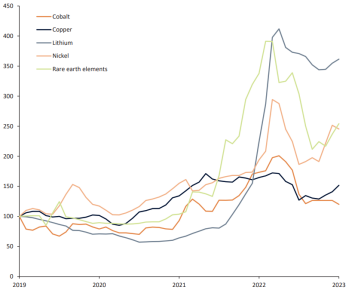
Europe is adopting a strategy to secure critical materials supply chains

European demand for inputs for the onshore and offshore wind industry (in thousands of metric tonnes)



Rystad Energy – Wind Supply Chain Report

Raw material prices



Rystad Energy – Wind Supply Chain Report

Sources: European Commission, Rystad Energy Wind Supply Chain Report

Industry challenges

The supply of critical materials is key for the industrialization of the wind industry

Materials	EU demand in 2022 (in thousands of metric tonnes)	Wind turbine components	Criticality
Iron & Steel	2378	Nacelle, Mast, Foundations	Low
Cement	748	Mast, Foundations	Low
Plastics	302	Blades, Nacelle	Low
Zinc	105	Nacelle, Mast, Foundations	Low
Fibreglass	70	Blades, Nacelle	Low
Aluminium	55	Nacelle	Medium
Copper	44	Electrical equipment	Medium
Manganese	27	Blades, Nacelle, Mast	Medium
Silicon	5	Blades	Medium
Nickel	3	Nacelle, Alloys	Medium
Lead	3	Electrical equipment	Low
Rare earths	1	Nacelle (magnets*)	High

The most critical materials are those with the lowest demand in wind turbine construction.

A dedicated **recycling chain** now exists with companies like Siemens Gamesa producing blades that are now 100% recyclable.

Vestas recently developed a chemical process with a view to transforming end-of-life blades into raw materials to then manufacture new blades.[1]

*It's worth noting that only 3% of French onshore wind farms in 2018 contained magnets (and therefore rare earths). They are, however, much more used in offshore wind power.[2]

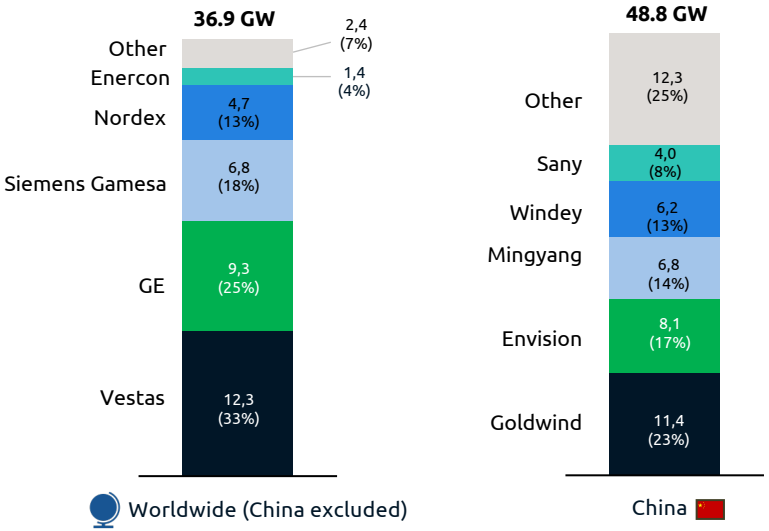
Materials considered critical and strategic by the European Commission (Study on the Critical Raw Materials for the EU 2023)

Source: Rystad Energy – Wind Supply Chain Report, INEC Capgemini report

[1] La Depêche – 10 February 2023. This new chemical process will allow for the complete recycling of wind turbines [2] ADEME

Industry challenges

Driven by a strong domestic market, Chinese turbine manufacturers dominate the market



Global installed capacity during the year 2022

Source: BNEF (2022 Global Wind Turbine Market Shares)

Around 85.7 GW of additional onshore and offshore wind capacity was commissioned in 2022. China, the world's largest wind market, has installed 48.8 GW of capacity, accounting for more than half (57%) of global construction.

Although there is a desire among Chinese turbine manufacturers to expand internationally, most of their orders today concern the **Chinese domestic market**, representing on average **97%** of the total capacity added in 2022.

Furthermore, wind turbine prices in China have fallen sharply since the expiration of buyout bonuses at the end of 2020. This has led to divergent cost trends compared to the rest of the world.

Industry challenges

This industrial ramp-up mobilizes critical skill sets that must be strengthened

Occupations facing recruitment difficulties[1]

CADRES et INGENIEURS

1. Project engineer
2. Business engineer
3. Mechanical engineer
4. Electrical engineer
5. Hydrodynamic engineer

TECHNICIAS and OPERATORS

1. Boilermaker/welder
2. Technician in boilermaking, piping and metal structures
3. Service/operation technician
4. Millwright/assembler/cable fitter/ assembly technician
5. Production operator

416 open positions for wind turbine maintenance technicians remain unfilled across the country[3]

The industry will have to install 12 GW of additional onshore wind power by 2028[4]

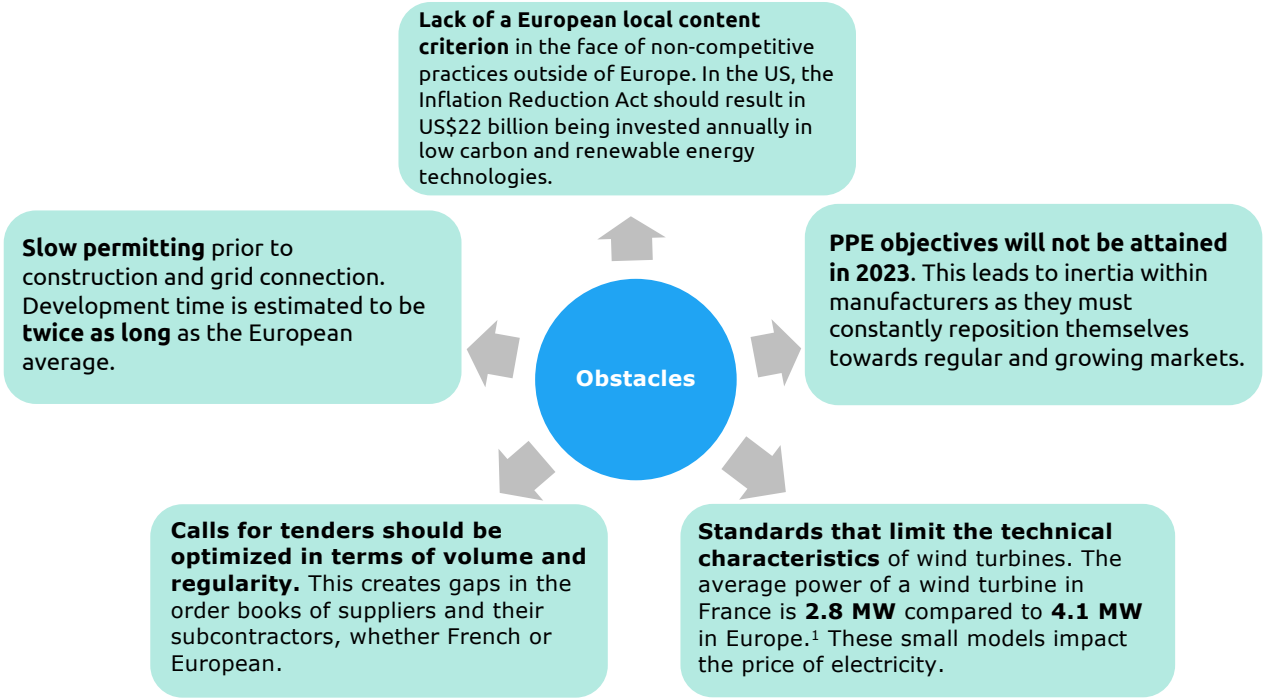
Skills in demand[2]

- Electromechanics
- Power electronics
- Handling
- Plastics processing
- Painting
- Welding
- Boilermaking
- Rolling
- Metal carpentry
- Sheet metal work
- Masonry
- Formwork and industrial maintenance

Sources: [1]COMED 2022 Report, which concerns several renewable sectors including wind power
[2] Pole-emploi
[3] Indeed, as at 21 August 2023
[4] To achieve the PPE's objectives

Challenges faced by the government in supporting the wind industry

There are bottlenecks and obstacles to a competitive industrial sector



Source: FEE study, 1Wind Europe

Industry challenges

Sustaining the industrialization of the sector – interview with Frédéric Petit, President of Siemens Gamesa

"Industrially, France is ahead of many other European countries. After 2026, France will not be installing any wind farms for 5 years, barring Dunkerque, in an expanding European market. **By 2030, the competitiveness of French industry will be crucial for accessing the European market, ensuring continued production within the country.**
Frédéric Petit – President of Siemens Gamesa Renewable Energy France.

The company advocates for the incorporation of **qualitative criteria** in auctions, favouring **European content**, to stimulate the local economy. "Wind energy has proven its competitiveness and deserves recognition as a strategic industrial sector by Europe." Siemens Gamesa is contributing to the emergence of a **European value chain** with its factories in France, Germany, the United Kingdom, Spain, Portugal and Denmark.

Another key issue is that of skills: "We've invested more than €10 million in training a qualified workforce." Our two production lines require the recruitment of new profiles such as manufacturing operators, maintenance technicians and supervisory staff."

Source: Siemens Gamesa

Siemens Gamesa

Siemens Gamesa has two production units on its Le Havre site for the **manufacturing of blades and nacelles** (which started production in 2022). This factory has generated more than **1,000 direct and indirect jobs**.

The company will equip five of the six wind farm projects currently under development in France.

Siemens Gamesa Renewable Energy plant, located in Le Havre

Industrial success stories

DILLINGER France

Production of heavy steel plates (600,000 tonnes/year)

Offshore wind – Foundations

530*

Dunkerque (since 1962)

"We recently invested in a new bevelling machine (€12 million) that meets the most exacting demands of wind energy professionals"

Philippe Nawracala, Deputy Managing Director at Dillinger France

Saint-Nazaire wind farm

Dillinger supplied approximately **76,400 tonnes** of steel plates for the Saint-Nazaire offshore wind farm. This steel is intended for the production of **monopiles** (steel tubes 25 to 47 metres long) serving as foundations for offshore wind turbines.

Strength and durability are required to cope with the sometimes extreme conditions prevalent in the high seas.

These sheets are made from steel slabs that are all imported from the parent company in Germany.

A 100% subsidiary of the Dillinger Group, a leading European steel product manufacturer, Dillinger France is a key industrial player in the French and European markets.

*520 FTEs across all the subsidiary's business lines, including offshore wind power

Industrial success stories

my wind parts – your key supplier

s·h·a secondhandactivity – REPAIRING · REVAMPING · REPOWERING

Spare parts supplier – Repair/Reconditioning – Technical advisory

Offshore wind - spare parts

10

Montpellier (since 2016)

2 nacelles being dismantled by Mywindparts

"We are actively developing a strong expertise in addressing the significant challenge of reconditioning"

Sébastien Duchesne – Founder and Managing Director of Mywindparts

Focus on component reconditioning

Mywindparts partners with expert dismantling companies to recover old components, recondition them and then sell them.
Two wind turbines have been dismantled to date by the company.

According to the company, the installation of second-hand wind farms could be a game changer.

The company has just deployed an e-commerce site and aims to establish activities in other countries

Industrial success stories

BW ideol

Floating foundations / Project development

Floating offshore wind

80

La Ciotat – Bouches-du-Rhône (2010)

"We are pioneers in the floating offshore wind market because we have long believed that it is the future of offshore wind"

Paul de la Guérivière, CEO of BW Ideol

Floatgen – the first and only floating wind turbine in France

Acting as project coordinator, BW Ideol oversaw the design and engineering of the foundation, followed by the construction and installation of the demonstrator equipped with a 2 MW wind turbine off the coast of Le Croisic. BW Ideol manages the maintenance of the now operational turbine.

EolMed – a BW Ideol pilot farm in the Mediterranean (slated for commissioning in 2024)

BW Ideol is a project partner and is supplying the floating foundation. This future pilot wind farm consisting of 3 10 MW wind turbines is currently being built in Port-la-Nouvelle.

10 GW: the built or installed capacity targeted by BW Ideol for 2030

Industrial success stories

MagREEsource

Manufacturing magnets from short-loop material recycling

Magnets (in the nacelle)

16

Grenoble (since 2020)

"Driven by the ambition of creating a European champion in magnet manufacturing, our company aims to respond to the two-fold challenge of sovereignty and the low-carbon economy"

Erick Petit – cofounder of MagREEsource

What are magnets used for in wind turbines and how can they be recycled?

These magnets, made of rare earth alloys such as neodymium, are used in turbine **generator**s to improve the conversion of mechanical wind energy into electrical power. MagREEsource uses a **hydrogen-based process** to first turn the recovered magnets into powder before remanufacturing new ones (a short-loop recycling approach).

The opening of a pilot factory followed by a Magfactory

This first pilot plant, scheduled to open at the end of 2023 (in Grenoble), will have a capacity to recycle and manufacture 50 tonnes of new magnets.

The Grenoble-based company aims to build the first magnet factory of its kind, the Magfactory, in 2027, along with 120 direct jobs and a manufacturing capacity of at least 500 t.

After 2027, capacity will be gradually increased to offer a viable European alternative for the growing wind market.

Industrial success stories

CAREMAG
MAGNETS RECYCLING BY CARESTER

Long-loop recycling of permanent magnets: 100% magnets accepted

NdFeB magnets (in the nacelle)

30

Lyon

“Our objective is to help the wind sector to approach a 100% recyclability rate on wind turbines and more broadly to participate in creating a virtuous ecosystem around rare earths in Europe”

Eugène Daronnat – sourcing manager at Caremag

Why recycle permanent magnets from wind turbines?

Based on the observation that only 1% of magnets are currently recycled, the CAREMAG project aims to recycle permanent magnets at the end of their service life as well as production scraps to generate pure rare earth oxides of the same quality as mine-extracted raw materials (the so-called “long-loop recycling”), in order to support the energy transition and Europe’s self-reliance in these critical metals. It allows for infinite recyclability.

Creation of an industrial recycling unit

An industrial facility capable of processing **2,000 tonnes of magnets and production scraps per year** is slated to be commissioned in late 2025. Located in Lacq, it will create 92 jobs. With investment exceeding €100 million, the project is bolstered by state support as part of France’s recovery plan.

A 3 MW wind turbine contains an average of 2 tonnes of magnets*

AD3R

*Permanent magnets are mainly found in direct drive turbines

Industrial success stories

Prysmian Group

Headquarters in France

Manufacturer of high voltage and submarine cables

Onshore and offshore wind – high voltage and submarine cables

2,560 (France)

10 factories in France
108 industrial sites in more than 50 countries

Source: Prysmian Group

"We are looking to secure our supply. Our latest generation P-Laser power cable, produced in our Gron factory in France, is 100% recyclable.

In order to meet the new and growing needs for inter-array cabling, a massive €61 million investment was undertaken by the industrial group on its centre of excellence with public financial support amounting to €5 million granted as part of the France 2030 plan to increase the site's production capacity."

Jawdat Mansour, Director of the High Voltage Business Unit — Prysmian Group

Application in offshore wind

The group manufactured 120 km of high-voltage inter-array submarine cables intended for the Saint-Nazaire wind farm in its French factories of Montereau-Fault-Yonne (77) and Gron (89).

These power cables undergo demanding rounds of testing to confirm their reliability.

Offshore wind cables must meet precise characteristics in order to withstand the high underwater pressure.

Our recommendations

…to increase the deployment of the wind industry

1. Simplify procedures related to developing and connecting wind projects
2. Promote the installation of more powerful, large-rotor wind turbines to the maximum extent possible
3. Ensure that the predefined authorization and tender volumes are met, strictly adhering to schedules
4. Train more students and employees for careers in the wind industry

These 4 pillars will make it possible to generate **investments** and **become more competitive**

2

Jobs in wind power

Key facts and figures

28,266 FTEs
in wind power at the end of 2022

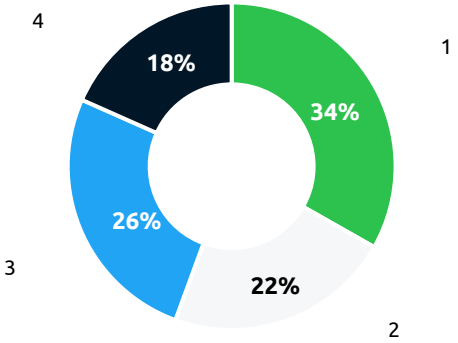
11%
increase in jobs in 2021

In 2022, **wind power jobs have continued to increase at a significant pace**, with a growth rate of 11% and a total of 28,266 direct and indirect jobs in France as at 31 December 2022.

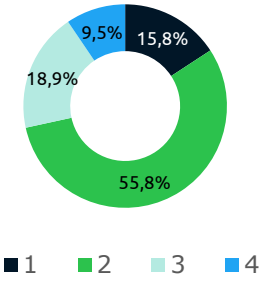
These winds jobs are primarily created in the Normandy and Pays de la Loire regions, in connection with the offshore wind industry.

34% are female[2]

Distribution of FTEs on the value chain



Breakdown based on company size[2]

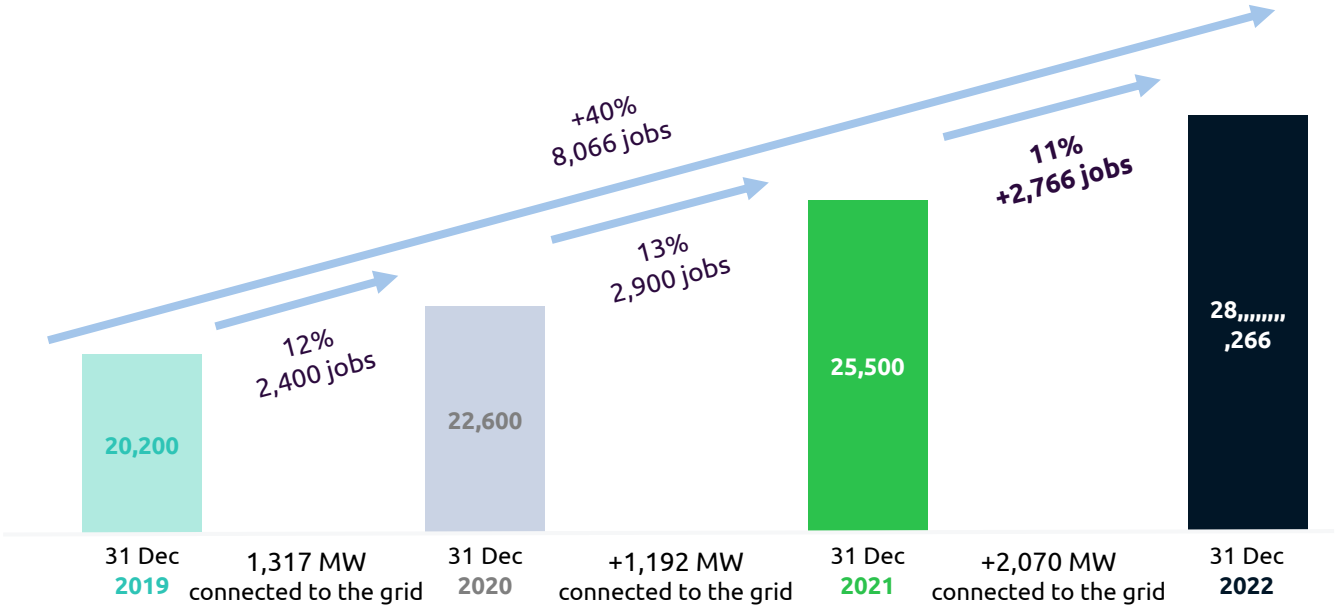


Sources: [1] Observatory for marine energies 2022
[2] Based on jobs recorded in 2022

Job growth in wind power in France in 2022

The amount of wind jobs is continuing to increase

Employment trends in wind power from 2019 to 2022



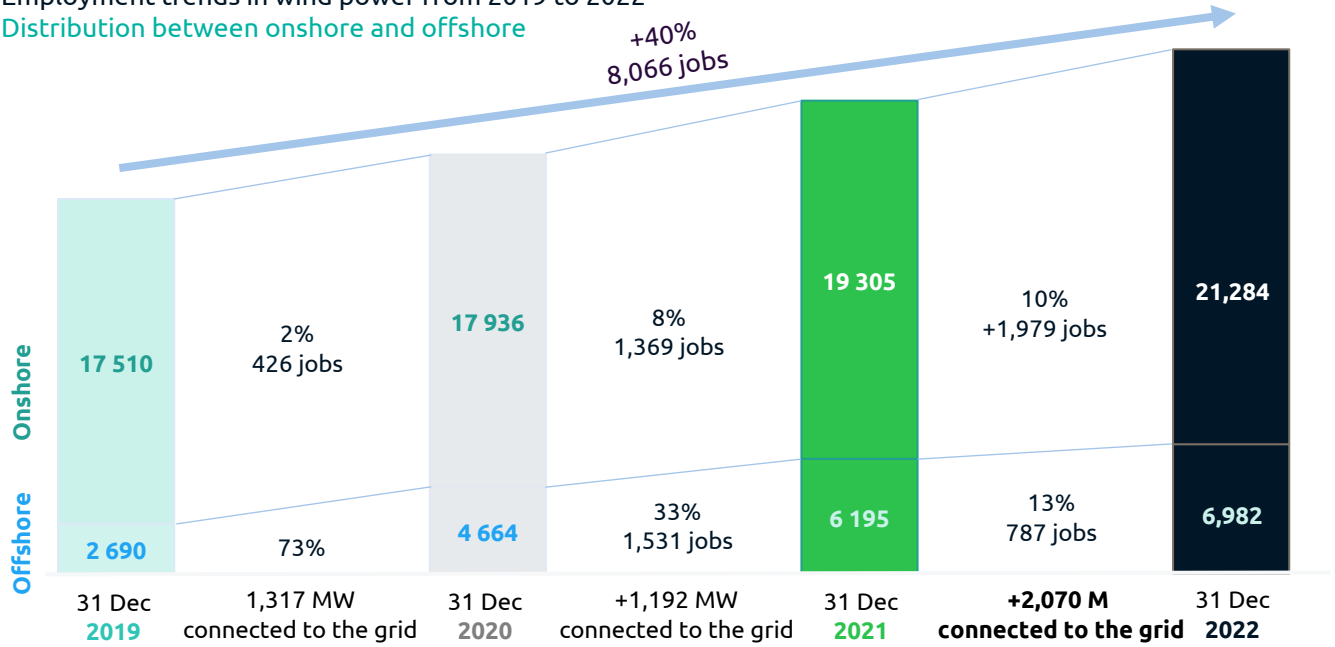
Source: 2023 FEE study, data processing by Capgemini Invent

JOBS

Job growth in wind power in France in 2022

The amount of wind jobs is continuing to increase both in offshore and onshore wind

Employment trends in wind power from 2019 to 2022
Distribution between onshore and offshore

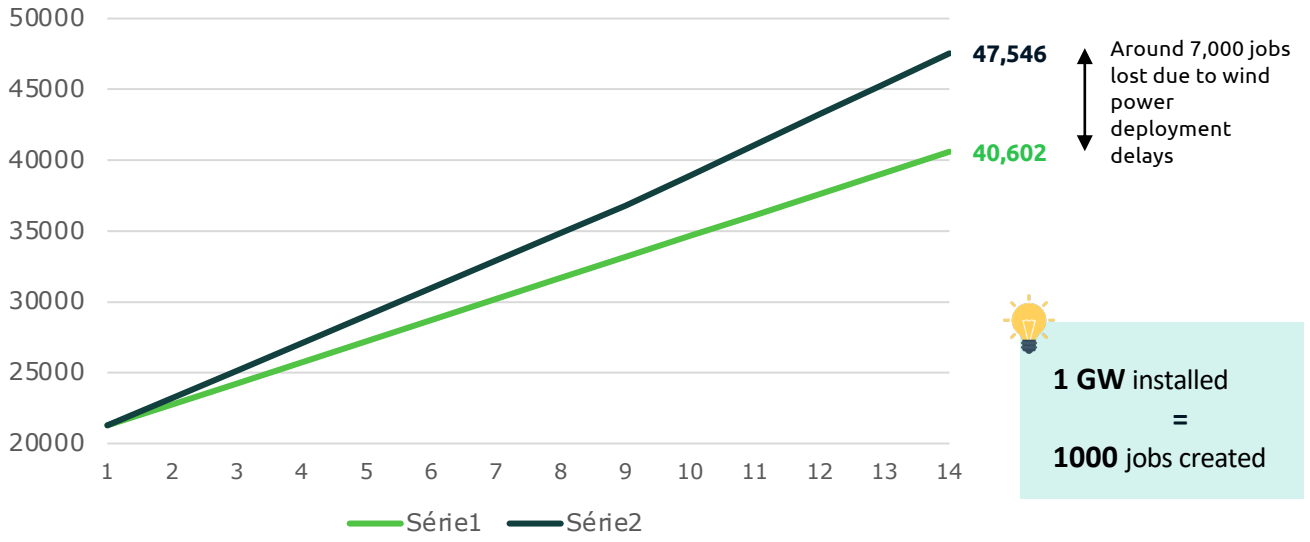


Sources: FEE 2023 study, Marine energy observatory 2023 and data processing by Capgemini Invent

