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WIND OBSERVATORY 2022

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

September 2022

Op-ed

The post-COVID economic recovery, the war in Ukraine and the difficulties experienced by France's nuclear power installations since autumn 2021 have deeply impacted European energy markets. Average electricity prices that are **well above €200 per MWh, double-digit inflation for many essential raw materials** (including steel, aluminium, and copper), and **tensions over gas and electricity supplies** are threatening French and European sovereignty. Given their scale and their potential to destabilise the country, these historic challenges require responses that are both urgent and more structural.

Dealing with **inflation** is among the most pressing issues, as it disrupts the economic balance, as is the issue of **electricity supply**, as more MWh must be produced to ease the tension on prices.

Unlike other European countries, France has decided, very early on, to **shield households** by applying price caps. This has limited the rise in electricity prices to 4%, which was largely **financed by the additional tax revenue generated by renewable energy producers** (primarily in wind and solar). In its July report on public electricity service charges, the French energy regulator, CRE, estimates that this additional revenue amounted to **€8 billion**, **in addition to €7 billion in avoided costs, i.e. a total of €14 billion.**

On the supply side, approximately **5 GW's worth of wind projects are awaiting authorisation** despite the current situation and the understanding that there will likely be a chronic shortage in power over the three years from 2022 to 2025. It is now urgent to ensure that **the backlog in authorisations is rapidly cleared**, which most European countries are now working on, in order to accommodate the construction and commissioning of these additional capacities, which, alongside energy sobriety and solving the difficulties of existing nuclear power plants, will help alleviate the pressure on supply and demand, and therefore subsequently on prices.

Beyond these emergency measures, it is also essential to **learn from the current crisis** and take more structural measures, which we believe should include:

- **Energy planning** in a form that provides a medium to long-term development framework for all carbon-free energies, and wind power in particular, thereby resolutely moving towards the phasing out of fossil fuels;

- **Securing a French and European production base for components** used in the manufacturing and assembly of onshore and offshore wind turbines. Europe and France still have a wind power industry that is active within their territory. It is crucial to stand behind this sector and ensure it prospers in order to avoid coming under foreign tutelage, as is the case of many other industries, as was brought to light by the COVID crisis;

- Preparing companies, local authorities and stakeholders in the agricultural world to the **development of long-term renewable electricity purchase contracts**, and from wind power in particular, in order to supply them with electricity at prices that are guaranteed over the long term, which is key in ensuring their competitiveness, their budgetary balance and securing their investment capacity.

As I write these lines, parliamentary work on an upcoming acceleration law will soon begin and preparations are being made for the energy programming bill.

On behalf of our 360 industry members, I express the hope that these recommendations will be heard, so that our sector can play its full role in protecting the French nation against any shocks linked to fossil fuels, climate change and purchasing power.

Anne-Catherine de Tourtier

President of France Énergie Éolienne

Executive summary

Key figures for 2021

THE FRENCH POWER MARKET

2nd largest renewable

contributing to France's electricity generation[1]

19 GW

of wind power installed as of 31 Dec 2021[1]

+6.8% installed capacity compared to 2020

36.8 TWh

of electricity produced in 2021[1]

7.7%*

of France's electricity consumption in 2021[1]

JOBS IN THE WIND SECTOR

No. 1 employer

among renewables in France[2]

25,500 jobs

in wind power at the end of 2021[3]

+12.8% compared to 2020

COSTS AND REVENUES

€67.5 per MWh

the average cost of wind electricity in the latest call for tenders (AO10)[4]

€8 billion

of net state revenue in 2021, generated thanks to renewable energies.[5]

Sources: [1] Electricity report for 2021, RTE, [2] Latribune.fr; [3] FEE data, processed by Capgemini znvent, [4] Here AO10 corresponds to the AO2 PPE2 call for tenders for onshore wind power,

[5] La manne budgétaire générée par l'éolien et le solaire n'en finit pas de grossir [The budgetary windfall generated by wind and solar power continues to grow], *Les Echos* (07 Sep 2022), * wind power's average coverage rate, RTE's 2021 electricity report