Spatial distribution of wind jobs in France

By limiting the deployment of wind power to the current rate, France would deprive itself of a work pool of several thousand jobs

Projected increase in onshore wind jobs in relation to installed capacity under two scenarios

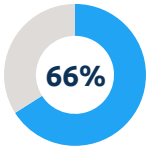


1 GW installed
=
1000 jobs created

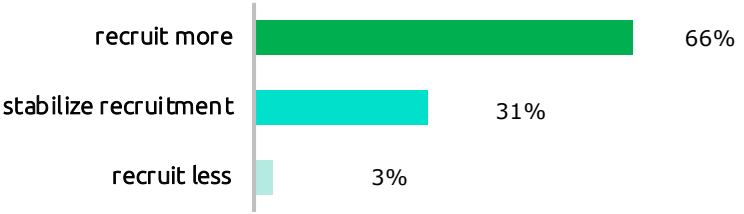
Source: FEE 2023 study + linear projection

Spatial distribution of wind jobs in France

Companies in the sector largely plan to recruit more in the short term, especially large enterprises



Companies[1] plan to recruit more within a one-year time horizon



Predicted recruitment needs on a one-year timeframe based on company size[1]

	VSE less than 10 employees	SME 10 to 250 employees	MSE 250 to 5,000 employees	GE above 5,000 employees
Recruit less	0%	6%	0%	0%
Stabilize recruitment	33%	26%	50%	11%
Recruit more	67%	68%	50%	89%

Source: FEE 2023 study, data processed by Capgemini
[1] Based on companies that responded to the 2023 survey

Details by link in the value chain

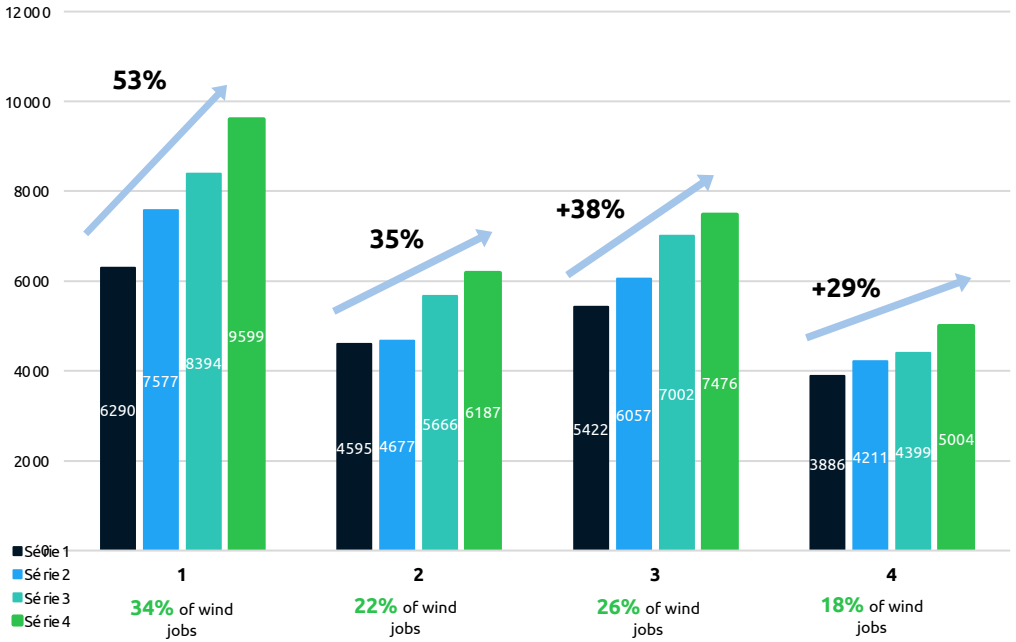
An activity that is organized along 4 segments

The French wind power industry has businesses operating along the entire value chain, providing wind power jobs within the following key activities:

		% of total jobs 2022
Planning & Design	e.g. engineering consultancies, wind measurement, geotechnical measurement, technical expertise, performance monitoring companies, developers, financial institutions	34%
Component manufacturing	e.g. casting parts, mechanical parts, rotor blades, nacelles, masts, yaw drives and bearings, brakes, electrical equipment for wind turbines and the electrical grid	22%
Engineering & Construction	e.g. assembly, logistics, civil engineering, power grid and wind farm electrical engineering, erection, grid connection	26%
Operations & Maintenance	e.g. assembly, logistics, civil engineering, power grid and wind farm electrical engineering, erection, grid connection	18%

Details by link in the value chain

Strong momentum on the “Planning & Design” link of the value chain, translating the industry’s involvement in achieving the objectives set out in the PPE.



34% of wind jobs

22% of wind jobs

26% of wind jobs

18% of wind jobs

Source: FEE study, data processing by Capgemini Invent

Distribution of jobs on the value chain: employment trends in wind power from 2019 to 2022 (rounded off)

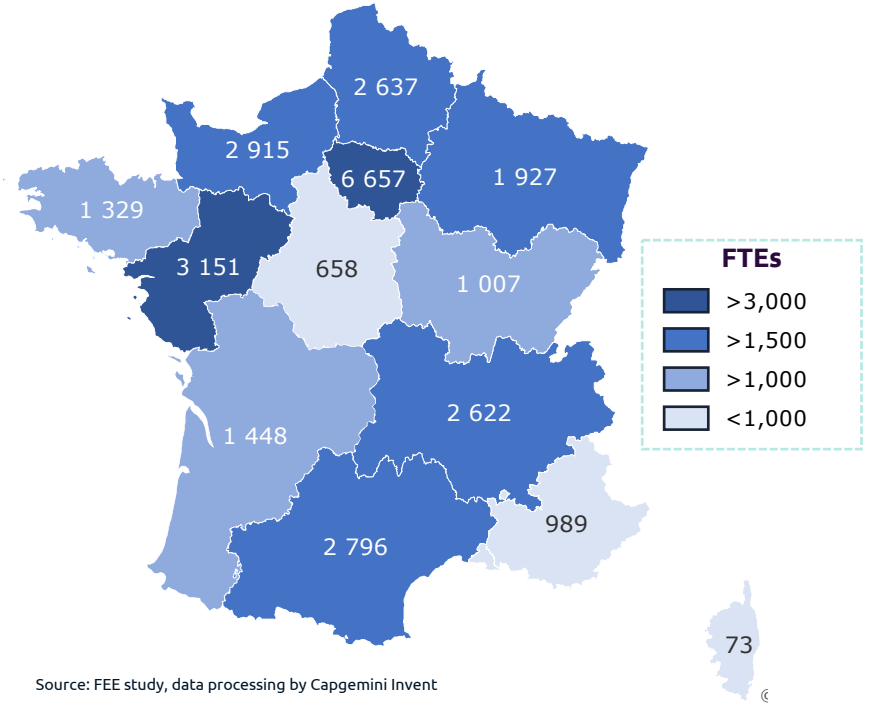
Take notice:

The database on which the study based its estimates of the number of FTEs has been updated so as to approximate market reality as closely as possible.

Job distribution in the value chain from one year to another can be impacted by changes in the granularity applied within large corporations or the inclusion of new players (particularly in offshore wind). compared to previous years.

Breakdown of wind jobs by region

Strong business growth in Pays de la Loire and Normandy regions thanks to offshore wind



Source: FEE study, data processing by Capgemini Invent

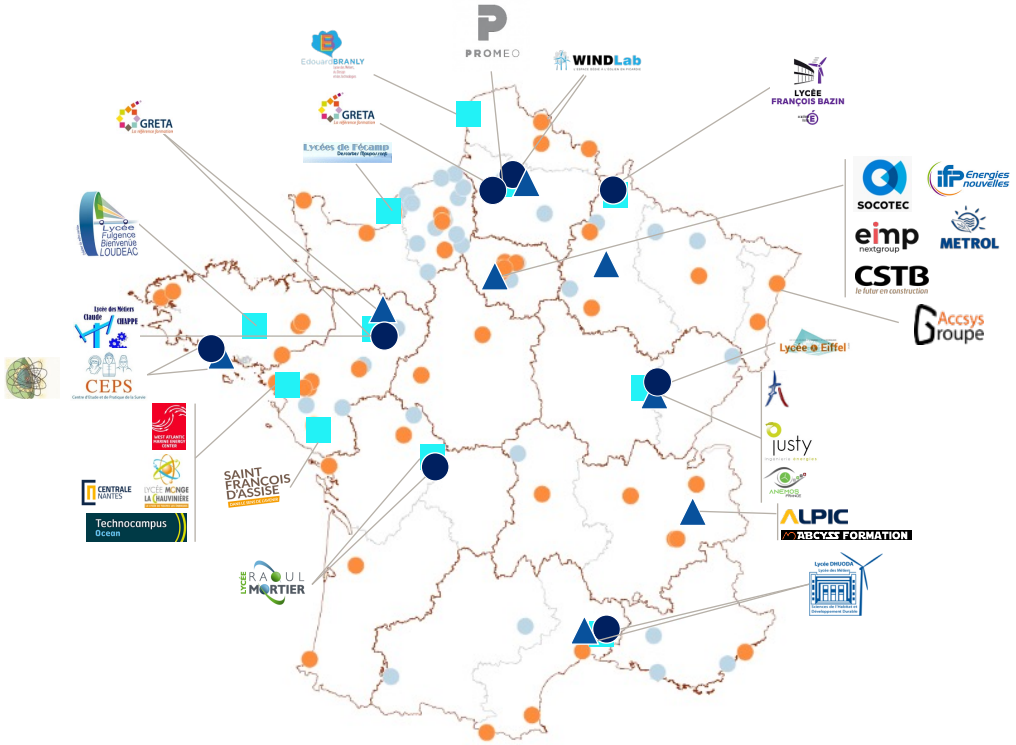
Top 10 employers*
(FTEs, 2022)

Bouygues Travaux Publics
EDF
Enedis
Enercon – Energie für die Welt
Engie Ineo
GE Renewable Energy
LM Wind Power – a GE Renewable Energy business
Schneider Electric
Siemens Gamesa Renewable Energy
Vestas

* Ordered alphabetically

Wind energy training programmes

A wide range of training programmes preparing for careers in wind power, distributed throughout the country



Wind energy training programmes

The wind power industry creates the most jobs within the renewable energy sector and is looking to recruit candidates from a variety of backgrounds ranging from high school level to postgraduate degrees

Programmes specific to the wind industry exist at all levels, from **high school level** (*bac professionnel*) to **engineering schools**.

Working in the wind energy sector has **many advantages**:

- **jobs are decentralized** and distributed throughout the country
- They are **stable jobs** (mostly on permanent contracts) that are necessary for the energy transition
- There are many **career opportunities**, whether internationally or through gateways between onshore to offshore wind.

3,400 jobs[1]
created this year

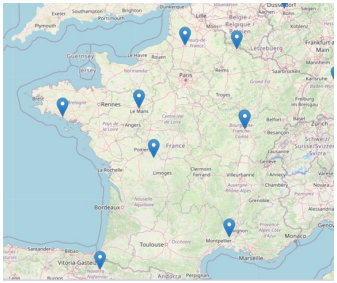
>80% of jobs on permanent contracts[1]

900 companies[2]
located throughout the country

Sources: [1] FEE data, Wind Observatory 2022
[2] L'éolien, une énergie qui crée des emplois tous les jours [Wind power, an energy that is creating jobs on a daily basis], FEE

Wind energy training programmes

Two international training programmes providing certification are available in France

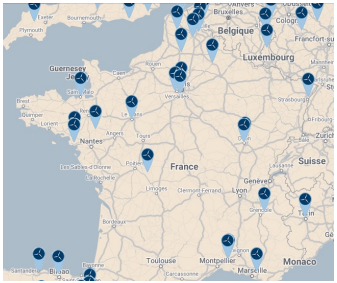


7 accredited institutions in France

BZEE - Technician certificate in wind power systems maintenance

- Advanced training in **wind turbine maintenance techniques and safety measures**
- More than 4,000 technicians trained alongside their partners
- Some of these training centres also offer GWO modules

Key modules: offshore operations, wind energy technology, wind turbine electronics, operations management…



24 accredited institutions in France

Basic Safety Training Certificate

- Safety training
- 33h 50 min of training
- 54,799 Europeans trained on an average of almost 4 modules

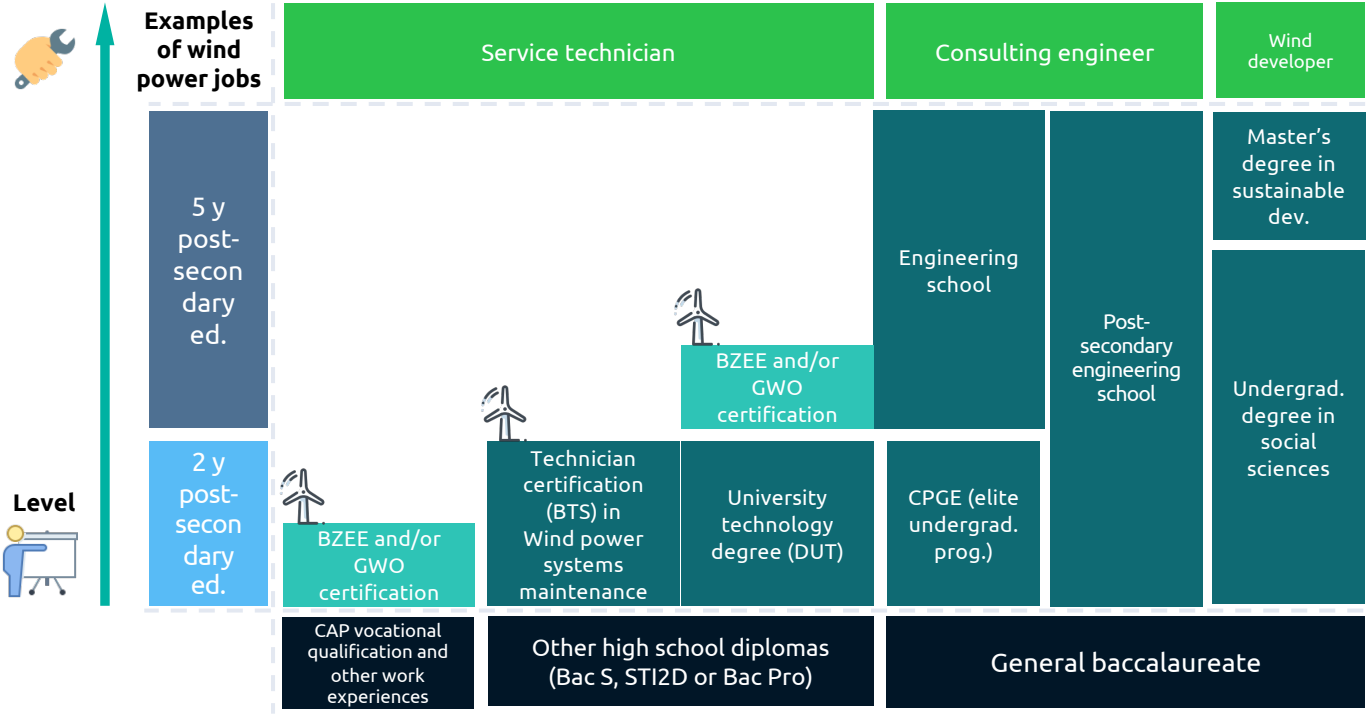
5 modules: first aid, manual handling, fire-hazard awareness, working at height, survival at sea.

Sources: [1] BZEE network and FEE data
[2] GWO + FEE data

Wind energy training programmes

Sample student itineraries

Jobs in the industry often offer rapid career advancement and diverse career opportunities



Grid integration – Training

Enedis, RTE and the electricity network sector are jointly launching power grid schools for the energy transition

Players in the electricity network sector (Enedis, RTE, FNTP, SERCE, SNER, GIMELEC, SYCABEL) **signed a partnership agreement in March 2023 relating to "power grid schools for the energy transition"** . This training programme aims to anticipate and support the massive recruitment needs of the sector in a context of strong growth in electricity network activities driven by decarbonization and the electrification of end uses.

The roadmap for the electrical networks sector is structured around 3 components, with a view to ensuring that all companies can smoothly carry out their recruitments, while also degendering technical professions, which is crucial to broadening the available workforce:

- **Bolster the attractiveness of wind professions among young people** choosing their career paths, as well as for career changers.
- **Ensure that training programmes match the requirements of the electrical network sector** by making allowance for technical and technological changes in the professions.
- **Support talent pipelines**, from career exploration to work-study programmes and mobility pathways within the industry. The objective is also to establish continuous learning programmes for workers fostering the acquisition, adaptation, and continual development of skills throughout their professional journey thus ensuring their employability within the electrical network sector as well as across the broader industry.

Partners of the industry are aiming to **kick off this new programme from the start of the 2023 academic year**, through:

- the co-construction with the French Ministry of Education of "training the trainer" programmes in grid engineering education,
- contributions to strengthening vocational guidance services in junior high schools (for children aged 11 and above),
- support for the education system through the contribution of electrical engineering teachers,
- and above all the creation of "electrical networks" classes in vocational high schools, together with mentoring systems and the active engagement of business within these educational establishments.

Grid integration – Recruitment

To build the new electric France, Enedis is stepping up recruitment

To cope with strong business growth and prospects for continued growth for the years to come, Enedis and RTE are stepping up their recruitment efforts: 3,900 employees will be recruited in 2023, including 2,000 on a fixed-term or permanent basis and 1,900 on work-study contracts. At Enedis and RTE, 25% to 30% of recruitments on long-term contracts come from work-study programmes.

The 3 major challenges for Enedis and RTE, and their current and future employees:

Technical challenge: Transforming Europe's largest power grid into a connected and controllable grid.

Their mission is to guarantee the quality and safety of France's electricity transmission and distribution networks over time. To support this mission, they are actively recruiting electrical technicians (from CAP post-secondary education to graduate degrees)

Technological challenge: Create a customer-centric public service for the ecological transition.

Their mission: protecting their customers' data by leveraging the latest technologies.

To support this mission, they are actively recruiting cybersecurity engineers, experts in electrical systems (from postgraduate degrees and engineering schools)

Ecological challenge: Enedis and RTE will, for example, be connecting several hundreds of thousands of renewable energy producers to the grid by 2030.

Their mission is to make every effort to concretely reduce CO_2 emissions and thus contribute to achieving carbon neutrality.

To support this mission, they are actively recruiting grid-connection account managers and project managers with a graduate or postgraduate background.

Spotlight on female talent:

Enedis and RTE view diversity in backgrounds, experiences and teams as sources of creativity and cross-fertilization. In 2022, women represented **24%** of employees at Enedis and RTE . Attracting more female talent is a major issue for both companies, requiring substantive work with schools and institutions to ensure that female students are made aware of the opportunities that exist in electrical engineering from an early age, thereby increasing the share of female students in all programmes, and in particular in technical institutions, engineering schools and digital education. In order to attract women to technical professions, Enedis and RTE are also working to combat prejudices about technical professions and to promote female leadership, inside and outside the company.

Wind energy training programmes

Focus on a selection of training programmes in wind power

Lycée Raoul Mortier
Post-secondary training programmes

- 12 students per year in **BTS MSE wind energy** post-secondary technical ed.
  12 **BZEE NetWork** trainees per year
- Accreditations:
  - 4 GWO BST modules for both students and trainees
  - Electricity: B2V, BR, BC, H0V and H1V
- Partners:

UIMM Brittany training centre
Post-secondary training programmes

- **Bachelor in Advanced Maintenance with a Wind Power specialization** (3 years of post-secondary education)
- **Maintenance Technician, with a Wind Power specialization** (post-secondary training or 2 years of post-secondary ed.)
- **Advanced Technician in Submarine Vehicle Maintenance** (2 years of post-secondary ed.)

Partners:

Other onshore and offshore wind players

École Centrale Méditerranée
Specialized Master's degree

- **Expert in Marine and Offshore Wind Engineering**
- Career opportunities:
  Design engineer for the design of offshore wind turbines or components, project director for offshore wind farm design…
- 98% of graduates are hired on completing their training

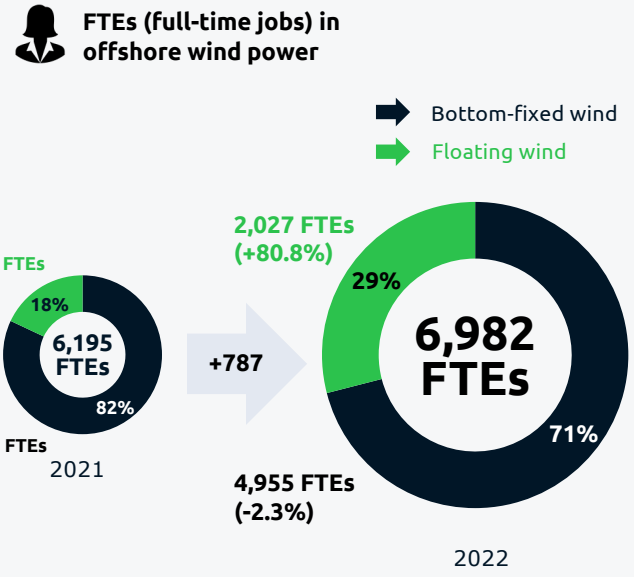
Partners:
Master's degree delivered with

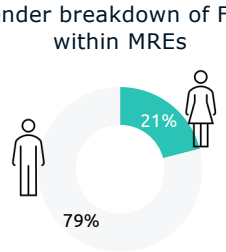
- Certifications:

Source: Lycée Raoul Mortier, UIMM Bretagne training centre, École Centrale Méditerranée

Focus on the Observatory for marine energies

Key figures for offshore wind and MREs (marine renewable energies)





~€2 billion in turnover

consolidated for the entire sector in 2022, which is a record (+43% vs. 2021), including €543 million in export sales

€3.2 billion invested in 2022

including 87% by developer-operators for the construction of wind farms and their connection to the grid

Source: 2023 Observatory for marine energies

Focus on the Observatory for marine energies

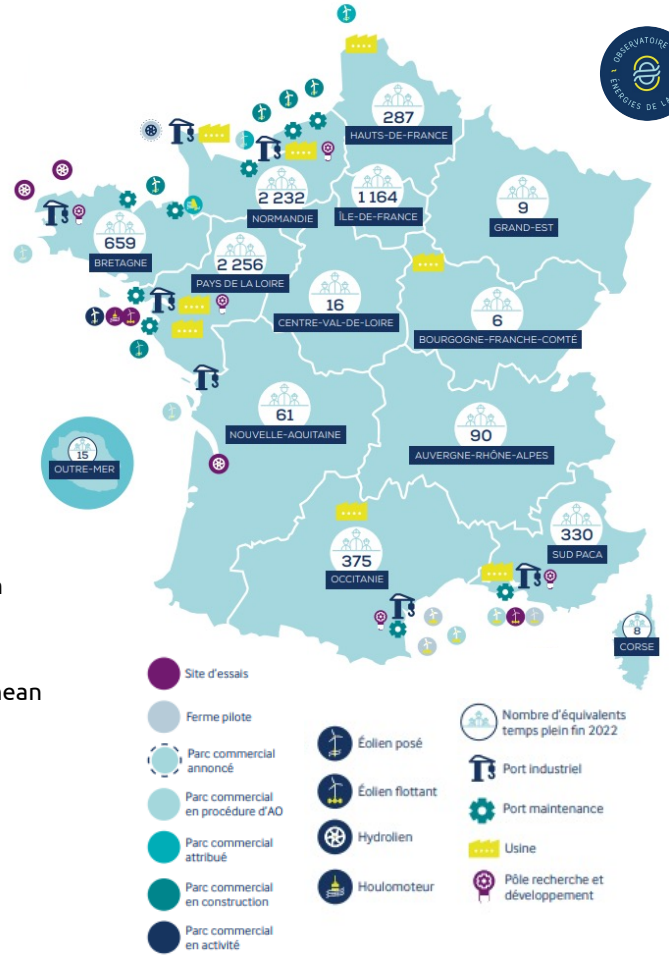
The very strong growth in FTEs stems from the St-Nazaire wind farm, pilot projects and exports

3 out of 5 jobs in Normandy and the Pays de la Loire
thanks to large industrial installations

+424 FTEs in Pays de la Loire
due in part to the implementation of the Saint-Nazaire wind farm

+53% FTEs in Occitanie and PACA
due in part to the construction of pilot projects in the Mediterranean

+€300 million in export
Export generates 28% of turnover value



Source: 2023 Observatory for marine energies

Focus on the Observatory for marine energies

Companies awarded construction lots in offshore wind provide an illustration of the emergence of a French value chain

Projet	SAINT-NAZAIRE		SAINT-BRIEUC		FÉCAMP		COURSEULLES-SUR-MER	
Activités	Fabrication	Installation	Fabrication	Installation	Fabrication	Installation	Fabrication	Installation
Poste terrestre	Hitachi, Siemens et GE	Eiffage Energies	Hitachi et Siemens	SPIE	Hitachi et Siemens	Omexom	Siemens	Omexom
Raccordement terrestre	Prysmian	Omexom et Eiffage	Nexans	Omexom	Prysmian	SPIE, Bouygues, SPAC	Prysmian	Sadertelec
Raccordement inter-éoliennes	SILEC (groupe Prysmian)	LD Travocéan	Prysmian	Prysmian	Prysmian	Prysmian / ASSO Divers	Prysmian	Prysmian / Asso Divers
Raccordement maritime	Prysmian	Prysmian	Nexans	Nexans	Prysmian	Prysmian	Prysmian	Prysmian
Fondation sous-station	Chantiers de l'Atlantique / Rosetti Marino	DEME	Iemants (Smulders)	Saipem	Chantiers de l'Atlantique / Rosetti Marino	DEME	Chantiers de l'Atlantique / Rosetti Marino	DEME
Sous-station en mer	Chantiers de l'Atlantique / GE Grid Solutions	DEME	Fabricom (EQUANS)/ Smulders	Saipem/ Global service maritime	Chantiers de l'Atlantique / GE Grid Solutions	DEME	Chantiers de l'Atlantique / GE Grid Solutions	DEME
Fondations des éoliennes	Eiffage	DEME	Navantia	Van Oord	Bouygues TP	Saipem/ Boskalis	EEW SPC et Bladt (en sous-traitance de SAIPEM)	SAIPEM
Mâts	GE Renewable Energy	SODRACO (groupe Jan de Nul) / GE Renewable Energy	Haizea Breizh/ SPIE	Siemens Gamesa/ Fred Olsen Windcarrier	GRI & Windar	Siemens Gamesa / DEME	À définir	Siemens Gamesa
Éoliennes	GE Renewable Energy		Siemens Gamesa		Siemens Gamesa		Siemens Gamesa	

Réalisé | En cours | Non réalisé

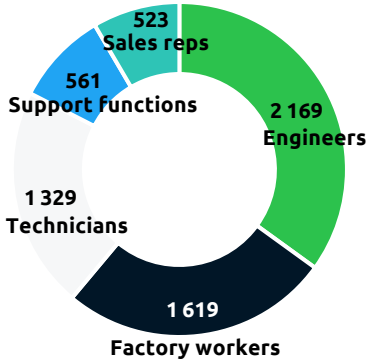
Overviews of wind farms under construction as at 31 Dec 2022

Source: 2023 Observatory for marine energies

Focus on the Observatory for marine energies

71 training programmes prepare for MRE jobs in a wide variety of positions

Breakdown of MRE FTEs by position*



* among service providers and suppliers in the value chain

1,700 new positions
expected for the sector in 2023

71 training programmes
linked to MREs have been identified

Despite **promising figures for MRE job creation**, the sector is still struggling to recruit. **Training is considered insufficient** by half (52%) of the companies surveyed, leading 17% of them to have their own training centre.

Top 5 hardest jobs to fill

1. Engineer (EHS, consultancy)
2. Electrician
3. Service technician
4. Welder
5. Boilermaker

Source: 2023 Observatory for marine energies

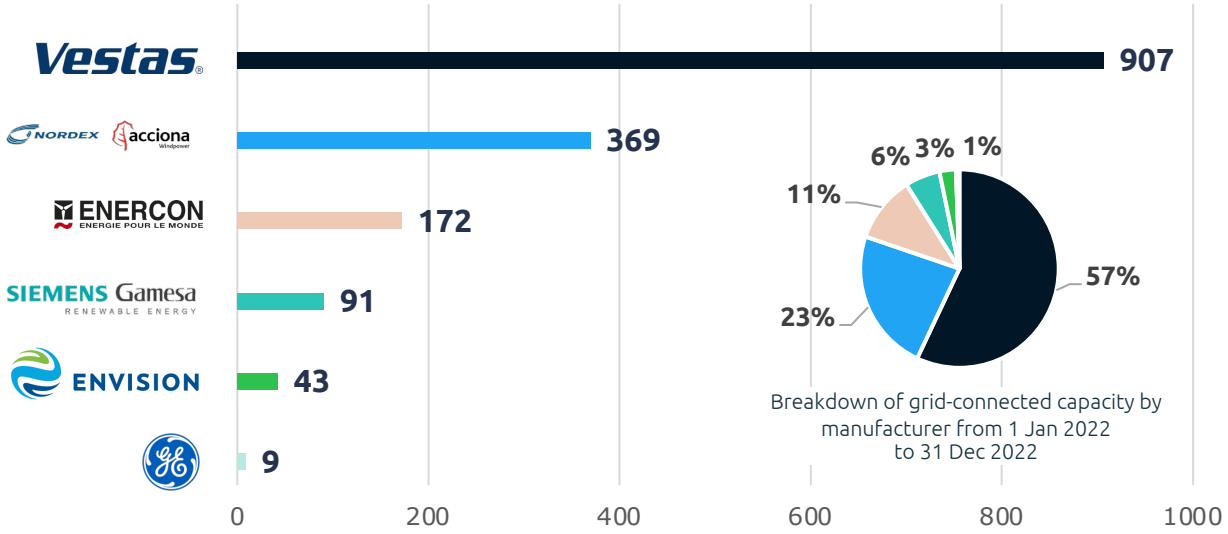
3

The French wind power market and economics in 2022

Overview of the onshore wind market

1.59 GW of onshore wind power capacity was connected to the grid in France in 2022

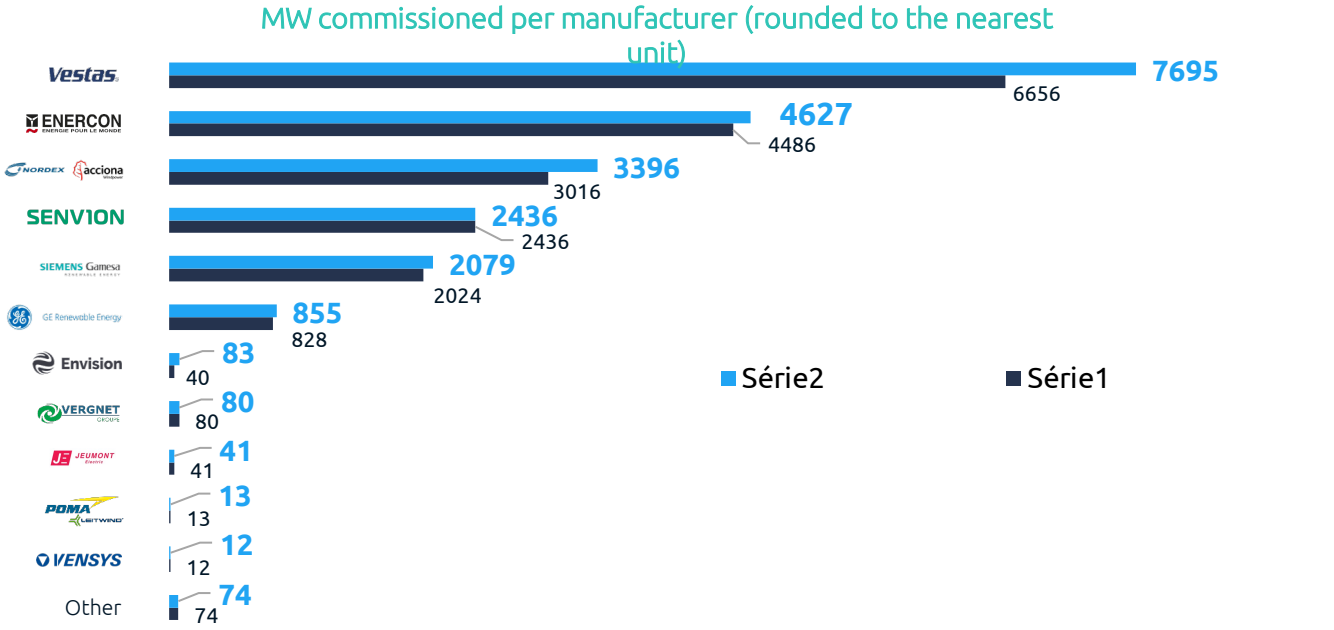
MW **installed by the 6 main turbine manufacturers from 1 Jan 2022 to 31 Dec 2022**



Source: FEE study, 2023

Overview of the onshore wind market

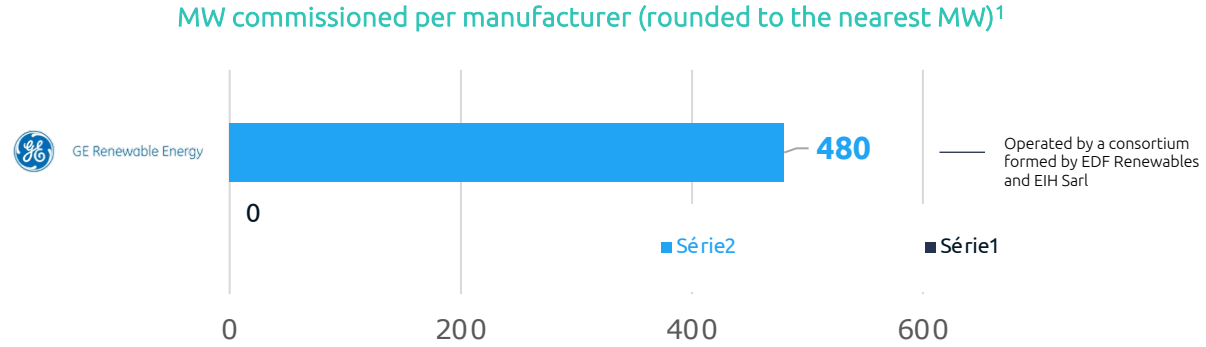
France's total operational onshore wind power capacity as at 30 June 2023 stands at 21.39 GW.



Source: FEE study, 2023

Overview of the offshore wind market

France's total installed offshore wind power capacity as at 30 June 2020 stands at 0.48 GW



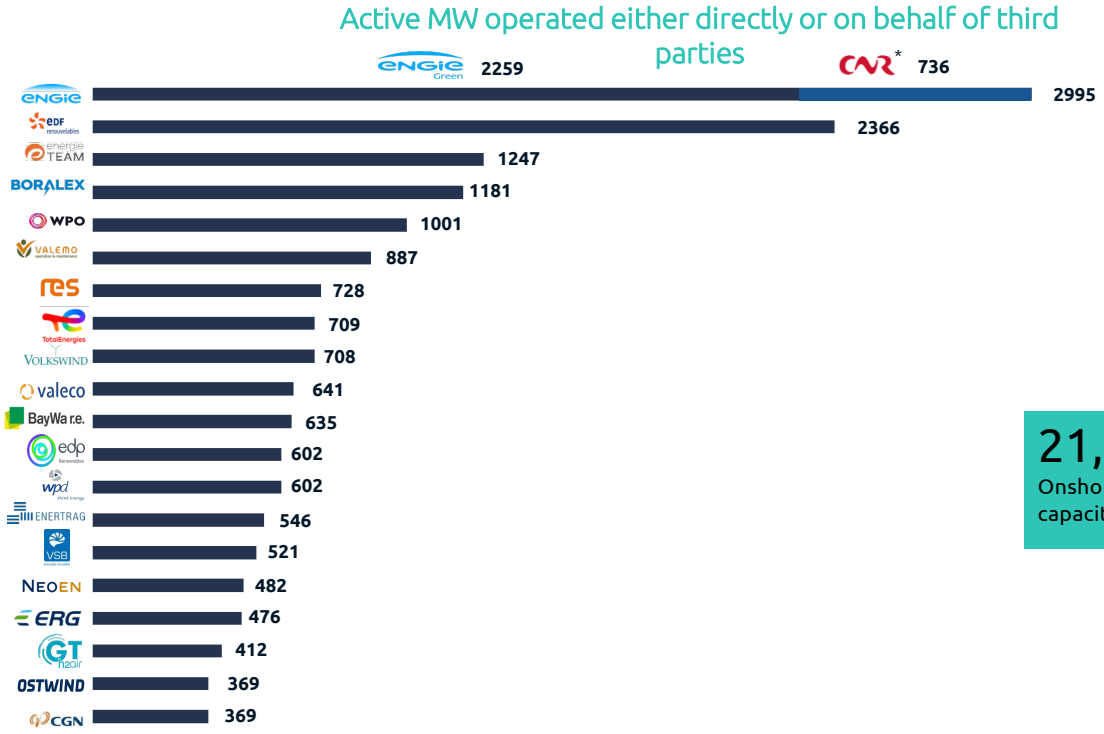
SIEMENS Gamesa RENEWABLE ENERGY

The full commissioning of the Saint-Brieuc wind farm (496 MW) is planned for the second half of 2023 and that of the Fécamp wind farm (497 MW) for the first half of 2024.[2]

Sources: [1] FEE study, 2023
[2] https://www.actu-environnement.com/ae/news/energies-renouvelables-acceleration-premier-trimestre-2023-41884.php4
https://www.actu-environnement.com/ae/news/eolien-mer-ailes-marines-installation-parc-saint-brieuc-41758.php4

Overview of the installed capacity

Top 20 onshore and offshore wind operators in France as at 30 June 2023



* 502 MW of which are operated by Energieteam 108 MW by Engie Green, and the rest by third parties

Source: FEE study, 2023

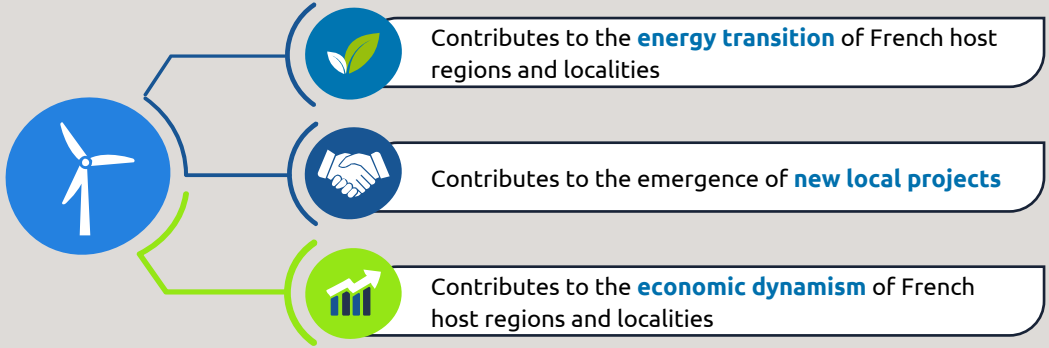
21,869 MW
Onshore and offshore installed capacity as at 30 June 2023

Economic and fiscal benefits for local authorities

Wind power contributes to the economic activity and appeal of French host regions and localities…

Wind energy acts as a catalyst for the energy transition of French regions. Many local authorities (municipalities, local public service companies – EPCI*, départements and regions) are working to support wind development. Private players with strong local links, the *syndicats d'énergie* (local authorities in charge of the management of the electricity and gas concessions), local distribution companies and local elected officials are committed to helping new wind farms set up successfully, thereby sending a strong signal of the vitality and modernity of the local economy and institutions.

The development of wind farm locally often **brings about promising local projects**, including biomass boilers, the rehabilitation of public buildings and tourist locations, road rehabilitation, preserving public services, the creation of short food supply chains and so on.

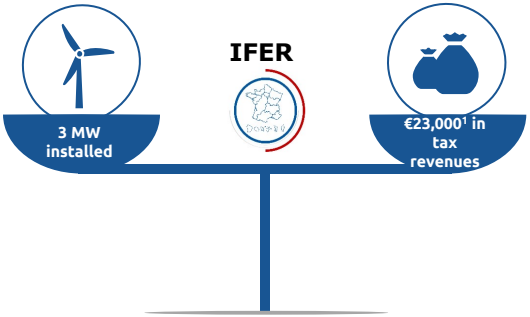


EPCI = Établissement Public de Coopération Intercommunale – local public service companies

Economic and fiscal benefits for local authorities

… and contributes to the budget of local authorities

Among their economic windfalls, wind power installations generate various **tax revenues**, notably in the form of **property taxes, the corporate real estate tax (*cotisation foncière des entreprises* – CFE), the company value-added contribution (*cotisation sur la valeur ajoutée des entreprises* – CVAE), and the flat tax on network infrastructure companies (*impôt forfaitaire sur les entreprises du réseau* – IFER).** The **2022 IFER rate** for wind power is set at **€7,820 per MW** of installed electricity generation capacity installed on the 1st of January of the tax year. The French central government also receives an additional levy of 3% of the amounts collected under the IFER system.



Zoom on IFER (the flat tax on network infrastructure companies)

The proceeds from the **IFER** is distributed between the host locality, the département and the EPCI (public inter-municipal cooperation establishment, which is an administrative entity that brings together several municipalities). The distribution of IFER proceeds differs according to whether the host community belongs to an EPCI or not (and the corresponding type of taxation structure):

	Single municipality	EPCI with complementary taxation (FA)	EPCI with zonal business taxation (FPZ)	EPCI with single wind power taxation (FEU)	EPCI with single business taxation (FPU)
Tax components of IFER for wind turbines	20% for the municipality 80% for the département	20% for the municipality 50% for the EPCI 30% for the département		70% for the EPCI 30% for the département	

Sources: Economie.gouv.fr; Journal de l'éolien

[1] This is the minimum amount received. Additional income can be derived from the CVAE tax, property taxes, and the Energy Economy Certificates scheme (CEE).

Economic and fiscal benefits for local authorities

Substantial tax revenues enabling municipalities to lower local taxes, borrow money, or fund projects

Examples of fiscal revenue

Number of turbines*	Tax revenue over the service life of a wind farm (20 years)**	Average tax revenue**	Annual distribution***
5	€2.3 million	€117,300 per year	• Localities/EPCI: €82,110 • Département: €35,190
10	€4.7 million	€234,600 per year	• Localities/EPCI: €164,220 • Département: €70,380
15	€7 million	€351,900 per year	• Localities/EPCI: €246,330 • Département: €105,570

These revenues generated by the installation and operation of the wind farms in the territory are long-standing and last for an average of **20–25 years**.

Let's debunk a few misconceptions around the cost of wind power

✔ Farmers can still grow crops in the fields after the wind turbines are installed. Only in the case of large wind turbines is the surface occupied by the turbines (approximately 1000 m² per wind turbine) lost to cultivation.

✖ The responsibility for ensuring that the wind turbines are eventually dismantled doesn't rest upon the owner of the lands where they are located. Operators have a statutory obligation to handle the dismantling of production units and site reclamation at the end of their service life.

** for a 3 MW wind turbine - ** €7,820/MW according to the IFER standard - *** Distribution according to the IFER standard*

Sources: MMA; Journal de l'éolien; Economie.gouv.fr

Territorial development

Wind farms can contribute to local development in a variety of ways

Renovation of monuments into tourist accommodation

- Thanks to the tax revenues derived from the wind farms, the town of Ally (Haute-Loire) has been able to **rehabilitate 3 former windmills** that can be visited and certain parts of which have been **transformed into holiday getaways.**
- Renovation of an **antimony mine** in the town of Ally to welcome visitors.

Tourism around renewable energies

- The town of Fitou, in the Aude département, plans to **rehabilitate a former Lafarge plant** to create a site combining **tourism** and **renewable energies.**
- Each year, the town of Ally welcomes **school field trips** on the topic of renewable energies.

Sport tourism

- Sainte-Colombe dans L'Yonne - creating **hiking trails** around the wind farms to combine sports and renewable energies
- In the Somme département, wind power has allowed the creation of a 20 km **hiking trail** around the wind turbines, with information boards on **biodiversity.**[1]

No depreciation in property values

- The impact of wind power on property prices is **comparable to that of other industrial infrastructures** such as transmission towers and cellular base stations. **There is strictly no impact in 90% of cases and a very low one on 10% of sold homes.**[2]
- The high-instance Court of Cassation has ruled that the mere proximity of wind turbines does **not create an abnormal impact** that would be open to compensation.

Sources: [1] "Paroles d'élus" [Testimonials from elected officials], France Énergie Éolienne; [2] Éoliennes et immobilier [Wind turbines and property values], Ademe, May 2022

Corporate PPAs

Competitive renewable electricity purchase contracts allowing companies to commit sustainably

- A **corporate PPA** (Power Purchase Agreement) is a **direct purchase agreement for renewable electricity** between a producer and an end user.
- The price of electricity resulting from the contract is **prearranged**. It can thus be decorrelated from market prices, in which case it usually is based on the cost of production.
- Corporate PPAs can extend over anything from 3 to 25 years, but are typically **long-term contracts** of 10 to 20 years in the case of new generation assets.[1]

Key examples

SNCF/CNR (Vensolair)

Type: Greenfield*

Duration: 25 years

Scope: 88 GWh per year

Signed in July 2023, this is the largest wind PPA in France. It covers the equivalent of the annual electricity consumption of the suburban commuter rail line RER D.

Leroy Merlin/Voltalia

Type: Greenfield*

Duration: 23 years

Scope: 60 GWh per year

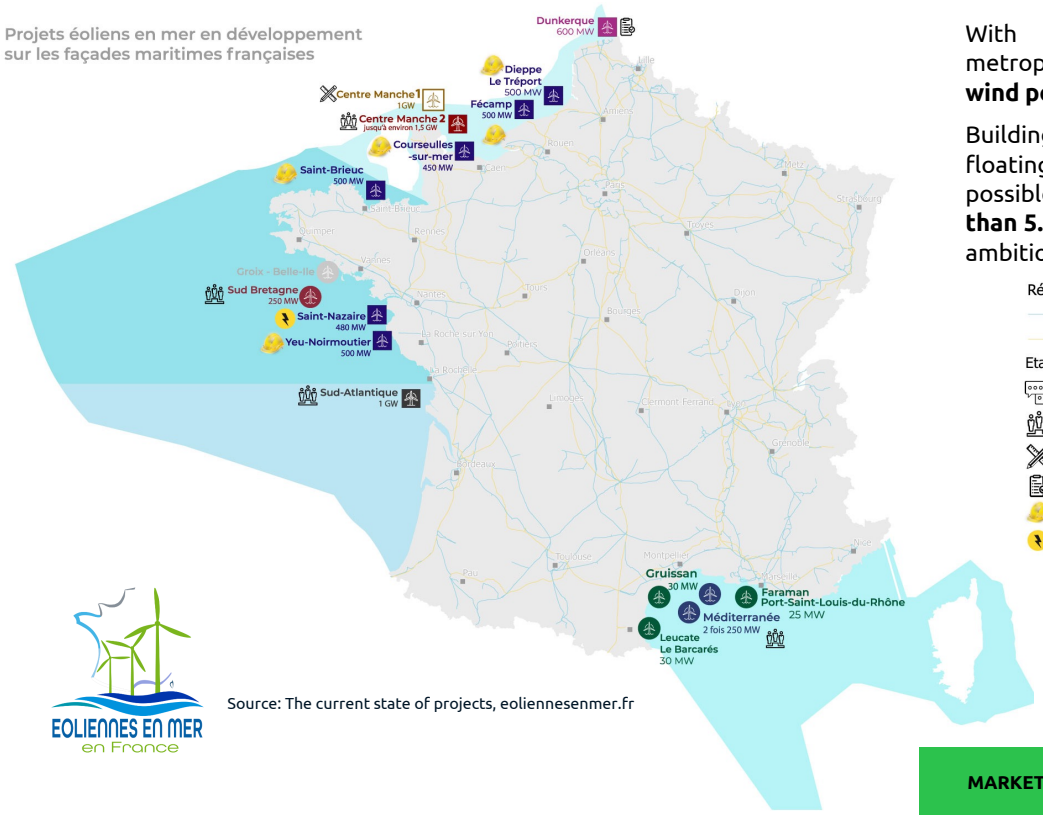
This first greenfield wind CPPA, signed in 2023, is meant to cover the equivalent of 20% of the electricity consumption of home improvement superstore operator Leroy Merlin.