The contributions of the French wind industry in 2021

Economic contributions benefiting everyone

€7.6 billion in wind revenue for the **State** in 2022 and 2023[1]

€220 million in local tax revenue in France in **2021**[2]

Local taxes aren't increasing or are decreasing in municipalities hosting one or more wind farms

A sector that contributes to France's reindustrialisation

€5.8 billion in turnover in 2019, for onshore alone[3]

€768 million in equipment and engineering exports[3]

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

Massive buy-in by French citizens

73% of French citizens[5] have a positive image of wind power

€102.4 million collected through crowdfunding to fund renewable energies in 2021[6]

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 solar and wind power in France[7]

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 2022
[2] Estimate based on an average of €12,500 per MW installed (IFER average) Ademe – 2021 Wind power market study

[4] Not including the Chantiers de l'Atlantique foundation production plant in Saint-Nazaire.

[5] 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

[7] Note : précisions sur les bilans CO_2 [clarifications on CO_2 assessments], RTE

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The French wind power market in 2021

418 wind turbines[1] installed in 2021

7.7%[2] of French electricity consumption in 2021*

1.2 GW[2] of wind power capacity installed and connected to the grid in 2021

36.8 TWh[2] of electricity produced from wind energy

Key figures

Almost **9,000 wind turbines** in France at the end of 2021, spread over nearly **1,400 wind farms**[3]

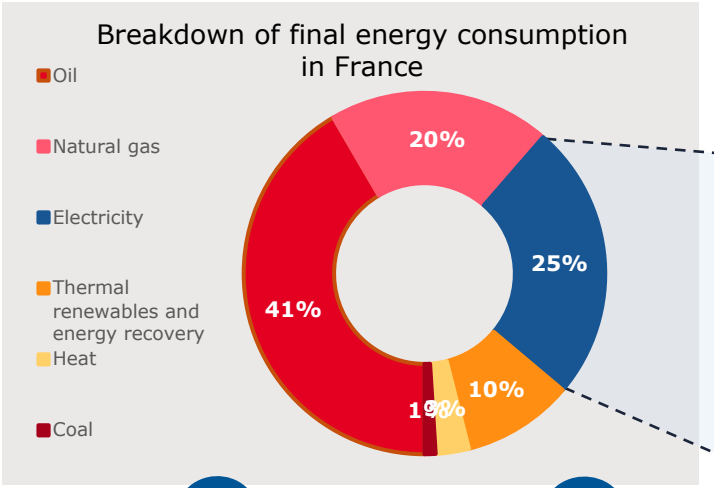
Installed wind capacity in 2021 is **down compared to 2020**, which saw the installation of 1.3 GW in new capacity. **700 MW of additional wind capacity** should have been installed in 2021. France is thus the only European country that is lagging behind on its annual renewable energy and heat recovery development objectives, risking a fine of €500 million.

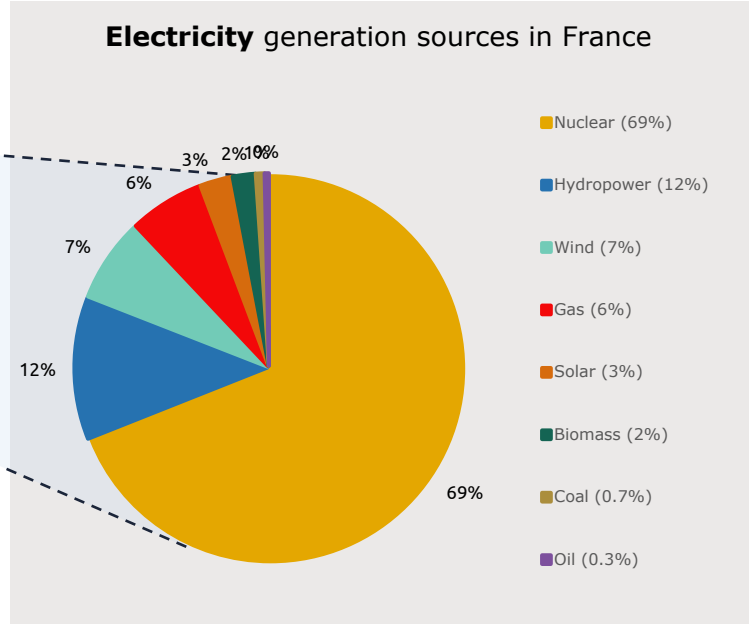
Wind power is the **second largest source of renewable electrical power** after hydropower, and the third largest electrical power source in France after nuclear power.