*A PPA is considered “greenfield” when it results in the creation of new assets

Sources: [1] Capgemini Invent

Offshore wind

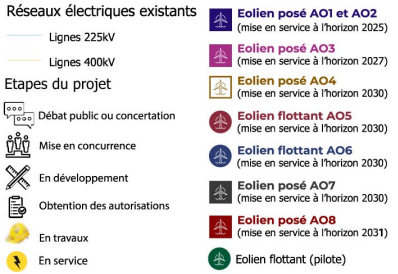
The first French offshore wind farm has been generating power since 2022, and this is just the beginning of a long series to come



Source: The current state of projects, eoliennesenmer.fr

With its **3,500 km of coastline**, metropolitan France has the **2nd largest wind power potential in Europe.**

Building many offshore wind farms, both floating and bottom-fixed, would make it possible to reach a total capacity of **more than 5.3 GW by 2028**, in line with the PPE's ambition for offshore wind.



€44.9 per MWh, strike price of the last offshore wind tender (AO4)

EOLIENNES EN MER en France

MARKET

Offshore wind

France boasts many advantages as far as offshore wind power is concerned, most notably its extended maritime boundaries as well as its industrial, energy and maritime expertise and port infrastructure, and meshed power grid

Offshore turbines are **more productive than onshore turbines** as they can harness stronger and more regular winds.

These new facilities will both help **achieve the national objectives** for diversifying the energy mix and help **bring about a vibrant wind power sector with the capacity to reach new markets abroad**. Several factories and hundreds of jobs dedicated to this industry have already been created. Several thousand more may emerge from the installation and commissioning of the projects.

In March 2022, an **offshore wind pact** was signed between the government and the industry. The French government thus affirms its desire to aim for a minimum of **2 GW per year in offshore wind capacity** attributed through tenders from 2025 in order to achieve a total of **40 GW in 2025**. As for the offshore wind industry, it has set out to **increase the amount of wind jobs fourfold by 2035, investing more than €40 billion** over the next 15 years **and having at least 50% local content** in its projects.[1]

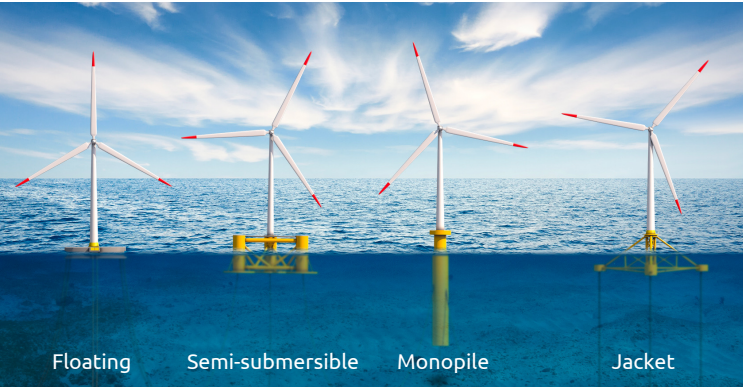
Sources: FEE study, 2021 Observatory for marine energies

[1] Pacte éolien en mer entre l'État et la filière [The offshore wind pact between the government and the industry], eoliennesenmer.fr

Offshore wind

Fixed-bottom and floating offshore wind power: two technologies that are developing in French waters

Examples of floating offshore wind installations:



Source: FEE, https://www.eoliennesenmer.fr/

Bottom-fixed offshore wind

Fixed-bottom wind turbines are intended for seabed depths of up to 50–60m and can harness strong coastal winds.

- **1 wind farm is currently active (0.48 GW)**
- 5 wind farms are currently under construction (2.45 GW)
- 3 other call for tenders are under way (3.5 GW)

Bottom-fixed wind is the most mature and competitive MRE technology. **Fixed-bottom offshore wind accounts for** 90% of the turnover of the sector.

Floating offshore wind

Floating wind turbines are connected to the seabed by anchor lines and can therefore be located further offshore at seabed depths starting at depths of 30 to 50 m.

- **2 other call for tenders are under way (0.75 GW)**
- 3 pilot farms are being constructed (0.9 GW)

MARKET

Offshore wind

Focus on project progress

Situation in 2022:

- **1 active wind farm (installed)**
- **5 projects under construction (in bottom-fixed wind)**
- 10 other upcoming projects or pilot projects (in bottom-fixed and floating wind)

Saint-Brieuc
496 MW
Bottom-fixed wind (jackets)
62 Siemens-Gamesa 8 MW wind turbines
Under construction
Commissioning scheduled for 2023

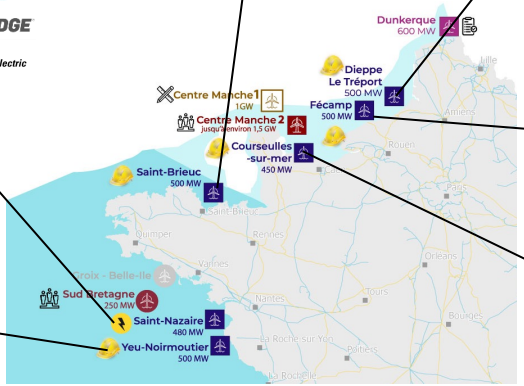
Dieppe – Le Tréport
496 MW
Bottom-fixed wind (jackets)
62 Siemens-Gamesa 8 MW wind turbines
Under construction
Commissioning scheduled for 2026

Saint-Nazaire
480 MW
Bottom-fixed wind (monopiles)
80 GE 6 MW wind turbines
Active
Commissioned in 2022

Fécamp
497 MW
Gravity-based foundation
71 Siemens-Gamesa 7 MW wind turbines
Under construction
Commissioning scheduled for the end of 2024

Courseulles-sur-mer
448 MW
Bottom-fixed wind (monopiles)
64 Siemens-Gamesa 7 MW wind turbines
Under construction
Commissioning scheduled for 2025

Islands of Yeu and Noirmoutier
496 MW
Bottom-fixed wind (monopiles)
62 Siemens-Gamesa 8 MW wind turbines
Under construction
Commissioning scheduled for 2025



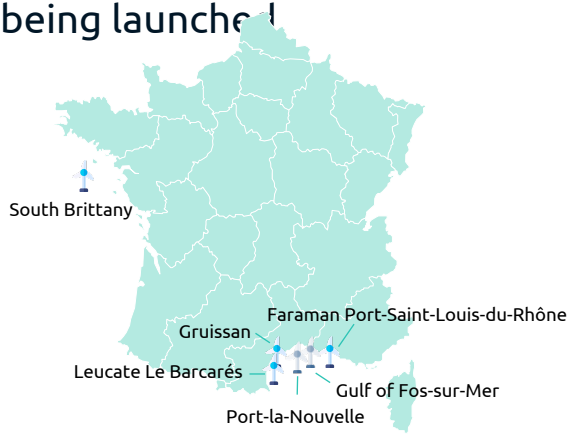
Sources: eoliennesenmer.fr and operators' website

Floating wind

The first floating offshore wind projects are being launched

In France, the Mediterranean Sea and the Brittany seaboard have **substantial wind power potential** for the installation of floating wind farms due to their **highly favourable and regular wind regimes** as well as its **bathymetry** (the ocean floors drop very steeply to a depth exceeding 60 m).

The main challenge for floating wind power is to make its cost converge towards that of offshore wind power, hence the need to develop several projects to industrialize the sector and **become more competitive.**



> "**80%** of Europe's wind resource is found in areas with depths exceeding 60 m" (Wind Europe)
>
> Wind Europe

Project	Type	Capacity:	Industrial partners
Faraman - Port-Saint-Louis-du-Rhône - Provence Grand Large	Pilot farm	24 MW (3 turbines)	EDF, SBM Offshore, Siemens Gamesa
Gruissan - Eolmed	Pilot farm	30 MW (3 turbines)	Qair, BW Ideol, Vestas, ArchiMed, TotalEnergies, Port La Nouvelle
Leucate-Le Barcarès - EFGL (Floating wind of Golfe du Lion)	Pilot farm	30 MW (3 turbines)	OW, Principle Power, Euroports, Vestas
Gulf of Fos-sur-Mer	Future wind farm	250 MW	Call for tenders is ongoing
Off Port-la-Nouvelle	Future wind farm	250 MW	Call for tenders is ongoing
South Brittany	Future wind farm	250 MW	Call for tenders is ongoing

Sources: 2021 Observatory for marine energies
eoliennesenmer.fr

Floating wind

Pilot farm at Port-La-Nouvelle

eolmed

Project context and description

One of the first floating offshore wind farms will come into being in **Occitanie** in the town of Port-la-Nouvelle with a planned commissioning in **mid-2024**. The farm will feature **3 turbines each with a 10 MW capacity**.

Two **core elements** are involved in setting up this floating wind farm:

- Steel **floats**: entirely manufactured in France (in the Occitanie region) by Archimed, they will be installed by the French company Bourbon
- Connection **hub**

This project contributes to the structuring of a French industrial sector in floating wind power. Each year, it will generate the equivalent of the domestic use of a city of 50,000 people.

A variety of protagonists are involved along the value chain:*

Developer	Codeveloper	Turbine	Foundations	Crowdfunding
Qair	TotalEnergies	Vestas	BW ideol	enerfip

Source: Vestas * *Non-exhaustive list*

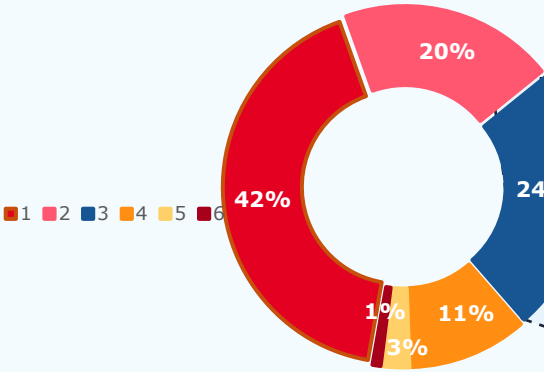
4

Overview and prospects

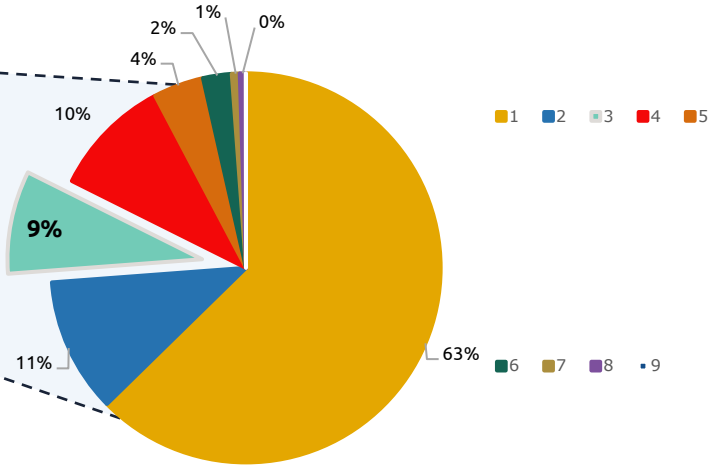
The place of wind power in France's energy mix in 2022

Electricity amounted to **25%** of France's energy use. In 2022, wind power accounted for **9%** of France's electricity production.

Breakdown of **final energy** consumption in France



Electricity generation sources in France



Total electricity generation
445.2 TWh

Wind
38.1 TWh

Sources: RTE's 2022 Electricity report and Key energy figures 2022, French Ministry of Ecological Transition

Key figures of the wind energy sector in 2022

2.1 GW[2]
of onshore and offshore wind power capacity installed and connected to the grid in 2022

38.1 TWh[2] of electricity produced from wind energy

642 wind turbines[1]
installed in 2022

2.6 million households
could be supplied in electricity derived from wind power

Key figures

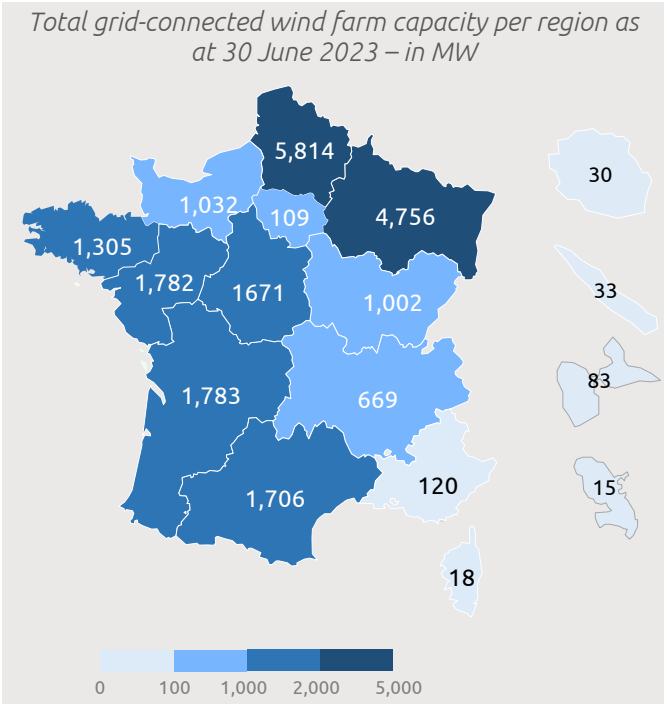
- Almost **9,500 wind turbines** in France at the end of 2022, spread over nearly **2,262 wind farms**[3] (2 of which were offshore wind farms).
- Installed wind capacity in 2022 has **increased compared to 2021**, which saw the installation of 1.2 GW in new capacity. **1.3 GW in additional wind power capacity** should have been installed in 2022 in order to meet the PPE objectives. France is thus the only European country that is lagging on its European renewable energy and heat recovery development objectives.
- The year 2022 was marked by the opening of the first offshore wind farm off the coast of Saint-Nazaire, with a capacity of 480 MW.
- Wind power is the **second-largest source of renewable electrical power** after hydropower, and the fourth largest electrical power source in France.

Sources:
[1] FEE data
[2] Electricity report for 2022, FEE study
[3] Transition-energetique.eco and The Wind Power

Overview of the wind power market by region

The current distribution of installed MW attests to the dominance of the north-east and west of France

Total grid-connected wind farm capacity per region as at 30 June 2023 – in MW



Source: FEE study, 2022 [1]Between June 2022 and June 2023

Wind capacities are distributed over the country, **with almost 2,200 wind farms** located in all regions of mainland France as well as in overseas territories.

Hauts-de-France and **Grand Est** are the top wind regions. These two regions alone represent **50% of France's grid-connected capacity**.

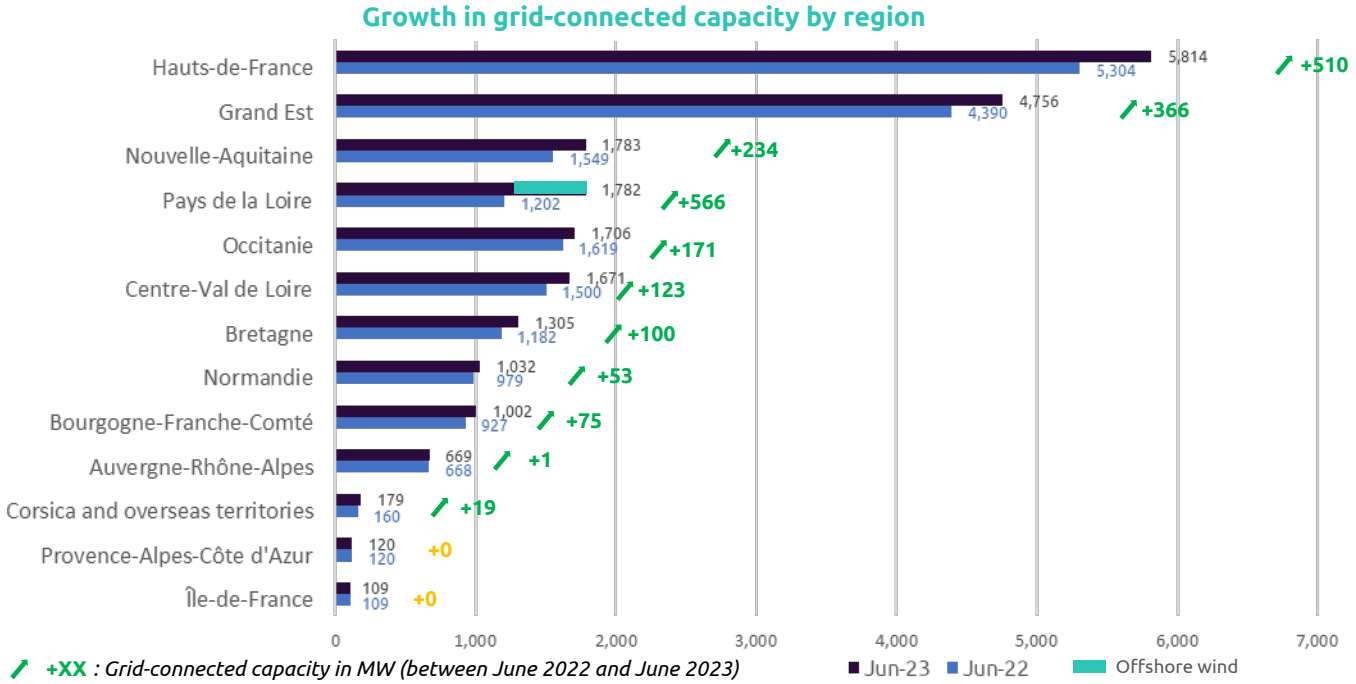
Other regions are continuing to make progress, notably **Nouvelle-Aquitaine** (+234 MW)[1] and **Centre-Val de Loire** (+171 MW).[1]

As for the **Pays de la Loire**, the region can expect the commissioning of the first offshore wind farm in Saint-Nazaire (+480 MW).

9 regions out of a total of 13 have more than **1,000 MW** of wind power connected to the grid as at the end of June 2023.

Growth in grid-connected capacity

France's grid-connected capacity has increased by more than 1 GW, with 7 regions installing more than 100 MW in 2022

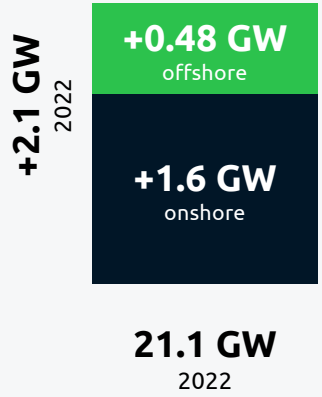


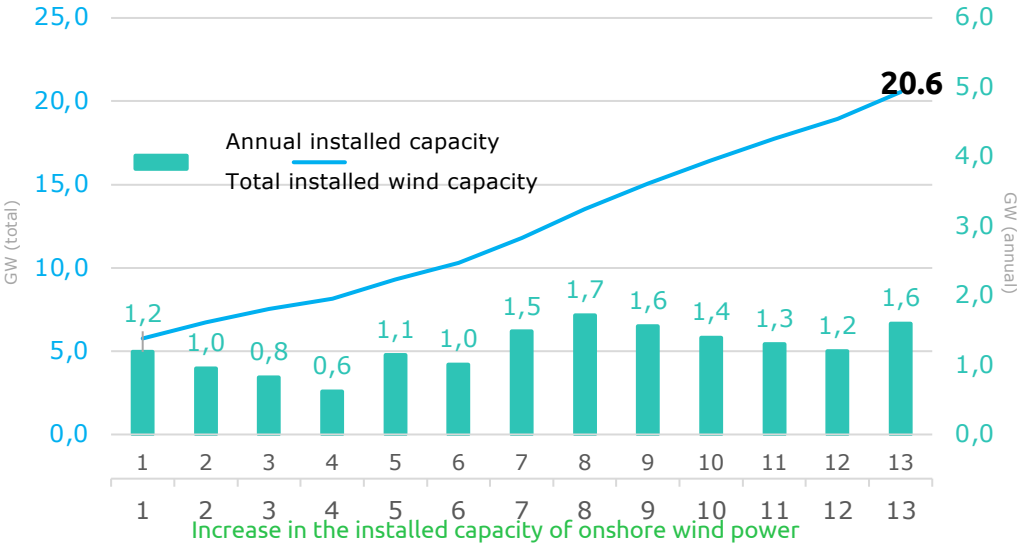
Source: FEE study & data processing by Capgemini Invent, 2022

Key figures of the wind energy sector in 2022

Installed capacity increased significantly in 2022

Installed wind capacity in 2022 (onshore and offshore)





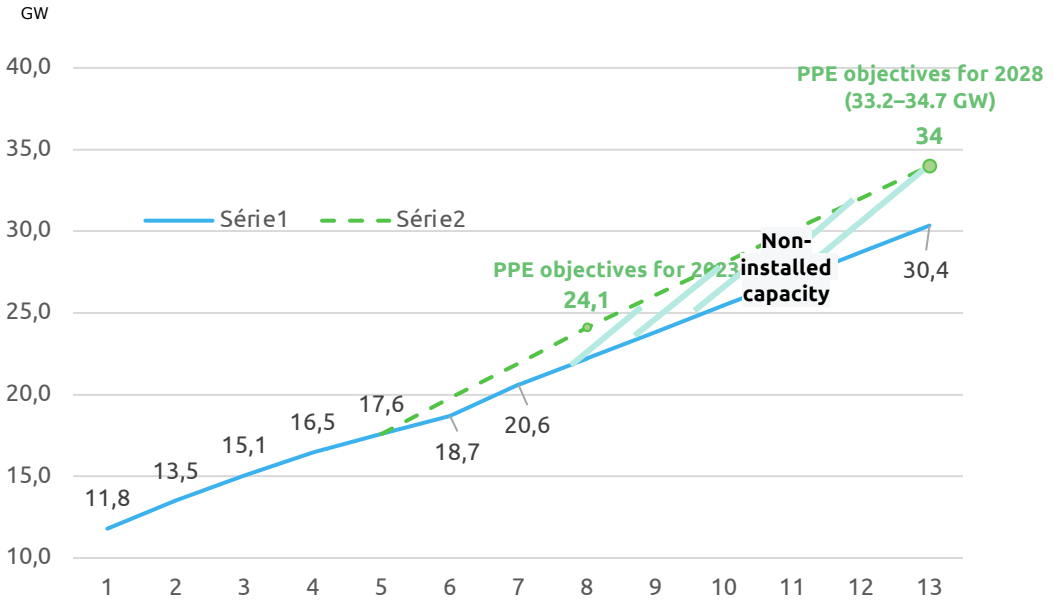
Source: RTE / FEE study
A detailed breakdown by year is available in the appendix.

PPE objectives

The current timeline, number of calls for tenders and authorizations given aren't sufficient to meet the objectives set by the PPE

France's 2050 carbon neutrality objective has been specified by the PPE published in April 2020.[1] Two wind targets were defined: for 2023 (24.1 GW) and 2028 (33.2-34.7 GW).

However, France is lagging on its objectives.



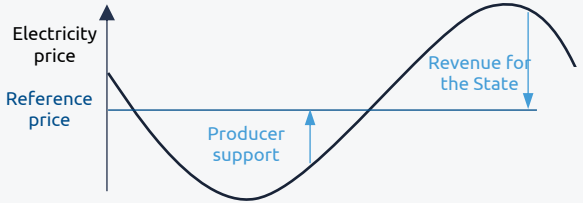
Backlog in installations compared to the PPE for onshore wind

Source: [1]PPE implementing decree, published in the French official gazette on 23 April 2020 & SDES 2020
[2] RTE data & linear projection

Wind power, a source of revenue for the State

The backlog in installations compared with the PPE is causing a shortfall of several billions of euros for the French state

Principle of additional remuneration



€10 billion in revenue for the French State in the event the PPE objectives are achieved in 2028[4]

€1.1 billion in total possible shortfall for the French government in 2028 if it doesn't honour the PPE objectives[4]

Revenues generated by wind power for the French State [2, 3]

Wind power and other renewable energies can be a source of revenue for the State thanks to the mechanism that integrates them into the energy market. This mechanism is referred to as "additional remuneration" and is based on two principles:

- When market prices are lower than the price that was set when the wind project was awarded, the State pays out an additional remuneration to the producer.
- Conversely, when market prices are higher than the price that was set when the wind project was awarded, the producer pays the difference to the State.

The wind sector (onshore and offshore) will pay €6.3 billion to the French government for the fiscal years 2022 and 2023.[3]

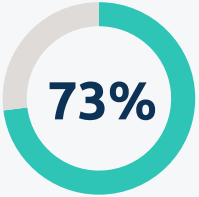
Achieving the objectives of the PPE would allow **the French State to secure a net income estimated at €10 billion by 2035.[4]**

The wind power sector therefore makes a positive contribution to public finances, while also helping lower fossil fuel imports.

Sources:
[1] FEE database
[2] Revenues from French wind power paid to the State, FEE
[3] Évaluation des charges de service public de l'énergie à compenser pour l'année 2023 [Evaluation of public energy service charges to be compensated for the year 2023], CRE
[4] Assumption: CSPE projection with market conditions similar to current ones

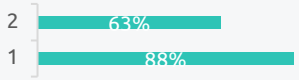
Public buy-in on wind power in France

Europeans massively endorse the choice of wind power as a necessary solution in the fight against climate change



of the French population has a positive image of wind power

of which



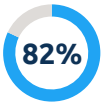
of the French population considers that **the development of wind power is necessary** to achieve the energy transition

of Poles support wind farm development in their country[2]

Offshore

96%

A survey of Scottish people living near an offshore wind farm showed that they **believe that these installations have a positive or neutral impact on their quality of life.**[2]



of Germans are in favour of the expansion of wind power[2]

5%

Only Irish people **oppose the development of wind farms** near their homes[2]

of Europeans surveyed **support the deployment of wind turbines near their homes**[2]

Sources: Harris Interactive, 2021; GreenUnivers – "Barometer of the crowdfunding of renewable energies", IRSN barometer

[2] FEE database

Public buy-in on wind power in France

Grassroots renewable power generation projects are proliferating in France

This civic energy, where decision-making, financing and initiatives stem from the **grassroots**, leverages the local natural resources of the territories involved through the generation of renewable energy. It also results in direct citizen involvement in renewable energy projects and the transformational challenges of the energy transition.

Within the calls for tenders, **new criteria for collective funding and shared governance** have emerged. "Bonuses" are thus conferred to candidates that have developed these aspects in their projects: **shared governance is valued at +€0.003 per kWh and crowdfunding at +€0.001 per kWh.**[1]

314 grassroots renewable energy projects[2]
including 37 in wind power generation
(2nd place after solar)

Grassroots wind power initiatives

1,219.2 GWh produced per year
including 975.46 GWh in wind power

>€100 million M€ collected via crowdfunding for renewable energy projects[3]

Source: [1] Deliberation No. 2022-02, CRE; [2] energy-partagee.org/; [3] In 2020, more than €100 million were raised via crowdfunding for renewable energy projects, GreenUnivers

Onshore technologies are continuing to make progress

There is a trend towards higher turbine capacity, nevertheless average installed turbine capacity still lags behind the European average of 4.1 MW.[1]

Top most installed turbines in 2022[2]

	Model	Manufacturer	Unit capacity (MW)	Mast height (France)	Installed capacity (MW)
1	N117	Nordex Acciona	3 to 3.7	76–120 m	220.8
2	V100	Vestas	2 to 2.2	75–100 m	176.8
3	V110	Vestas	2 to 2.2	85–120 m	169
4	V150	Vestas	4 to 4.2	105 m	154
5	V126	Vestas	3 to 3.8	87–137 m	143.2
6	N131	Nordex Acciona	3 to 3.6	84–120 m	108.6
7	V117	Vestas	3 to 4.2	87–92 m	69.9
8	V136	Vestas	3 to 4.2	97–112 m	66
9	V112	Vestas	3 to 3.3	94 m	65.7
10	E-138	ENERCON	4.2	111 to 131 m	54.6
11	SG3.X-132	Siemens Gamesa	3	84 to 114 m	54

Sources: WindEurope – Wind energy in Europe – 2022[1]; FEE, 2023[2]

Onshore technologies are continuing to make progress

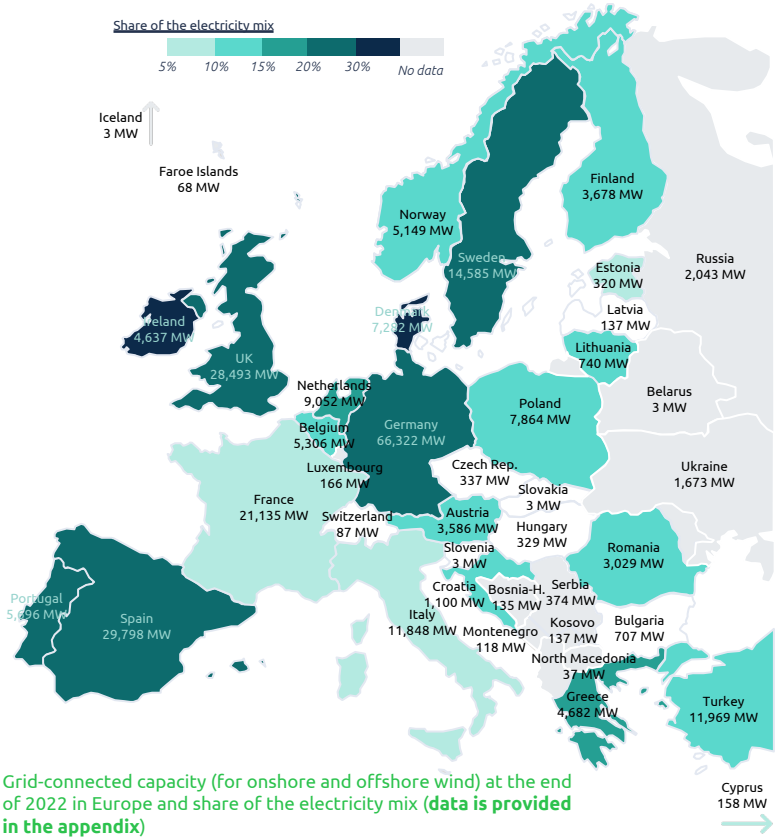
The most installed turbines in France have generation capacities and sizes that are limited compared to the possibilities offered by manufacturers

Most installed turbines **as at 30 June 2023 (total number)**

	Model	Manufacturer	Unit capacity (MW)	Rotor size/height	Total capacity (MW)
1	V100	Vestas	1.8 to 3.8	75–150m	1758
2	E-82	ENERCON	1.5 to 3	59–108m	1717
3	V90	Vestas	2 to 3	78–145m	1680
4	E-70	ENERCON	2 to 2.35	54–99m	1524
5	MM-92	SENVION	2	59–100m	1508
6	N117	NORDEX / acciona	2.4 to 3.7	91–120 m	1124
7	V110	Vestas	2 to 2.2	80–125m	869
8	N90	NORDEX / acciona	2.3 to 2.5	125–145m	844
9	V112	Vestas	2 to 3.6	69–119m	779

None of the most installed models in France has a turbine capacity above the European average for onshore turbines (4.1 MW).[1] The height of French turbines is also lower than the European average (115 m compared to 130 m in Europe).[2]

Source: FEE study, 2023 [1] Wind Energy in Europe 2021, WindEurope, [2] Wood Mackenzie global wind power installation database Q4 2021



Grid-connected capacity (for onshore and offshore wind) at the end of 2022 in Europe and share of the electricity mix (**data is provided in the appendix**)

The data on capacity growth in France presented by WindEurope differ from those presented by FEE because they are based on a different calculation method.

Sources: WindEurope, "Wind energy in Europe in 2022"

The French wind market within the European context

Europe's wind energy sector continues to grow, with strategies that differ for offshore and onshore wind in different countries

Total EU-27
204,499 MW
(16% of the electricity mix)

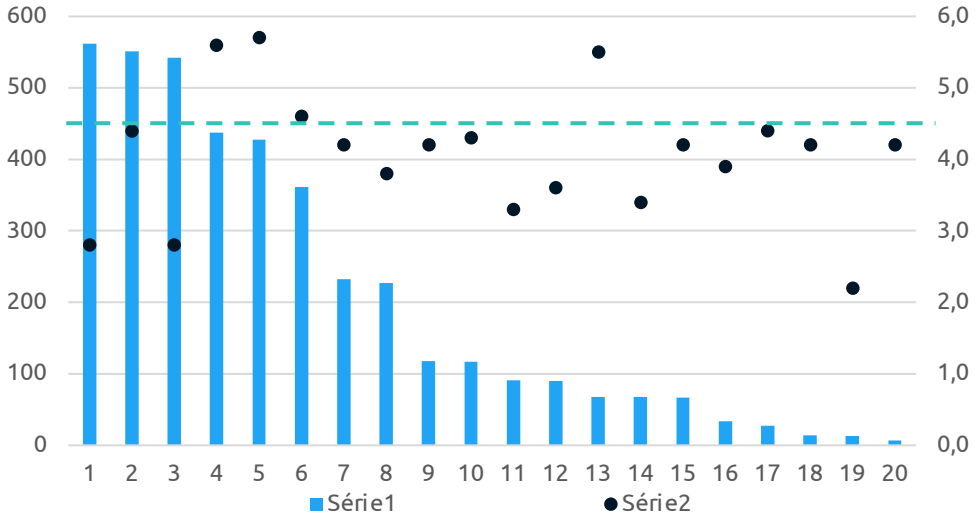
Total for Europe
254,788 MW
(17% of the electricity mix)

Countries with a high percentage of wind power in their electricity mix demonstrate the **technical feasibility** of managing a power grid incorporating a high share of renewable energies.

Onshore technologies are continuing to make progress

France has installed the largest number of wind turbines in Europe in 2022, but their average capacity is one of the lowest in the region (at 2.8 MW)

Number of wind turbines installed in European countries in 2022 (onshore) and their average turbine capacity



Sources: Wind energy in Europe in 2022

The average turbine capacity installed in Europe in 2022 was **4.1 MW**.

This is due to the strong regulatory constraints, further increased in 2021, and **which restrict the potential cost decreases for wind power in France.**

Yet, supersize wind turbines, which are higher and therefore more powerful, would help lower the number of installed turbines and therefore also lower electricity prices for the community.

Offshore technologies are continuing to make progress

Offshore wind turbines will gradually draw nearer to the European average (of 8 MW)[1] thanks to future wind farms

The most installed turbine in 2022[2]

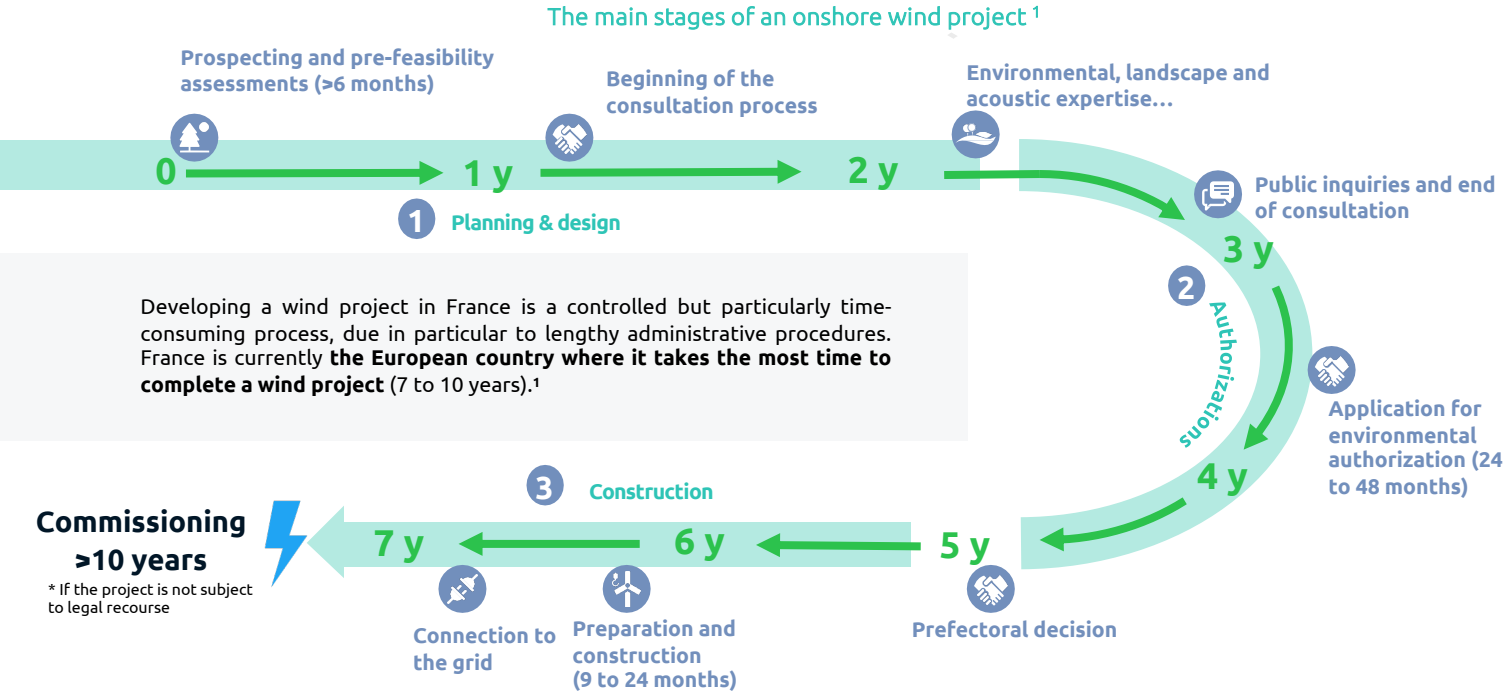
	Model	Manufacturer	Unit capacity (MW)	Mast height (France)	Installed capacity (MW)	Fixed-bottom or floating
1	Haliade 150	GE Renewable Energy	6		480	Fixed-bottom

23.8 MW in turbine capacity projected during the last call for tenders for offshore wind (AO4)[3]

Sources: WindEurope, "Wind energy in Europe in 2022"[1]
FEE study, 2023[2] CRE[3]

Construction of an onshore wind farm project

In France, the construction of a wind farm takes twice as long as the European average



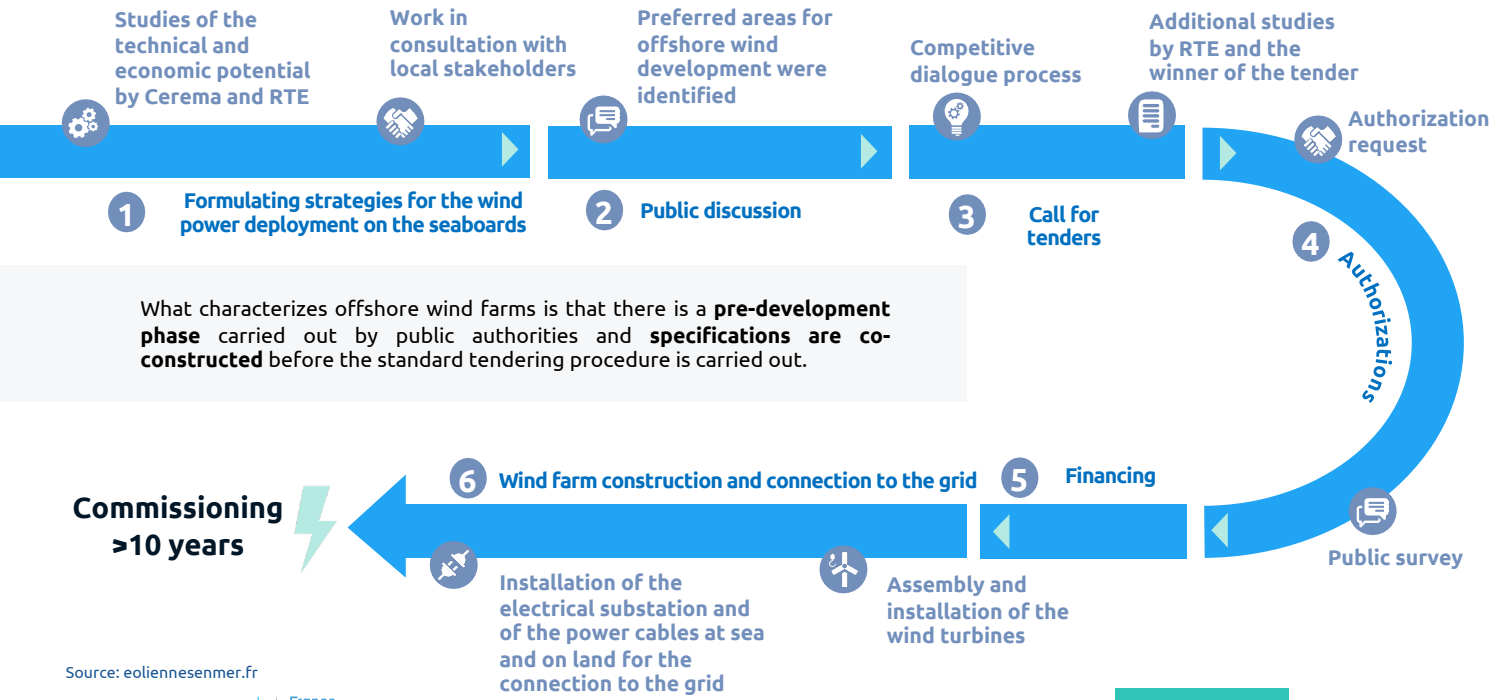
Developing a wind project in France is a controlled but particularly time-consuming process, due in particular to lengthy administrative procedures. France is currently **the European country where it takes the most time to complete a wind project** (7 to 10 years).[1]

Source: [1] Comment se décide et se construit un parc éolien [How are wind farms decided on and built], info-eolien.fr

Construction of an offshore wind farm project

In France, the construction of a wind farm takes twice as long as the European average

The main stages of an offshore wind project[1]



What characterizes offshore wind farms is that there is a **pre-development phase** carried out by public authorities and **specifications are co-constructed** before the standard tendering procedure is carried out.

Source: eoliennesenmer.fr

Construction of a wind farm project

Despite ambitious national objectives, significant constraints of various types affect wind farm location

Administrative and regulatory constraints

Obtaining the environmental authorization takes about 18 months, followed, for two thirds of all projects, by an average of 4 additional years for related planning appeals[1]

Some wind projects are eliminated for administrative reasons such as a missing document in the tender file

Territorial constraints

Military constraints: when the wind farm is to be located close to a military radar or military air lanes, approval from the Ministry of Armed Forces is required, which prevent the installation of wind turbines on almost 50% of the French territory

Soft law is increasingly developed and taken into account by public authorities (as in the case of the landscape section of the national guide relating to impact assessments)

Constraints on production

The curtailment of wind turbines for environmental and acoustic reasons is sometimes required.

Obtaining a new environmental authorization is required when changes to the wind farm brought about by repowering are deemed substantial.[2]

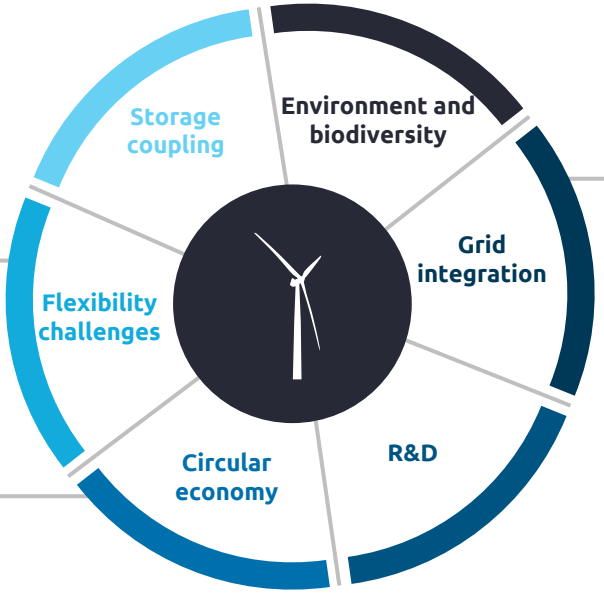
Market constraints

Substantial changes in construction prices (turbines, connection to the grid, civil engineering) may have appeared in the interval between the moment when manufacturers shared their prices for the calls for tenders and order confirmation – prices have indeed increased by 30% since September 2021.

Sources: [1] La réglementation en France [France's regulatory environment], FEE;
[2] Renouvellement des parcs éoliens entre ambitions et contraintes [Wind farm renewal – between ambitions and constraints], lemondedelenergie.

Overview of the key challenges

Wind energy faces many challenges in its development



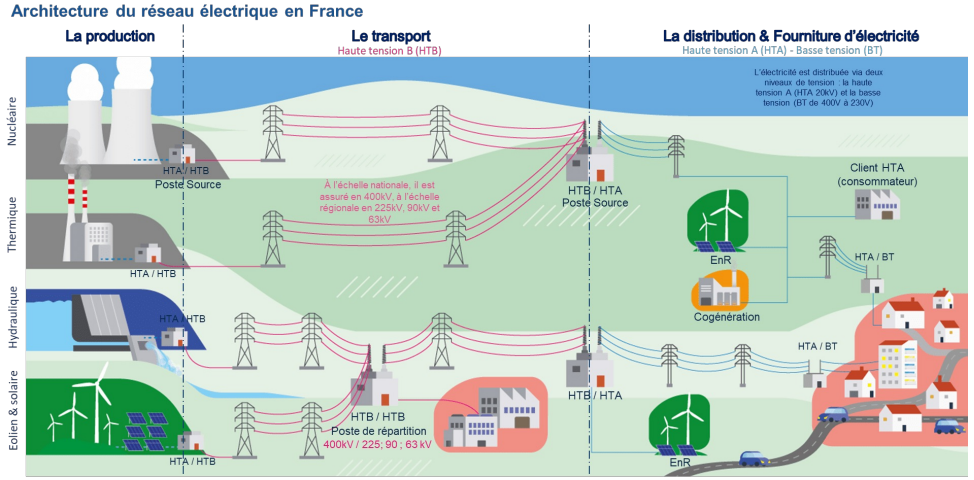
- Production flexibilities
- Active management of prospective grid flexibilities

- "Zero waste" over the lifecycle of the wind farms
- Retrofit, revamping and repowering

- Renewables integration (on all time scales and at all levels of the grid)
- Energy future looking towards 2050
- Innovation
- Training

Integration into the network at all levels

Enedis and RTE are accelerating the connection of renewable energy facilities to the grid



Enedis and RTE have been engaged in a process of major adaptation of their networks for several years in order to accommodate new electricity generation while also assuring the security and safety of the electrical grid.

Enedis and RTE are developing grids that could **accommodate twice as much land-based/onshore renewables by 2035** than in the previous 10 years.