Sources: [1] WindEurope, "Wind energy in Europe in 2021", [2] Electricity report 2021, RTE and FEE study, [3] Transition-energetique.eco and The Wind Power, * wind power's average coverage rate, RTE's 2021 electricity report

The place of wind power in the French energy mix in 2021

Electricity corresponds to **25%** of energy consumption in France.
In 2021, wind power represented **7%** of France's electricity production.

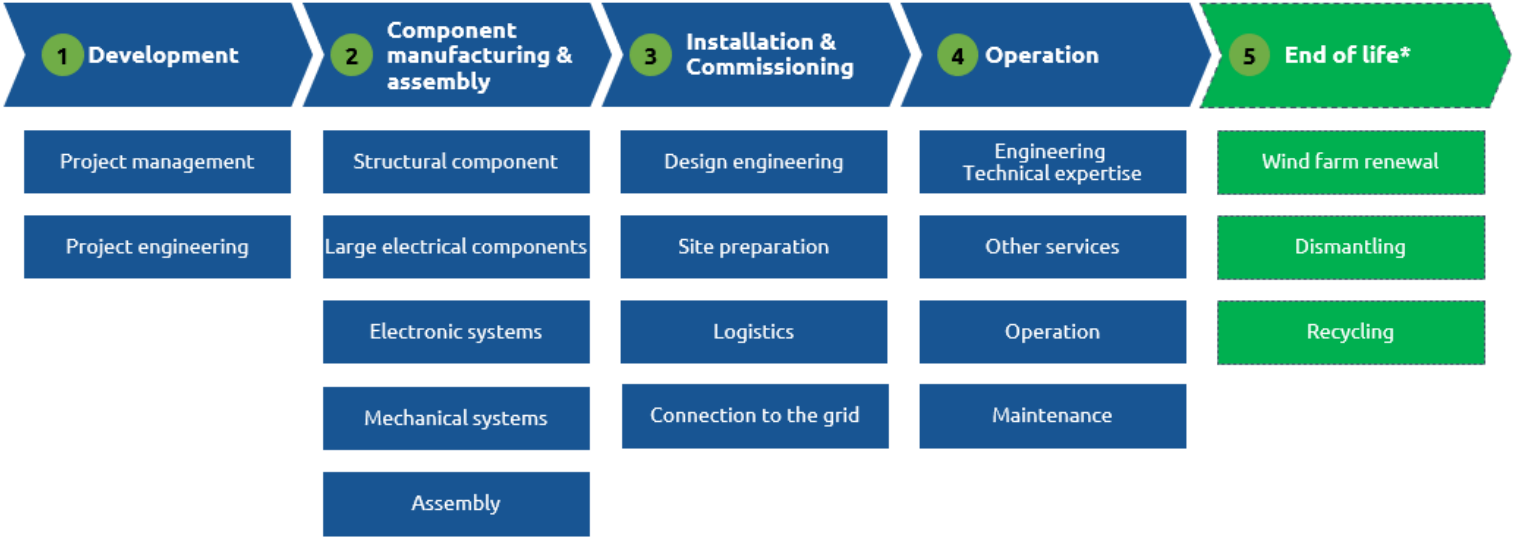




Sources: RTE's 2021 Electricity report and Key energy figures 2021, French Ministry of Ecological Transition