55%

Electricity accounts for 55% of France's final energy consumption in 2050, compared to 24% in 2021.[1]

+135 GW minimum

To the very least 135 GW of installed capacity from wind (offshore and onshore) and solar in 2050, compared to 37 GW in 2022.[1]

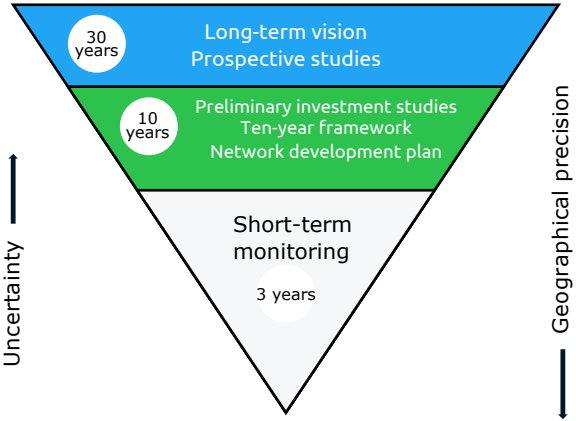
Sources: [1]RTE

Integration into the network at all levels

Grid connections are prepared over different time horizons

The power distribution grid is developed based on technical and economic studies over various timeframes.

- **RTE's *Bilan prévisionnel* forecast** examines the changing dynamics between power generation and use. The next Forecast Report will be published in September 2023 and will present developments in the electricity mix and an assessment of energy security looking to 2030 and 2050; it follows on the Energy Futures 2050 report published in 2022.
- RTE's **ten-year network development plan** (*Schéma décennal de développement du réseau* – SDDR) summarizes the short-term, medium-term and long-term visions of the French public transmission network. Work on the SDDR is launched at the end of 2023 and publication is planned for early 2024.
- The **TYNDP (Ten-Year Network Development Plan)** concerns the European grid and is prepared collaboratively within ENTSO-E.
- And lastly, the **S3REnR regional schemes for the connection of renewable energy facilities to the grid** are key to identifying and anticipating needs on the transport and distribution networks, thus achieving the ambitions for renewable energy development set out by the region prefects on a 10 to 15 year planning horizon.
- **The Network Development Plan** introduced by the French Energy Code in transposition of the Clean Energy Package is applicable since 5 March 2021. This is a new document which will present the challenges, methods and orders of magnitude of the investments that must be carried out in the distribution network in the medium term (the next 5 to 10 years), as well as new high-impact themes (flexibilities, renewable energy, electric mobility).



Prospective outlook and planning of the development of the grid

Network development plan

Like each of its European equivalents, Enedis publishes a network development plan

Publishing a Network Development Plan is a **new regulatory obligation** for European distribution system operators (DNOs). These documents must:

- be published every two years
- be prepared together with stakeholders (network users, organizing authorities for public electricity distribution and RTE)
- then filed for review by the French Energy Regulation Commission (CRE), which has the authority to request modifications, and the Committee for the Public Electricity Distribution System (CSDPE).
- outline projected investments over the next 5 to 10 years
- emphasize, among other things, the integration of renewable energies and vehicle charging infrastructure, as well as the use of flexibilities

Enedis published a preliminary document in March 2023, pending the implementing decree that will specify the regulatory requirements for Network Development Plans.

This draft document serves an **educational purpose** and lays out in a public document the key principles of network development as well as the scale of investment needed.
The document is available on Enedis' website at https://www.enedis.fr/nouvelle-france-electrique-horizon-2027-et-2032-enedis-publie-le-document-preliminaire-un-futur

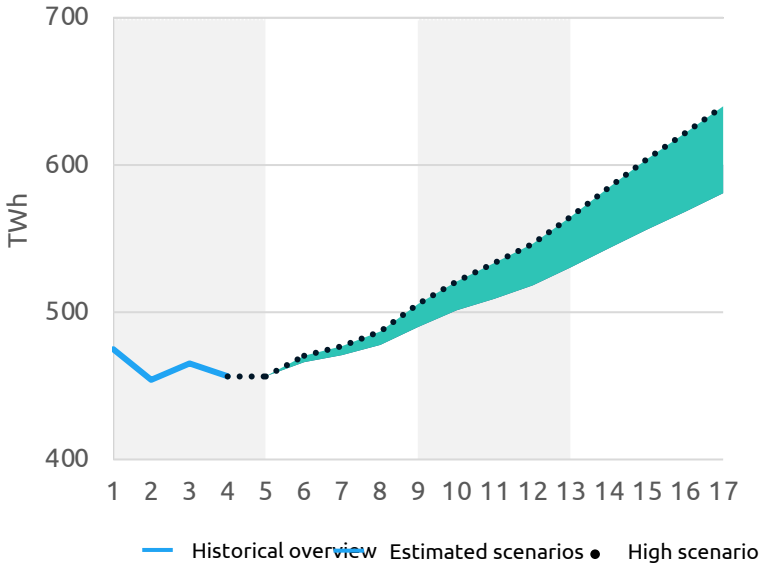
ENEDIS lays out 5 convictions in its draft Network Development Plan:

1- The grid provides high collective value
2- Enedis develops and operates the grid through a combination of national and local dialogues
3- Enedis has strong know-how in optimizing and sequencing investments
4- Investment approaches that are stable over time to stay on course…
5- …with a rate of development that is accelerating as the ongoing energy transition is gaining momentum

Accelerating the energy transition

The objectives for climate action and reindustrialization by 2035 herald a rise in electricity consumption

Increase in electricity use
(aggregated needs, declared in the public consultation + adjustments)



Electricity consumption is projected to range between 580 and 640 TWh by 2035, assuming the successful achievement of these objectives

Between 2025 and 2035, electricity use will grow faster than in the median trajectory described in the Energy Futures 2050 report, but will nevertheless remain consistent with the "acceleration" trajectory which anticipated the consequences of the future European objective (55% net reduction in greenhouse emissions by 2030 compared to 1990 levels).

While this trajectory aligns with **all** public goals including decarbonization and reindustrialization, it presents a substantial challenge.

One pivotal factor in covering these power needs is accelerating the development of renewable energy sources.

Accelerating the energy transition

The objective that was defined for renewables is to integrate the implications of the Renewable Energy Acceleration Act within the perspectives of each sector

The need and possibility of accelerating the deployment of renewable energy deployment – a key driver for rapidly increasing carbon-free output – are supported by a substantial majority of respondents. The trajectories for accelerating the development of renewable energies considered from the next Forecast Report and retained following the public consultation process, are as follows:

Offshore wind: **there is a strong ambition to accelerate the development of the sector** - acceleration in commissionings from 2030 onwards, subject to massification, standardization and acceleration of allocations in the coming years

Solar holds promising prospects, yet its full potential relies on the development of a specific model that entails necessary changes in the surfaces employed and a clear interest in relocating the solar value chain to France or Europe

Onshore wind: **the political debate on the technology must be taken into account in the formulation of offshore wind development plans political debate to be integrated, but it remains a vital sector in a context of increasing electricity demands** – sustaining historical momentum entails making the most of repowering opportunities, while the question of territorial planning becomes crucial for enhancing acceptability.

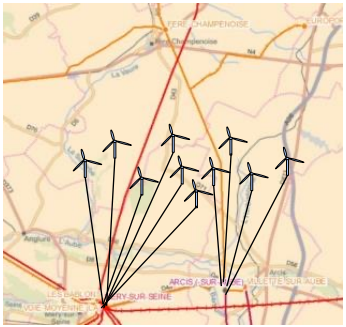
Trajectories in the 2030–2035 forecast

Low	Intermediate	High
Limited to commissioning of PPE2 projects *(10 GW - 35 TWh in 2035)*	Some additional commissioning *(14 GW - 50 TWh in 2035)*	The Offshore wind pact is achieved *(18 GW - 60 TWh in 2035)*
No tangible acceleration *(50 GW, equivalent to +3 GW/year - 60 TWh in 2035)*	Close to PPE2 objectives *(65 GW, equivalent to +4 GW/year - 80 TWh in 2035)*	Relocating in the value chain *(90 GW, equivalent to +7 GW/year - 110 TWh in 2035)*
Slowing down the pace *(30 GW, equivalent to +0.7 GW/year - 65 TWh in 2035)*	Maintaining the historical pace *(40 GW, equivalent to +1.5 GW/year - 90 TWh in 2035)*	Accelerating the pace *(45 GW, equivalent to +2 GW/year - 100 TWh in 2035)*

Integration into the network at all levels

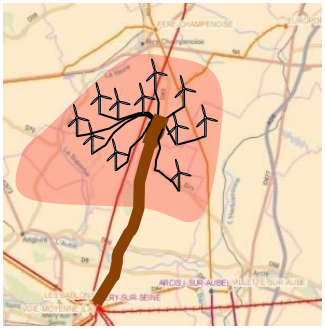
The S3REnR* schemes are an effective instrument for anticipating the integration of renewables into the grid while providing good visibility for all stakeholders

Before the S3REnR regional schemes



Grid adaptations were processed as connection requests are received, with costs borne by applicants, even when the adaptation would benefit subsequent applicants.

With the S3REnR regional schemes



Grid adaptations developed based on a comprehensive vision from the wind resource to the target as well as shared investment costs.

The objectives of the S3REnR schemes:

- **Increase renewable energy accommodation capacity** by restricting new installations
- **Provide visibility** on the planned grid reinforcements and developments
- **Anticipate network adaptations** in order to facilitate renewable energy accommodation
- **Share investment costs** between renewable energy producers, via the scheme's "quote-part"(QP) mechanism

* The "QP" fee (k€/MW) corresponds to an infrastructure cost share requirement that is paid by producers when connecting their wind farms to the grid.

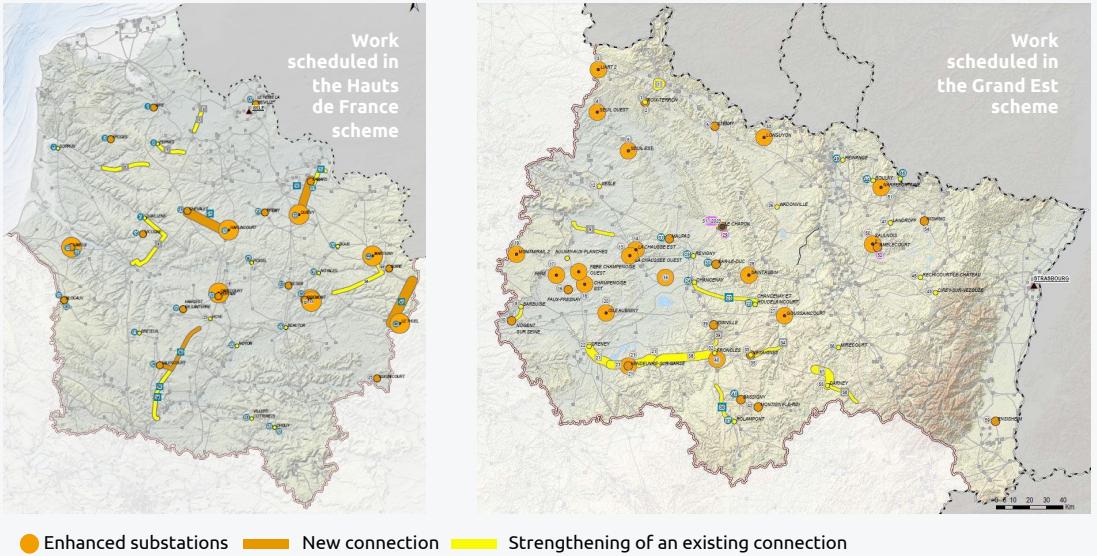
*regional network connection scheme for renewable energy

Integration into the network at all levels

Improving the grid in northern France

At the end of 2022, the S3REnR represented

- 58.5 GW in renewable energy accommodation capacity in mainland France
- €5.7 billion in investments project by grid operators



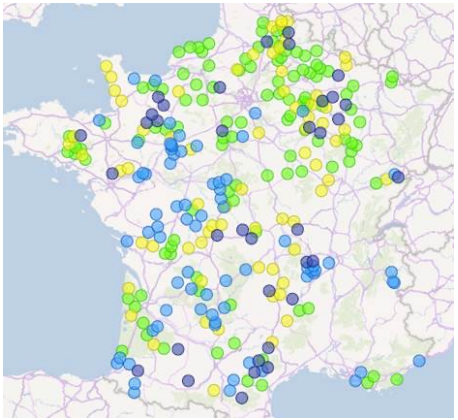
Challenges relating to flexibility

Voltage rise mitigation on the power grids: a serious issue requiring the contribution of all stakeholders in the electricity system

Pursuant to Article 30 of the Renewable Energy Acceleration Act of 10 March 2023, power generation facilities have to follow prescriptions relating to reactive power control given to them by distribution network operators when technically possible in order to mitigate voltage rises on public distribution and transmission networks.

In April 2023, 518 production sites connected to the Enedis high voltage grid, including 445 wind farms, were asked by Enedis to apply new requirements for reactive power control so as to manage the high voltage constraints identified by RTE and Enedis on 185 source substations. More than half (228) of the wind farms requested to change their reactive power absorption conditions did so as at 1 July 2023.

In addition to the investments made by RTE and the contribution of producers connected to the public transmission network, the contribution of producers connected to the distribution network is key to managing voltage levels.



- Substation with new requirements that were accepted
- Substation with new requirements that were refused
- Substation with no new requirement due to a lack of direct connection
- Substation with no new requirements due to a risk of transit constraint

Managing variability

New levers to manage network constraints (in transmission and distribution) in order to promote the integration of renewables

A flexibility consists in a **voluntary power modulation** of one or several energy production or consumption sites, either upwards or downwards, over a given period, in response to an external signal and with the aim of providing a service.

RTE and Enedis have been working for several years on implementing flexibilities to address **the massive arrival of renewable energies on the power grid**, with several use cases:

1 **Alternative technical solutions allowing for feed-in curtailment,**
To connect producers and end users to the grid both faster and cheaper. *(See next slide)*

These flexibilities form an individual means of action to improve connection times and/or costs for customers requesting them.

2 **Optimizing investments in the S3REnR schemes**
To connect more renewables and faster for the same amount of work. More additional renewable energy would be generated than the power lost to load shedding.
The NAZA (RTE) and Reflex (Enedis) projects fall within this framework.

3 **Optimizing the design and operation of power grids**
To avoid or postpone investments in the electricity networks, or as an alternative to resupply infrastructure, whether in anticipation or following an incident, or perhaps to avoid power cuts during construction.[1] In this use case, flexibility services are contracted out using market-based solutions.

These flexibilities form a collective means of action to improve connection times and/or costs, collectively.

1 Enedis site, Co-construire les flexibilités [Co-building flexibilities]

Wind power's contribution to balancing the electricity grid

Wind power, which now represents a larger share of the energy mix, is given an increased role in balancing the electricity mix

Installed wind farm capacity is growing very strongly and now accounts for a greater share in the energy mix. This gives it an enhanced role in balancing the electrical system on two levels:

1. Providing approaches for balancing supply and demand
2. Helping better anticipate the balancing of power output and consumption

Wind power's contribution to balancing the electricity grid

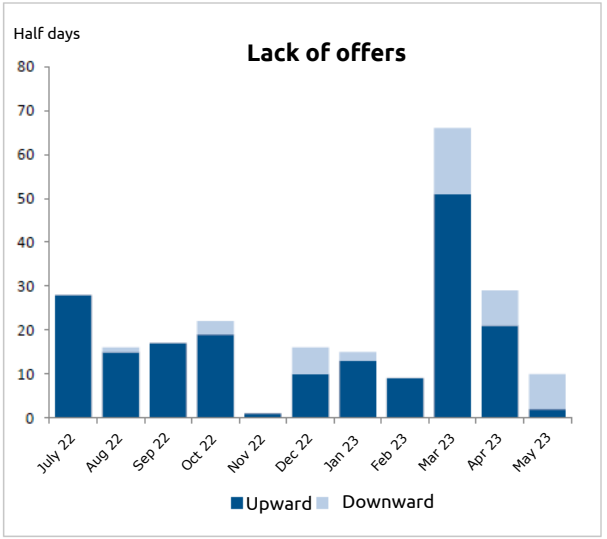
Approaches for balancing supply and demand

The French electricity system regularly faces a lack of mechanisms for downward adjustments of power supply and demand.

It is becoming crucial that wind power takes part in CRE's Adjustment Mechanism (*mécanisme d'ajustement*) a **supplemental reserve** that currently only concerns a total of 70 MW.

As for RTE's *services système fréquence*, the **grid's primary and secondary reserves**, installations subject to declared net capacity are required by law to offer an amount of power that is at least equal to their switchyard output on reserve markets as an ancillary service.

This rule now applies to certain wind farms and must give rise to collaboration with RTE in order to specify the appropriate certification measures.



Wind power's contribution to balancing the electricity grid

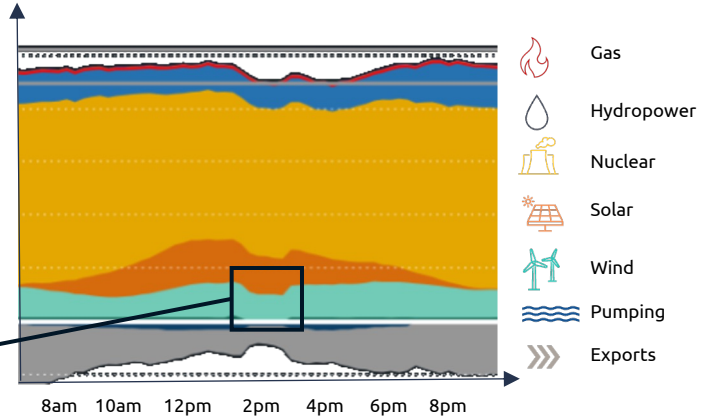
Better anticipating the balancing of power output and consumption

Wind production is no longer only determined by weather, but also by environmental constraints, market context, etc.

For example, renewable energy curtailment coupled with income derived from **negative spot prices** is becoming increasingly frequent and extended.

Increased comprehensiveness and reliability in day-ahead scheduling for renewable energy generation systems is becoming essential to enable RTE to anticipate supply and demand balancing and apply the relevant tools to regulate the grid.

Date	Duration	Times	Estimated curtailed wind output (wind + PV)
Sat 20 May	1 h	2pm-3pm	2,800 MW
Sun 21 May	6 h	11am-5pm	2,400 MW
Sat 27 May	3 h	1pm-4pm	3,100 MW
Sun 28 May	8 h	10am-6pm	3,400 MW
Mon 29 May	7 h	10am-5pm	4,400 MW
Sat 3 June	4 h	12pm-4pm	3,100 MW
Sun 4 June	4 h	12pm-4pm	3,100 MW
Sun 11 June	4 h	1pm-5pm	2,300 MW
Sun 25 June	2 h	1pm-3pm	3,000 MW



Electricity production by source on 20 May 2023 (*Eco2 mix RTE*)

The electricity production curve by source on 20 May 2023 illustrates how curtailed wind output enabled a **rebalancing of the electricity system** during a period of negative prices.

Grid integration – Innovation

Power utilities are investing in long-term R&D projects to develop a grid capable of accommodating increasing volumes of renewable energies

Enedis and RTE are involved in ambitious long-term research projects and have close links with stakeholders in the regions and various partners (manufacturers, SMEs, start-ups, universities and laboratories) in order to collaborate on the construction of the electricity grid of the future..

R&D budgets related to the energy transition:

- **RTE:** €90m of Turpe 6's €160m from 2021 to 2024
- **Enedis:** €130m of its €227m R&D budget from 2021 to 2024

Partnerships – what's new:

- Renewal of the agreement with **France Énergies Marines**
- Setting up a partnership with CEA on new approaches to managing the electrical system that is conducive to renewable energy integration
- Partnership on biodiversity with the **Paris Museum of Natural History**, with whom RTE is undertaking the SPECIES (Submarine Power Cables Interactions with Environment and associated Surveys) project

- Continued partnership with **Grenoble INP** and the cross-disciplinary AI institute of Grenoble, **MIAI Grenoble-Alpes**, in particular on the integration of renewables and operating and managing smart grids
- Partnership with **Datastorm** to better adjust renewable energy production forecasts and their impact on flows at different levels.

CAP R&D – RTE's R&D roadmap

In 2021, RTE confirmed its 2021–2024 R&D roadmap, which aims to prepare the electrical system for the changes required to achieve carbon neutrality by 2050
It is available on the following institutional website:
Feuille_de_route_RTE_RD_2021-2024

Many aspects of this roadmap relate to the integration of renewable energies: sizing the grid optimally by leveraging high-performance controllers, ensuring the operating stability of a system that is largely modified by the power electronics inherent in renewable energies and addressing the challenges of short-term forecasts, safety margins as well as offshore grid connection.. All the solutions addressing these challenges are examined from a technical, economic and environmental perspective.

Method: the projected work on RTE's R&D roadmap is shared annually with CRE and, also regularly, in the future, within the framework of the Commission on system and network perspectives (CPSR – *Commission perspectives système et réseau*).
Periodicity: annual.

ENEDIS: the consultation of distribution network stakeholders conducted by Enedis has made it possible to enhance and adjust its R&D program ahead of the TURPE6 period

Renewable hydrogen

Interview with Dominique Darne, President of the REI Inthy Group

What is hydrogen used for?

Primarily used for industrial applications, hydrogen is also employed as fuel, gas or a means of energy storage. It is considered carbon-free when produced through water electrolysis using decarbonized or renewable electricity.

For example, hydrogen can be produced from wind electricity (from onshore or offshore wind).

With its "France 2030" plan, France has set the objective of installing **6.5 GW of electrolysis capacity by 2030**, resulting in the production of 600 kt per year of carbon-free hydrogen.[1]

"With the rise in energy prices, hydrogen produced locally from renewable electricity represents an opportunity for territories and local authorities. "

Dominique Darne – President of the REI Inthy Group

Focus on Inthy – French hydrogen player

Inthy is a company that grows several business lines:

- Development of renewable energy generation projects (in PV and wind), in part to fuel the production of hydrogen intended for heavy vehicle fleets in passenger (buses) and freight transportation (lorries).
- Carbon-free freight transport service in the form of Mobility as a Service
- Hydrogen logistics and distribution
- Smart optimization systems

Sources: [1] French government | France 2030

Storage

Interview with Xavier Romon, Executive Director of Club Stockage d'énergies

What is the purpose of storage?

Storage offers **maximum adjustment** possibilities, helps avoid overproduction and contributes to **decarbonizing** the electricity system. Storage systems can be coupled with wind power (hybridization) or directly connected to the grid.

By storing surplus electricity during production peaks, or by injecting power into the grid during high demand periods, storage offers complementary operation with wind power.

~5 GW[1] installed capacity of pumped-storage hydropower stations in 2022

~500 MW:[2] installed capacity of stationary (lithium-ion) batteries in 2022

Storage-related innovations are flourishing, with technologies including pumped hydro, sodium batteries, zinc-air batteries and lithium-air batteries.

"Storage is the ultimate solution for active management, as it generates benefits for power generation, electricity and the grid. "

Xavier Romon – Executive Director of Club Stockage d'énergies

Sources: FEE

Smart Grids

Interview with Régis le Drézen, Executive Director of Think Smartgrids

What are smart grids used for?

Smart grid technologies use sensors, information technology and communications systems to optimize the entire electrical system, make it more flexible and smarter and thus:

- ✓ Enable the electrification of end uses
- ✓ Accelerate the roll-out of renewable energies
- ✓ Optimize the flows of electricity delivered through the grid thanks to active management of energy generation and use

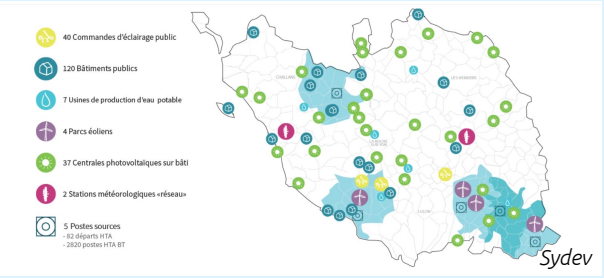
20 to 70 GW in need for flexibilities by 2050[1]

> "The millions of electric vehicle batteries connected to the grid will represent an opportunity for managing renewable energy production sources."