Industry overview

Overview of the wind industry value chain



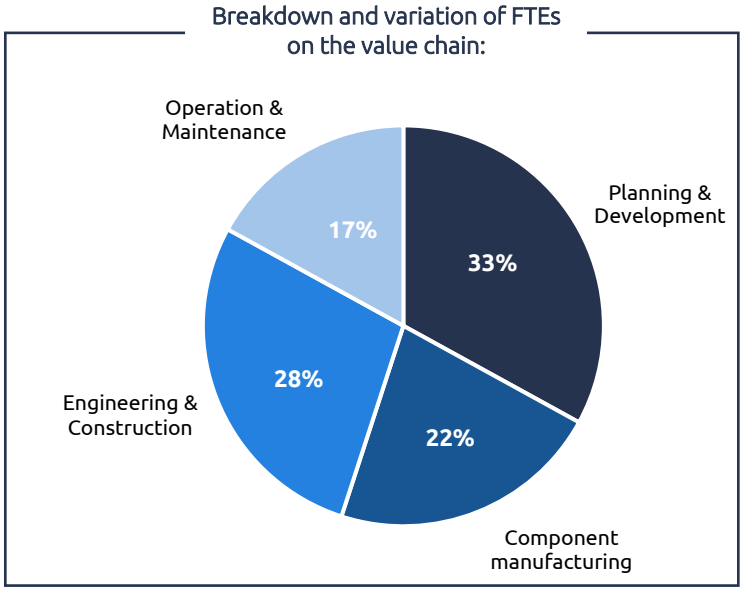
Key facts and figures

25,500 FTEs
in wind power at the end of 2021

12.8%
increase in jobs in 2021

In 2021, **wind power jobs have continued increasing at a significant pace**, with a growth rate of 13% and a total of 25,500 direct and indirect jobs in France as at 31 December 2021.

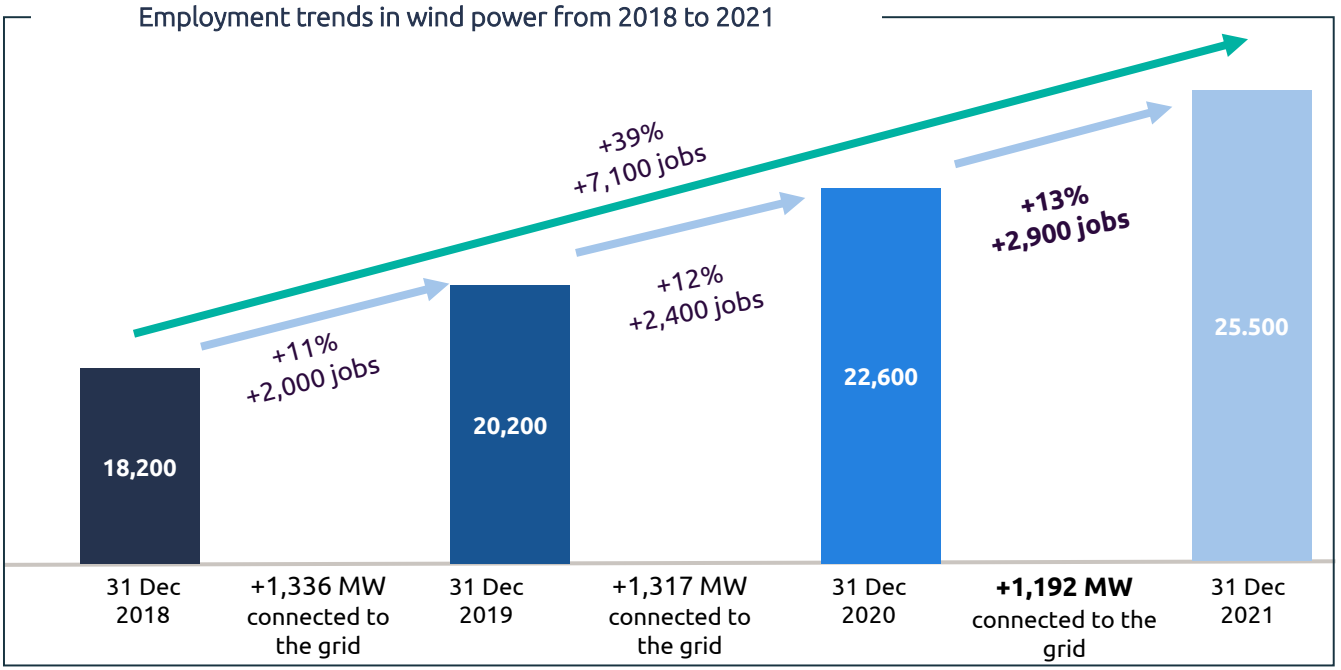
As in 2020, offshore wind boosts job growth in the French wind industry. This trend is largely due to the stepping up of the Saint-Nazaire, Fécamp and Saint-Brieuc farms. With an observed growth of more than 20%, offshore wind accounts for approximately 6,300 jobs in 2021.[1] These jobs are primarily created in the Normandy and Pays de la Loire regions.