Focus on the Smart Grid Vendée project (2013–2018)

This smart grids demonstrator was used to test at scale the so-called "alternative technical solutions" connecting wind and PV farms on existing feeders without any strengthening of the grid in return for th possibility of feed-in curtailment at the margin.

This project enabled ENEDIS to develop a new way of connecting renewable energy sources to the grid that is both faster and cheaper f the project owner.



Source: [1] According to RTE's Energy Future report (Futur Énergétique, page 17), depending on the share of renewable energy in the French electricity mix

Recycling foundations

Interview with Antea Group, FEDRE project lead – Sustainable Wind Turbine Foundations and Repowering

FEDRE is a collaborative research project, led by Antea Group, that aims to find **innovative solutions to make use of part of the foundations from turbines that are being dismantled** as part of repowering projects.

Today's new, more powerful turbines require more massive foundations. The solution developed by Antea Group and its partners consists of **deconstructing only part of the foundation when replacing a turbine in order to build a new footing on top.** As a result, there is no need to completely deconstructing the previous foundation and this reduces the amount of reinforced concrete required for the new foundation.

~20 years: average service life of a turbine

~25% reinforced concrete saved according to

"Our main objective is to reduce the environmental impact of wind turbine foundations"

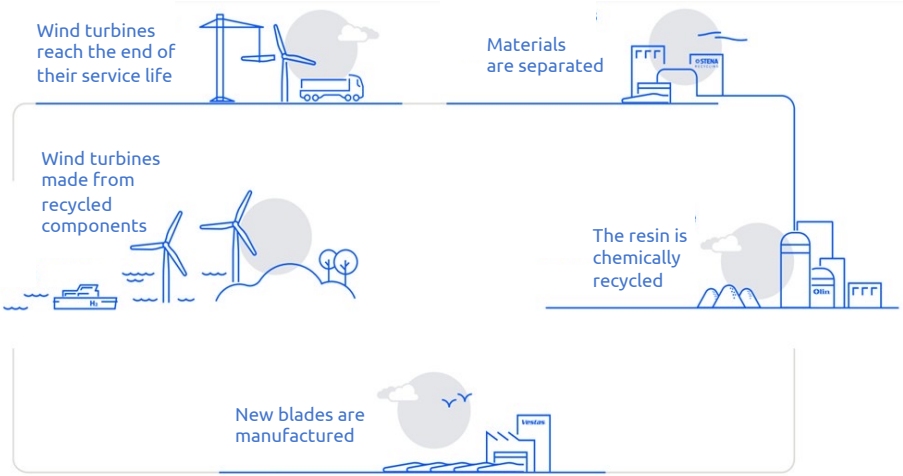
Eric Antoinet, Technical Director for Infrastructure – Antea Group

1/10 scale model of a foundation. Tests carried out at INSA Lyon.

A major innovation for the recycling of existing and future blades

Vestas

Currently, **wind turbines are approximately 93% recyclable**, and their various components can be recovered separately. Blades made of composite materials are the most complex components to recycle.



In order to achieve a **recycling rate of 100%**, Vestas has developed a new circular solution for recycling blades made of epoxy resin, which does not require any change in the design or composition of the blades. Bringing together a chemical technology that was recently discovered within the CETEC project and partner technologies from Olin and Stena Recycling, **this solution can be applied to the epoxy resin blades that are currently in service as well as to future blades.**

This solution makes it possible to **separate materials** and **reuse** the resin in new wind turbine blades, thus making the process circular.

Optimizing wind farm performance

Interview with Sereema, Windfit project lead – Wind farm optimization platform

Sereema's flagship project, Windfit, is a revolutionary platform for optimizing the operation of wind farms. It allows both to **monitor the overall performance of a fleet and to obtain detailed diagnostics for each turbine**.

It brings together advanced data analytics, IoT sensors and a portal to improve asset profitability and lifespan.

Over 600 turbines have been monitored over the past 12 months, for a total exceeding 1.5 GW.
In addition to optimizing wind farms, our company has created 10 jobs.

"We are a carbon negative company. Over the past year, our diagnostics have helped avert the emission of over 2,000 tonnes of CO_2 equivalent.

We have enabled an additional 8 GWh of power to be produced in 2022 without any additional wind turbines. "

Sereema

Future prospects

Expanding our offering to provide a specific response to the challenges faced by each type of wind farm owner.

Initiating a new phase of technological development in order to meet the future requirements of wind turbines, which will become interactive machines capable of adapting to their environment.

Expanding and strengthening of our presence in Europe (in both onshore and offshore wind)

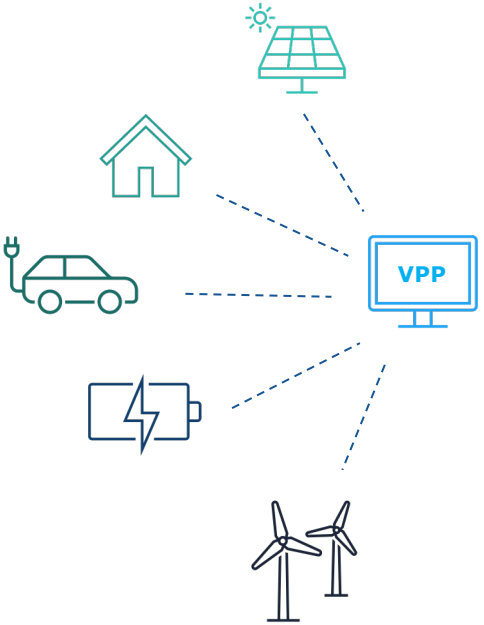
Virtual power plants (VPPs)

Focus on a new approach to managing renewables

What is a VPP?

A virtual power plant is a **grouping of a variety of distributed generation and storage resources** (solar, wind, storage, flexible distributed energy resources such as electric cars) coordinated by a single system. The electricity is then sold to the market and distributed to the grid, typically through an aggregator.

- **Improved active management** of renewable energy sources
- Electricity sales at the appropriate time based on market prices
- Adaptation of power generation to electricity consumption



Our convictions

1. **Consolidate a legal and regulatory framework** that will streamline project implementation timeframes and make them align with European standards

2. **Enhance clarity and ambition** in outlining development goals for 2030 and 2035

3. **Ensure a stable economic environment** for renewables capable of effectively responding to shifting economic circumstances

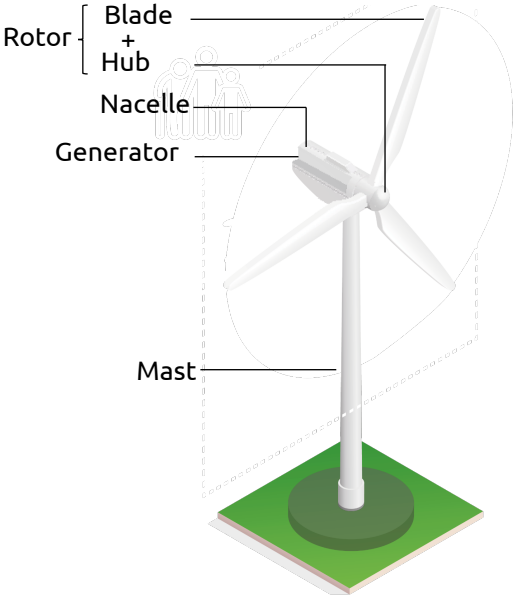
4. **Foster an enabling approach** between the renewables industry, government agencies and local authorities

These four prerequisites are key to successfully reducing fossil fuel use through the electrification of end uses.

Appendixes

How wind turbines operate

Wind turbines transform the kinetic energy of the wind into electrical power



The force of the wind is captured by the blades of the wind turbine…

…which then spin at between 10 to 25 revolutions per minute, which, in turn, spins the rotor, which is connected to the main shaft.

In the nacelle, the generator converts the movement of the rotor into electricity.

This electricity is then converted before being fed into the network through underground cables.

Source: L'éolien en 10 questions [Wind power in 10 questions], ADEME

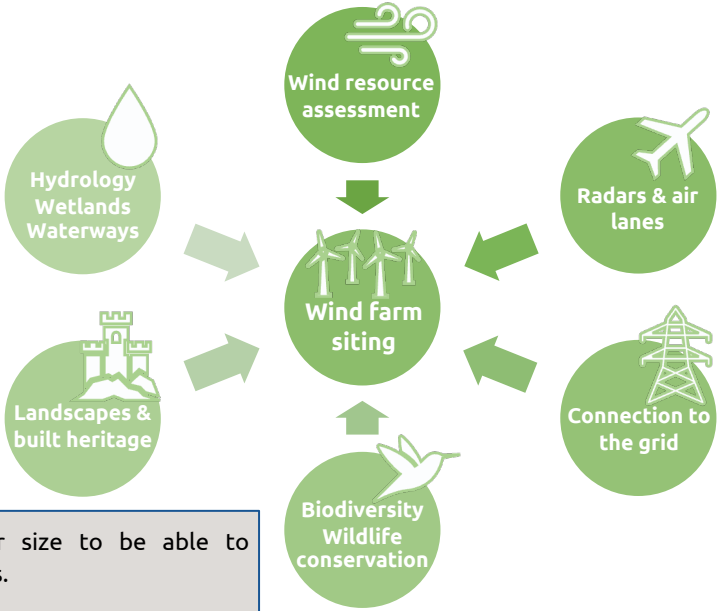
Selection criteria for the location of wind farms

Wind resource assessments are critical to confirm site suitability

The wind, a source to be mastered

The efficiency of wind turbines depends on wind speed and frequency. A site with winds averaging 30 km/h will be approximately eight times more productive than another site with winds averaging 15 km/h. In France, a project is considered economically interesting when the annual average speed at the site is around 21 to 25 km/h.

Other criteria are also taken into account, such as the capacity of the soil to support the foundations and the connection to the power grid.



Wind turbines must aim for an optimal rotor size to be able to capture winds that are both strong and continuous.

The larger the diameter of the rotor (5 and 6), the more energy is captured.

Source: Le parc et l'éolien [Wind power in the natural park], Parc naturel régional Loire-Anjou-Touraine

The French wind power market in Europe: grid-connected capacity and share of the electricity mix

Europe's wind energy sector continues to grow, with strategies that differ for offshore and onshore wind in different countries

TABLE 1. New additions, total wind capacity and the share of wind in the electricity demand in 2022 [2] [3]

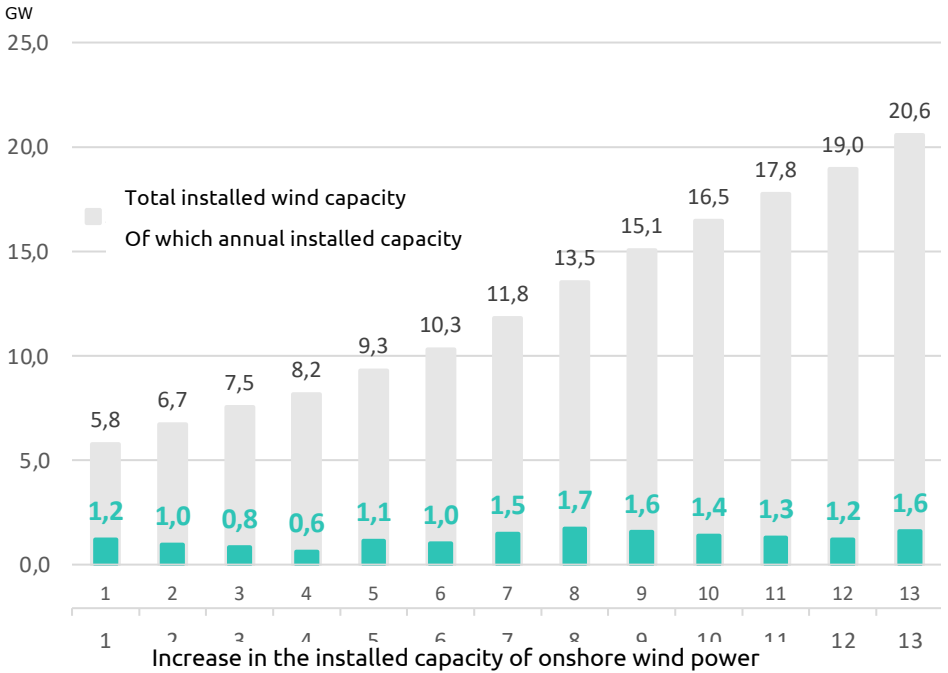
	New installations in 2022 (MW)			Cumulative capacity (MW)			Share of wind in power mix in 2022		
EU-27	**Onshore**	**Offshore**	**Total**	**Onshore**	**Offshore**	**Total**	**Onshore**	**Offshore**	**Total**
Austria	328	-	**328**	3,586	-	**3,586**	12%	-	**12%**
Belgium	303	-	**303**	3,045	2,261	**5,306**	5%	8%	**13%**
Bulgaria	-	-	**-**	707	-	**707**	4%	-	**4%**
Croatia	-	-	**-**	1,100	-	**1,100**	13%	-	**13%**
Cyprus	-	-	**-**	158	-	**158**	6%	-	**6%**
Czechia	-	-	**-**	337	-	**337**	1%	-	**1%**
Denmark	131	-	**131**	4,974	2,308	**7,282**	31%	25%	**55%**
Estonia	-	-	**-**	320	-	**320**	8%	-	**8%**
Finland	2,430	-	**2,430**	5,607	71	**5,678**	14%	-	**14%**
France	1,590	480	**2,070**	20,653	482	**21,135**	8%	-	**8%**
Germany	2,403	342	**2,745**	58,267	8,055	**66,322**	21%	5%	**26%**
Greece	230	-	**230**	4,682	-	**4,682**	19%	-	**19%**
Hungary	-	-	**-**	329	-	**329**	1%	-	**1%**
Ireland	280	-	**280**	4,612	25	**4,637**	34%	-	**34%**
Italy	496	30	**526**	11,818	30	**11,848**	7%	0%	**7%**
Latvia	59	-	**59**	137	-	**137**	3%	-	**3%**
Lithuania	69	-	**69**	740	-	**740**	12%	-	**12%**
Luxembourg	29	-	**29**	166	-	**166**	-	-	**-**
Malta	-	-	**-**	-	-	**-**	-	-	**-**
Netherlands	933	369	**1,302**	6,223	2,829	**9,052**	12%	7%	**19%**
Poland	1,517	-	**1,517**	7,864	-	**7,864**	11%	-	**11%**
Portugal	28	-	**28**	5,671	25	**5,696**	26%	0%	**26%**
Romania	-	-	**-**	3,029	-	**3,029**	12%	-	**12%**
Slovakia	-	-	**-**	3	-	**3**	0%	-	**0%**
Slovenia	-	-	**-**	3	-	**3**	0%	-	**0%**
Spain	1,659	-	**1,659**	29,793	5	**29,798**	25%	-	**25%**
Sweden	2,441	-	**2,441**	14,393	192	**14,585**	25%	-	**25%**
Total EU-27	**14,927**	**1,221**	**16,148**	**188,216**	**16,283**	**204,499**	**14%**	**2%**	**16%**

	New installations in 2022 (MW)			Cumulative capacity (MW)			Share of wind in power mix in 2022		
Others	**Onshore**	**Offshore**	**Total**	**Onshore**	**Offshore**	**Total**	**Onshore**	**Offshore**	**Total**
Albania	-	-	**-**	-	-	**-**	-	-	**-**
Belarus	-	-	**-**	3	-	**3**	-	-	**-**
Bosnia & Herzegovina	-	-	**-**	135	-	**135**	-	-	**-**
Faroe Islands	-	-	**-**	68	-	**68**	-	-	**-**
Iceland	-	-	**-**	3	-	**3**	-	-	**-**
Kosovo	-	-	**-**	137	-	**137**	-	-	**-**
Liechtenstein	-	-	**-**	-	-	**-**	-	-	**-**
Montenegro	-	-	**-**	118	-	**118**	-	-	**-**
North Macedonia	-	-	**-**	37	-	**37**	-	-	**-**
Norway	372	60	**432**	5,083	66	**5,149**	11%	-	**11%**
Russia	-	-	**-**	2,043	-	**2,043**	-	-	**-**
Serbia	-	-	**-**	374	-	**374**	-	-	**-**
Switzerland	-	-	**-**	87	-	**87**	0%	-	**0%**
Turkey	867	-	**867**	11,969	-	**11,969**	11%	-	**11%**
UK	502	1,179	**1,681**	14,575	13,918	**28,493**	12%	15%	**28%**
Ukraine	-	-	**-**	1,673	-	**1,673**	-	-	**-**
Total others	**1,741**	**1,239**	**2,980**	**36,305**	**13,984**	**50,289**	**-**	**-**	**-**
Total Europe	**16,668**	**2,460**	**19,128**	**224,521**	**30,267**	**254,788**	**14%**	**3%**	**17%**

Source: WindEurope, "Wind energy in Europe in 2022"

Key figures of the wind energy sector in 2022

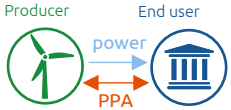
Installed capacity increased significantly in 2022



Source: RTE

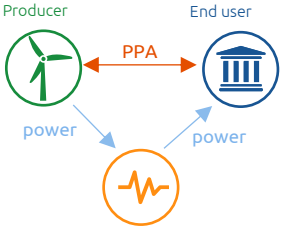
Corporate PPAs

There are several corporate PPA structures that leverage either new (greenfield) or existing (brownfield) assets



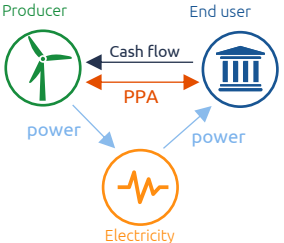
"On-site" physical

The electricity is delivered directly and physically to the consumer.



"Off-site" physical

An end user purchases electrical power from a producer and has it delivered by their utility (which also fills any remaining need).



Virtual

The end user enters into an agreement with a producer of green energy to provide additional remuneration based on the market price. There is no notion of physical delivery.

PPAs can be either **greenfield PPAs** (relating to new assets, such as wind or solar farms) or **brownfield PPAs** (based on existing assets), offering an alternative to standard feed-in tariffs. In the years to come, the wind power sector will potentially have assets to put on the **"brownfield" PPA market. The first greenfield wind PPA was signed in 2023.**

Source: Capgemini Invent

Value chain participants, by region

Value chain participants, by region

Auvergne-Rhône-Alpes

Key figures

2,622 jobs (+8% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
554	734	759	575

669 MW installed as at 30 June 2023

€5.2 million in tax revenue*

311 companies

Ain	**30** MW	Loire	**0** MW
Allier	**66** MW	Haute-Loire	**69** MW
Ardèche	**186** MW	Puy-de-Dôme	**51** MW
Cantal	**107** MW	Rhône	**12** MW
Drôme	**146** MW	Savoie	**0** MW
Isère	**3** MW	Haute-Savoie	**0** MW

Top 10 wind job employers

1. OMEXOM
2. ANDRÉ LAURENT
3. Schneider Electric
4. GE
5. ENGIE Ineo
6. SPIE
7. BORALEX
8. NTN
9. 2W
10. Bodycote

Top 10 operators

1. BORALEX
2. EDF renouvelables
3. WPO
4. ENGIE Green
5. RES
6. valeco
7. EOS HOLDING
8. CNR
9. TotalEnergies
10. NEOEN

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Auvergne-Rhône-Alpes region:

CNR, SEPALE, INNEREX, EOLICA, egis, SOFIVA ENERGIE, NTN, heliopales, TRELLEBORG, sse Renewables, Greenvolt Power, CHOMARAT, 2W

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Value chain participants, by region

Bourgogne–Franche-Comté

Key figures

1,007 jobs (+12% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
238	378	372	19

1,002 MW installed as at 30 June 2023

€7.8 million in tax revenue*

160 companies

Côte-d'Or	**349** MW	Territoire de Belfort	**0** MW
Doubs	**168** MW	Yonne	**385** MW
Haute-Saône	**18** MW		
Jura	**18** MW		
Nièvre	**52** MW		
Saône-et-Loire	**12** MW		

Top 10 wind job employers

1. ENGIE Ineo
2. Schneider Electric
3. Prysmian Group
4. GEOTEC
5. r. bourgeois
6. MSB
7. alsecco
8. CONNECTED WIND SERVICES
9. openR
10. A.E.2.I

Top 10 operators

1. res
2. VSB
3. ENGIE Green
4. WPO
5. wpd think energy
6. EDF renouvelables
7. NEOEN
8. VOLKSWIND
9. EOS HOLDING
10. CGN

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Bourgogne-Franche-Comté region:

TAUW, MSB, r. bourgeois, alsecco, A.E.2.I, opale, openR, DeltaBox, ANEMOS FRANCE

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Value chain participants, by region

Brittany

Key figures

1,329 jobs (+10% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
545	199	361	224

1,305 MW installed as at 30 June 2023

€10.2 million in tax revenue*

206 companies

Côtes-d'Armor	**483** MW
Finistère	**220** MW
Ille-et-Vilaine	**158** MW
Morbihan	**444** MW

Top 10 wind job employers

1. HTMS
2. SAIPEM
3. MARC
4. SANDEN
5. KOHLER SDMO
6. IBERDROLA
7. P&T TECHNOLOGIE
8. SIEMENS Gamesa RENEWABLE ENERGY
9. EIFFAGE ÉNERGIE SYSTÈMES
10. LANGA

Top 10 operators

1. ENGIE Green
2. edp Renewables
3. BORALEX
4. EDF renouvelables
5. TotalEnergies
6. VALEMO operation & maintenance
7. Kallista energy
8. BayWa r.e.
9. VSB
10. wpd think energy

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Brittany region:

GROUPE NASS&WIND · P&T TECHNOLOGIE · GTM OUEST · François Beuzit · IEL · Quénéa · ACOUSTIBEL

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Value chain participants, by region

Centre-Val de Loire

Key figures

658 jobs (+6% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
222	71	248	117

1,671 MW installed as at 30 June 2023

€13.1 million in tax revenue*

108 companies

Cher	**268** MW	Loir-et-Cher	**55** MW
Eure-et-Loir	**797** MW	Loiret	**227** MW
Indre	**324** MW		
Indre-et-Loire	**0** MW		

Top 10 wind job employers

1. VERGNET
2. Vestas
3. anteagroup
4. NORDEX
5. KONECRANES
6. Stromag – Altra Industrial Motion
7. ABO WIND
8.
9. HUTCHINSON
10. RONIS

Top 10 operators

1. WPO
2. edp renewables
3. EDF renouvelables
4. VALEMO operation & maintenance
5. VOLKSWIND
6. BORALEX
7. ERG
8. VSB energies nouvelles
9. CNR
10. Kallista energy

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Centre-Val de Loire region:

VERGNET, ZEPHIR, anteagroup, Guerton newlgroup, SKY WORK travaux sur cordes, Imagin'ER

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Value chain participants, by region

Grand Est

Key figures

1,927 jobs (+7% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
488	408	688	343

4,756 MW installed as at 30 June 2023

€37.2 million in tax revenue*

275 companies

Ardennes	**671** MW	Moselle	**362** MW
Aube	**1,025** MW	Bas-Rhin	**43** MW
Marne	**1,347** MW	Haut-Rhin	**0** MW
Haute-Marne	**503** MW	Vosges	**81** MW
Meurthe-et-Moselle	**170** MW		
Meuse	**554** MW		

Top 10 wind job employers

1. Schneider Electric
2. SPIE
3. Pertuy Construction
4. Venathec
5. Gantois Industries
6. Vestas
7. GHM
8. OMYA
9. CPE Energies
10. SERMES La solution électrique maîtrisée

Top 10 operators

1. ENGIE Green
2. EDF renouvelables
3. TotalEnergies
4. energie TEAM
5. res
6. VALEMO operation & maintenance
7. NEOEN
8. WPO
9. BORALEX
10. BayWa r.e.

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Grand Est region:

SERMES La solution électrique maîtrisée, OMYA, VENT D'EST, Windvision, SUPAIRVISION WIND TURBINE SERVICES BY DRONE, VENATHEC, URANO, CALYCÉ DEVELOPPEMENT

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Value chain participants, by region

Hauts-de-France

Key figures

2,637 jobs (+8% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
634	512	884	607

5,814 MW installed as at 30 June 2023

€45.5 million in tax revenue*

264 companies

Aisne	**1,262** MW
Nord	**398** MW
Oise	**605** MW
Pas-de-Calais	**1,404** MW
Somme	**2,145** MW

Top 10 wind job employers

1. DILLINGER
2. CELTIC LEVAGE
3. DUFOUR
4. SPIE
5. cetim
6. h2air
7. Vestas
8. SEL Groupe
9. BORALEX
10. MERSEN

Top 10 operators

1. energie TEAM
2. ENGIE Green
3. BORALEX
4. EDF renouvelables
5. ENERTRAG
6. eurowatt
7. CNR
8. VOLKSWIND
9. OSTWIND
10. WPO

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in Hauts-de-France region:

h2air, BORALEX, RP GLOBAL RENEWABLE POWER, ESG, windmanager, KDE ENERGY FRANCE, innovent, ESCOFI, VERSPIEREN, POWEEND

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Value chain participants, by region

Île-de-France

Key figures

6,657 jobs (+3% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
3,562	657	1,458	980

109 MW installed as at 30 June 2023

€0.9 million in tax revenue*

424 companies

Paris	0 MW	Val-de-Marne	0 MW
Seine-et-Marne	57 MW	Val-d'Oise	0 MW
Yvelines	17 MW		
Essonne	35 MW		
Hauts-de-Seine	0 MW		
Seine-Saint-Deni s	0 MW		

Top 10 wind job employers

1. EDF renouvelables
2. RTE
3. RWE
4. GE Energy
5. HUTCHINSON
6. NORDEX
7. edp renováveis
8. CGN Europe Energy
9. GSM HEIDELBERGCEMENT Group
10. Holcim

Top 5 operators

1. VALEMO operation & maintenance
2. CGN
3. energie TEAM
4. WPO
5. BayWa r.e.

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Île-de-France region:

GE Grid Solutions, eurowatt, NEOEN, SYNERIA, SIEMENS Gamesa RENEWABLE ENERGY, Naturgy, ARTELIA, ERG, VOLKSWIND, élicio, Greensolver creating value, IFP Energies nouvelles, skyborn, terr.a, OW, BKW

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Value chain participants, by region

Normandy

Key figures

2,915 jobs (+27% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
268	2,024	331	291

1,032 MW installed as at 30 June 2023

€8.1 million in tax revenue*

152 companies

Calvados	**169** MW
Eure	**106** MW
Manche	**141** MW
Orne	**52** MW
Seine-Maritime	**564** MW

Top 10 wind job employers

1. Bouygues Travaux Publics
2. LM Wind Power
3. Siemens Gamesa Renewable Energy
4. Schneider Electric
5. Bolloré Transport & Logistics
6. Engie Green
7. énergie environnement
8. Nordex
9. Euclyd Eurotop
10. vensolair

Top 10 operators

1. Engie Green
2. energie TEAM
3. Kallista energy
4. edp renováveis
5. wpd think energy
6. Boralex
7. EDF renouvelables
8. VSB
9. CNR
10. Valemo operation & maintenance

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Normandy region:

énergie environnement · les 7 vents · Fondouest Élément Terre · Nollet · everoze · Orféa acoustique

**Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)*

Value chain participants, by region

Nouvelle-Aquitaine

Key figures

1,448 jobs (+12% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
550	161	584	153

1,783 MW installed as at 30 June 2023

€13.9 million in tax revenue*

285 companies

Charente	**246** MW	Landes	**0** MW
Charente-Maritime	**326** MW	Lot-et-Garonne	**0** MW
Corrèze	**16** MW	Pyrénées-Atlantiques	**0** MW
Creuse	**100** MW	Deux-Sèvres	**565** MW
Dordogne	**0** MW	Vienne	**390** MW
Gironde	**0** MW	Haute-Vienne	**140** MW

Top 10 wind job employers

1. Valorem
2. Eurovia
3. Nidec – All for dreams
4. Epsilon Composite
5. Volkswind France SAS
6. Encis énergies vertes
7. Vestas
8. Fonderie du Poitou Fonte
9. Eiffage Énergie Systèmes
10. Cap Ingelec

Top 10 operators

1. Volkswind
2. BayWa r.e.
3. Valemo operation & maintenance
4. Encavis
5. EDF renouvelables
6. wpd think energy
7. Engie Green
8. WPO
9. Enertrag
10. res

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in Nouvelle-Aquitaine region:

Valemo · Cap Ingelec · MCM · Singulair · Eolise · nca environnement

**Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)*

Value chain participants, by region

Occitanie

Key figures

2,796 jobs (+10% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
1,315	151	827	503

1,706 MW installed as at 30 June 2023

€13.3 million in tax revenue*

283 companies

Ariège	**0** MW	Hérault	**273** MW
Aude	**463** MW	Lot	**6** MW
Aveyron	**395** MW	Lozère	**90** MW
Gard	**11** MW	Hautes-Pyrénées	**0** MW
Haute-Garonne	**45** MW	Pyrénées-Orientales	**174** MW
Gers	**0** MW	Tarn	**249** MW
		Tarn-et-Garonne	**0** MW

Top 10 wind job employers

1. Vestas
2. Bouygues Travaux Publics
3. EDF renouvelables
4. valeco
5. ENGIE Ineo
6. Razel-Bec
7. ENERCON
8. Augizeau
9. apexenergies
10. Baurès Profilans

Top 10 operators

1. EDF renouvelables
2. valeco
3. ENGIE Green
4. res
5. TotalEnergies
6. VALEMO operation & maintenance
7. edp Renewables
8. BORALEX
9. ENERTRAG
10. VSB

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Occitanie region:

8.2 | The Experts in Renewable Energy · VSB · Ingeteam · my wind parts · valeco · elys · eoltech · apexenergies · energiter · biotope · Qair · biotope · éolissun

**Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)*

Value chain participants, by region

Pays de la Loire

Key figures

3,151 jobs (+23% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
719	720	637	1075

1,782 MW[1] installed as at 30 June 2023

€13.9 million in tax revenue*

235 companies

Loire-Atlantique	**975** MW[1]
Maine-et-Loire	**226** MW
Mayenne	**197** MW
Sarthe	**85** MW
Vendée	**299** MW

[1]including the Saint-Nazaire offshore wind farm

Top 10 wind job employers

1. GE
2. Chantiers de l'Atlantique
3. Defontaine
4. RTE
5. ENGIE Ineo
6. Charier
7. BayWa r.e.
8. AMS Atlantique Maritime Services
9. Maier Engineering
10. GRETA CFA

Top 10 operators

1. EDF renouvelables
2. energie TEAM
3. CNR
4. wpd think energy
5. ABO WIND
6. VSB
7. ENGIE Green
8. VALEMO operation & maintenance
9. WPO
10. TotalEnergies

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Pays de la Loire region:

SAB Energies Renouvelables, abei Energy, Planeta, WKN France, Chantiers de l'Atlantique, Maier Engineering, Defontaine, david énergies, AMS Atlantique Maritime Services

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Value chain participants, by region

Provence-Alpes-Côte d'Azur

Key figures

989 jobs (+12% compared to 2021)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
420	169	308	92

120 MW installed as at 30 June 2023

€0.9 million in tax revenue*

163 companies

Alpes-de-Haute-Provence	**0** MW
Hautes-Alpes	**0** MW
Alpes-Maritimes	**0** MW
Bouches-du-Rhône	**38** MW
Var	**60** MW
Vaucluse	**22** MW

Top 10 wind job employers

1. BW ideol
2. FONDASOLUTIONS
3. Qenergy
4. voltalia
5. DNV·GL
6. res
7. MEDIACO
8. Principle Power
9. SIEMENS Gamesa RENEWABLE ENERGY
10. IBERDROLA

Top 5 operators

1. CNR
2. BayWa r.e.
3. WPO
4. VSB
5. ENGIE Green

NB: Figures as of June 2023, except for EDF and Neoen (2022)

The following companies have their headquarters in the Provence-Alpes-Côte d'Azur region:

tenergie · BW ideol · juwi · FONDASOLUTIONS · Gaïa Energy SYSTEMS · TRANSCAUSSE WORLDWIDE LOGISTICS · NGE

Based on the following calculation: 1 MW = €7,820 in tax revenues (following IFER standards)

Wind energy training programmes

Zoom on the Vestas campus

The Vestas campus opened its doors in 2021 with the aim of providing students with training to become advanced technicians in **wind power maintenance**. The particular interest of this co-op program is that it is particularly geared towards **early school leavers and young adults seeking job retraining** from throughout the country. Vestas emphasizes human skills, teamwork, learning ability, autonomy and initiative.

Prerequisites

- **Training:** Technical baccalaureate (maintenance, automobile mechanics, electrical engineering) or CAP (vocational qualification)/BEP (occupational studies)
- Driving licence
- Elementary English

Skill set developed

- Mechanics
- Electricity
- Hydropower
- 70% on the field
- 30% on campus
- GWO Certification

Cohorts

1st cohort (2021–2022): 7 hires on permanent contracts out of the 9 students

Followed by two cohorts per year

Location

- **Theoretical background:** Reims (51)
- **Practical training:** on the various wind farms in Troyes (10), Langres (52), Reims (51), Nancy (54), or Saint Quentin (59) – at the student's choice

Permanent or professionalization contracts

- 12-month interim professional training contracts through temporary staffing company ADECCO.
- 3-week *ad hoc* training for job seekers under the POEC scheme with the support of the national employment agency, Pôle Emploi
- At the end of the training programme, VESTAS offers long-term employment contracts if the prerequisites are met.

Wind energy training programmes

Zoom on the Nordex Academy

The Nordex Academy is based in Laon (02) since 2022 and comes in addition to other Nordex Group training centres around the world.

The training provided at the Nordex Academy complements the general training programmes already present in the region and allows Nordex France to ensure its maintenance technicians specialize in its products **from the moment they are hired and then throughout their career** (GWO training, electrical accreditations, technical training, OHS training). The **in-service training of its teams is a core practice of the Nordex Group** . The Nordex Academy is equipped with the full range of converters used in France and replicates all the communication interfaces of wind turbines in order to achieve ever greater efficiency and a training environment that is as close as possible to real conditions.

The centre is open to all Nordex Group employees from the Mediterranean region and, starting in 2024, training will also be offered to the group's customers and partners. The team of GWO instructors will be expanded next year to round off Nordex Academy's training portfolio and train nearly 500 people each year at the Nordex Academy.

Wind energy training programmes

Focus on the ENERCON training centres

Since September 2017, the wind turbine manufacturer Enercon has been operating a training centre for the whole country located in Le Meux (60). This 1,400 m² building accommodates 600 commissioning and maintenance technicians (Enercon staff and service providers) each year. A team of 5 trainers is present on site to provide training in electricity, mechanics and safety.

The centre is equipped with 2 platforms (Podest) intended for rescue training (from heights or from below) and to teach trainees how to use ladders with the required safety equipment. It also has 2 lifts to make trainees familiar with their general use and for evacuation drills, as well as a mock-up nacelle for training on UVM8/10 and C5-1L models and evacuation procedures, 3 e-modules consisting of a transformer and switchgear cabinets, etc.

Driving the industry forward

The industry is driven by a variety of stakeholders that can be grouped in three main types:

Competitiveness clusters

Clusters bringing together companies, research units, training facilities and public bodies around a field of activity that points towards a promising future.

Seven competitiveness clusters in wind power are currently active in France:

- PÔLE MER Bretagne Atlantique
- Technopole Brest-Iroise
- EMC2
- DERBI
- PÔLE MER Méditerranée
- Capenergies
- Tenerrdis

Clusters

Groupings of public and private stakeholders enabling knowledge transfers between those involved. Eight clusters involved in wind power have been identified in France.

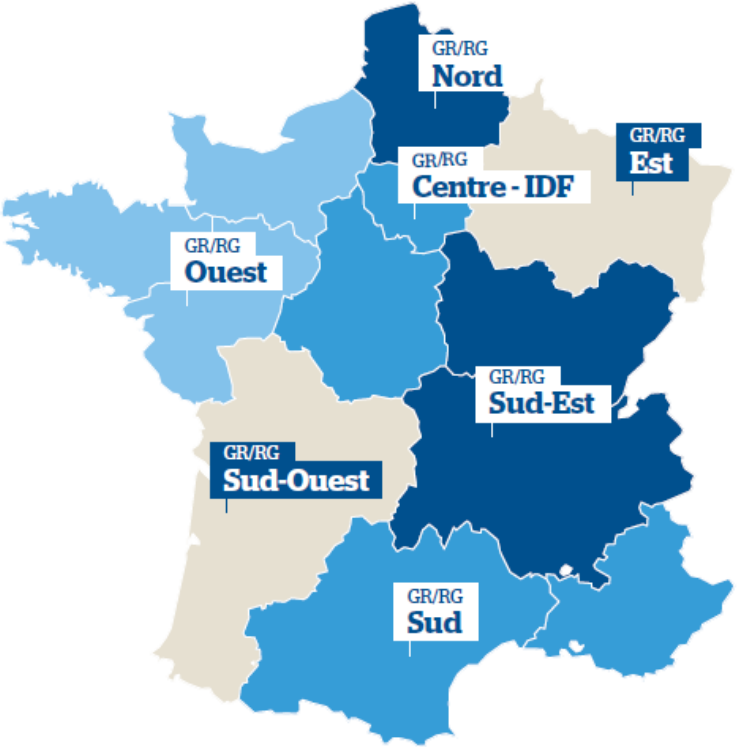
- Cluster Maritime Français (the French Maritime Cluster)
- MEDEE
- Ouest Normandie Énergies Marines
- France Énergies Marines
- Neopolia
- Technocampus Ocean, West Atlantic Marine Energy Center
- Cluster Eolien Aquitain
- CEMATER

Other relevant actors

Professional unions and federations that, like France Énergie Éolienne, bring together wind industry professionals:

- FNTP
- FNTR
- UFL
- Cluster Maritime Français (the French Maritime Cluster)
- Gimélec
- EVOLEN
- SER…

FEE facilitates the wind industry in the various regions thanks to its regional representatives (regional groups)



Driving the industry forward

Focus on FOWT, the world's largest event in floating offshore wind, co-hosted by FEE

Since 2013, Pôle Mer Méditerranée and the Marseille-Provence Chamber of Commerce and Industry have cohosted the Scientific and Technical Seminars of Floating Offshore Wind every year, thus fostering the emergence of the sector. The conference, renamed FOWT (Floating Offshore Wind Turbines) in 2016, is cohosted by France Énergie Éolienne.

FOWT has three ambitions: to accelerate the increase in the share of floating wind power in the global energy mix; to support the structuring of an ecosystem and to promote interactions between participants of the FOW value chain; and to turn FOWT into a showcase for international expertise of the floating offshore wind industry. **FOWT 2024 will be held from 24 to 26 April 2024 in Marseille**.

The 2023 edition of FOWT was held from 10 May to 12 May 2023 in Nantes.

Topics covered

Financing, regulatory framework, environmental impacts, technological innovations, industrial and marshalling issues, insurance, zoning, etc.

All these topics are covered during the seminars to help reveal the key issues related to the emergence and the industrialization of floating offshore wind in France and in the rest of the world.

The best in science & the best in technology

In order to ensure than the programme is relevant and diverse during the whole three days, the event committee launches a call for papers.

It should be noted that an Irish minister (Eamon Ryan) and 3 ambassadors (from Ireland, Norway and Denmark) took part in the event, among a total of 7 European delegations.

Key data on the event (2023 edition):

Four partner regions: The Occitanie region, the Sud-Provence-Alpes-Côte d'Azur region, Brittany and the Pays de la Loire region • More than 40 sponsors and industrial and institutional partners • 2 days of plenary conferences • 1,400+ participants • + 30 nationalities represented

Methodology

Job survey

- Questionnaires were sent out to all identified corporations and companies (in April to June)
- Survey of jobs at the company level

Installed capacity survey

- Survey of turbine manufacturers active in France regarding newly installed capacity (between 1 July 2021 and 30 June 2023). The "Top manufacturers & operators" list in the appendixes is based on this data.
- Survey of dismantling or repowering operations

Update of cumulative installed power

Maps

How the companies appearing on each regional map are selected:

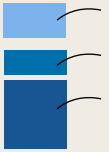
- **Top 10** wind job employers.
- Head offices of **companies with more than 5 FTEs that responded to the census.**

Estimated number of jobs

Breakdown of surveyed wind jobs by link in the value chain

1. Planning & Design
2. Component manufacturing
3. Engineering & Construction
4. Operations & Maintenance

For each link, estimate of the total number of jobs based on the number of jobs surveyed and their growth compared to the previous year



Companies that weren't surveyed in 2022: estimated data

Companies surveyed in 2022, but not in 2021: actual data

Companies surveyed in 2021 and 2022: actual data to establish a growth rate for estimated data

Photo credits

The credits below correspond to the photos provided by manufacturers for the Observatory*

Page	5	**Nordex**
Page	14	**Vestas**
Page	19	**Siemens Gamesa**
Page	29	**La Dépêche du Midi**
Page	29	**Binmeij.jp**
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Page	31	**Port La Nouvelle**
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* The other photos match the sources cited in the corresponding page or are royalty-free

France Énergie Éolienne's members

2.0
2W RH
3D ENERGIES
3E
8.2 FRANCE
ABCYSS FORMATION
ABEI ENERGY FRANCE
ABO WIND
ACAJOO ADVISORY
AD3R
ADE
ADI-NA (AGENCE DE DEVELOPPEMENT ET D'INNOVATION NOUVELLE)...
AEOLIA AUDIT ET CONSEIL
AGREGIO
ALEXIS ASSURANCES
ALPIC
ALPIQ ENERGIE FRANCE
ALTERRIC SARL
AM'EOLE GMBH
AMUNDI TRANSITION ENERGETIQUE
ANEMOS FRANCE SAS
ANTAL
ARHYZE
ARKEA BANK E&I
ARKOLIA ENERGIES SAS
ARTELIA
ATLANTIQUE MARITIME SERVICES
AUDDICE ENVIRONEMENT
AXPO SOLUTIONS AG
BAYWA R.E FRANCE
BCTG AVOCATS
BDO IDF
BENTAM
BILLAS AVENIR ENERGIE
BIODIV-WIND SAS
BIOSECO SA
BIOTOPE
BIRD & BIRD AARPI
BKW ENERGIE AG
BLUEFLOAT ENERGY HOLDINGS FRANCE SAS
BLUESIGN
BMEOL SARL
BMH AVOCATS
BORALEX
BPCE ENERGECO
BPI FRANCE FINANCEMENT
BRETAGNE POLE NAVAL
BRITTANY AVIATION
BUREAU VERITAS SERVICE FRANCE
BW IDEOL
BWTS FRANCE
CABINET BRUN CESSAC
CABINET RAVETTO ASSOCIES
CAISSE DES DEPOTS ET CONSIGNATIONS
CALYCE DEVELOPPEMENT
CEGELEC RENEWABLE ENERGIES
CEMATER
CEPS
CEZ FRANCE SAS
CGN EUROPE ENERGY
CMI TECHSI PASTOR
COLAS FRANCE
CONQUEST INVESTISSEMENTS
COPENHAGEN OFFSHORE PARTNERS A/S
CORIO GENERATION LIMITED
COVERWIND SOLUTIONS FRANCE
CREDIT AGRICOLE CIB
CREDIT AGRICOLE LEASING ET FACTORING
CREDIT INDUSTRIEL ET COMMERCIAL
CXC SL
DAVID ENERGIES SAS
DEKRA INDUSTRIAL SAS
DEMINETEC
DEMOPOLIS CONCERTATION SAS
DERASP
DERBI
DEUTSCHE WINDTECHNIK S.A.R.L
DIADES MARINE SAS
DLA PIPER FRANCE LLP
DLGA
DNV FRANCE SARL
DS AVOCATS
ECO DELTA
ECOLE CENTRALE NANTES
ECOSPHERE
EDPR FRANCE HOLDING
EES ENERGIE EOLIENNE SOLIDAIRE SAS
EFINOR ALLAIS
ELATOS
ELAWAN ENERGY FRANCE SAS
ELEC-ENR SASU
ELEMENTS SAS
ELICIO FRANCE
ELYS
EMERGYA WIND TECHNOLOGIES B.V.
ENBW FRANCE
ENCAVIS ASSET MANAGEMENT
ENCIS WIND
ENERCON GMBH
ENERCOOP SCIC - SA
ENERGIE EOLIENNE FRANCE
ENERGIE PARTAGEE ASSOCIATION
ENERGIES CITOYENNES EN PAYS DE VILAINE
ENERGIETEAM
ENERGITER
ENERGREEN PRODUCTION
ENERTRAG SE
ENERYO
ENESI SARL
ENGIE GREEN FRANCE
ENVINERGY TRANSACTIONS
ENVOL ENVIRONNEMENT
EO (EX SITE A WATTS DEVELOPPEMENT)
EOL-C
EOLE CERNON SAS
EOLE CONSTRUCTING
EOLEC
EOLFI
EOLICA
EOLISE SAS
EOLISSUN
EOLTECH
EOS WIND FRANCE
EPSILINE
EQOS ENERGIE LUXEMBOURG SARL
EQUINOR WIND POWER AS
ERCONSEIL
ERG FRANCE
ESA ENERGIES SAS
ESCOFI ENERGIES NOUVELLES
ESG ENERGY SERVICE GROUP
ETCHART GCM
EUROPEAN ENERGY FRANCE
EUROVIA MANAGMENT
EUROWATT DEVELOPPEMENT
EUROWATT SERVICES
EVEROZE
EWZ
EXPLAIN - LMP
EXUS FRANCE SAS
FEECRM
FIDAL
FILHET-ALLARD ET COMPAGNIE
FIPELEC
FMTC SAFETY
FONDEOLE
FRTE (TERRA ENERGIES)
GAIA ENERGY SYSTEMS
GAZEL ENERGIE SOLUTIONS
GDES WIND SAS
GE ENERGY SERVICES FRANCE
GEG ENR
GIDE LOYRETTE NOUEL AARPI
GIE QUALITE ENTREPRISES
GOTHAER
GOWLING WLG FRANCE
GP-JOULE FRANCE SARL
GREENCOAT RENEWABLES
GREENSOLVER
GREENVOLT POWER FRANCE S.A.S
GRETA-CFA DU MAINE
GRID SOLUTIONS SAS
H2AIR
HELIANTIS ENERGIES
HELIOPALES
HK LEGAL
HYDRONEXT
IBERDROLA FRANCE SAS
IDENTIFLIGHT
IEL DEVELOPPEMENT
IFOPSE
IFP ENERGIES NOUVELLES
IMAGIN'ERE
INDDIGO
INERSYS - SYSCOM
INNERGEX FRANCE SAS
IQONY WIND FRANCE S.A.S
IRIDA A.I. TECHNOLOGIES
JEANTET
JIGRID
JOHN COCKERILL
JP ENERGIE ENVIRONNEMENT
KALLIOPE
KDE ENERGY FRANCE
KJM CONSEIL SAS
LABORELEC SCRL
LANTHAN SAFE SKY
LERIA
LHYFE
LINKLATERS
LOCOGEN SAS
LOUIS DREYFUS ARMATEURS
LOXAM
LPA - CGR AVOCATS
LYCEE DHUODA
LYCEE SAINT FRANCOIS D'ASSISE
MAGREE SOURCE
MASER ENGINEERING
MD WIND
MENARD
METROL
MIROVA
MISTRAS
MW ENERGIES
NASS & WIND SAS
NATURAL FORCES RENEWABLES IRELAND
NATURAL POWER FRANCE
NATURGY RENOUVELABLES FRANCE SAS
NCA ENVIRONNEMENT
NEOTEK SAS
NET WIND
NORDEX FRANCE
NORIA
NORMANDIE ENERGIES
NORMANDIE MARITIME
NORTON ROSE FULBRIGHT LLP
NOTUS ENERGIE FRANCE SERVICES
NOUVERGIES
OBSTA
OCEAN WINDS
OMEXOM RENEWABLE ENERGIES OFFSHORE
GMBH
OMNES CAPITAL
OPALE DEVELOPPEMENT
OSTWIND INTERNATIONAL
OVP SOLUTIONS SAS
OX2 AB SUCCURSALE FRANÇAISE
P&T TECHNOLOGY SAS
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