Sources: [1] Observatory for marine energies 2022

Job growth in wind power in France in 2021

The number of wind jobs continues growing, spurred on by the development of offshore wind



Source: FEE study, data processing by Capgemini Invent

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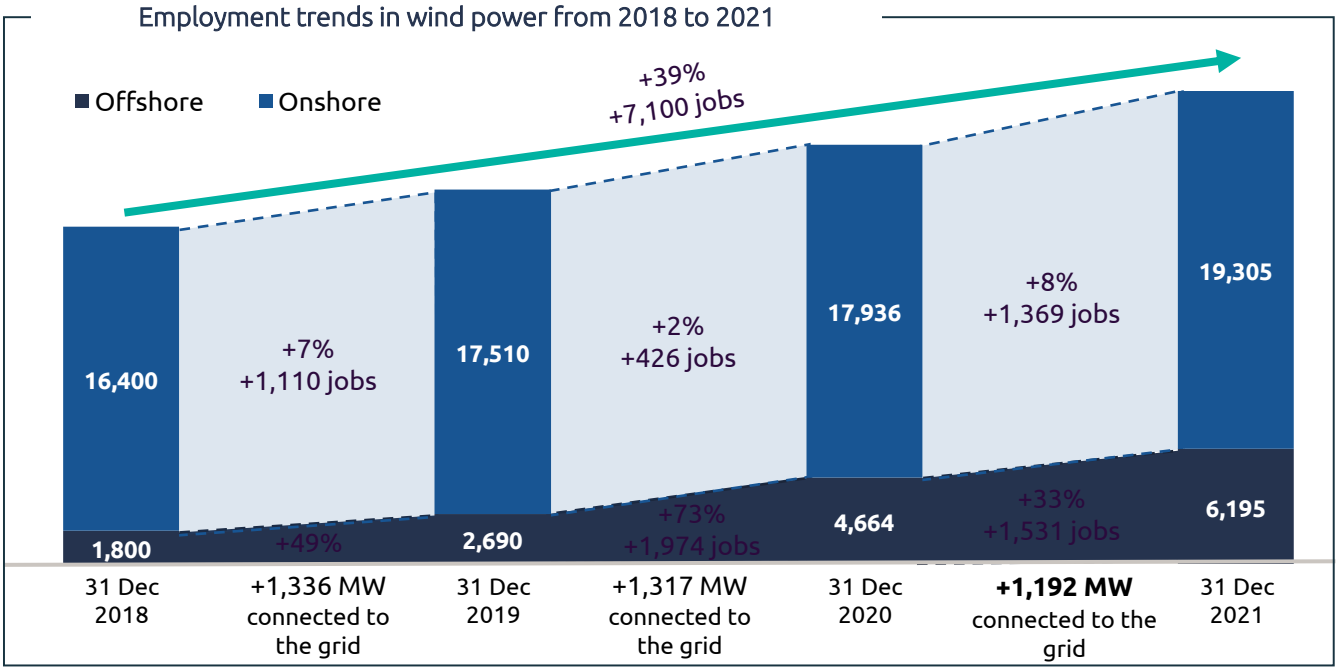

Source: FEE 2022 study, Marine energy observatory 2022 and data processing by Capgemini Invent

Table of contents

Table of contents

The French wind power market in 2021

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The French wind power market – Introduction

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

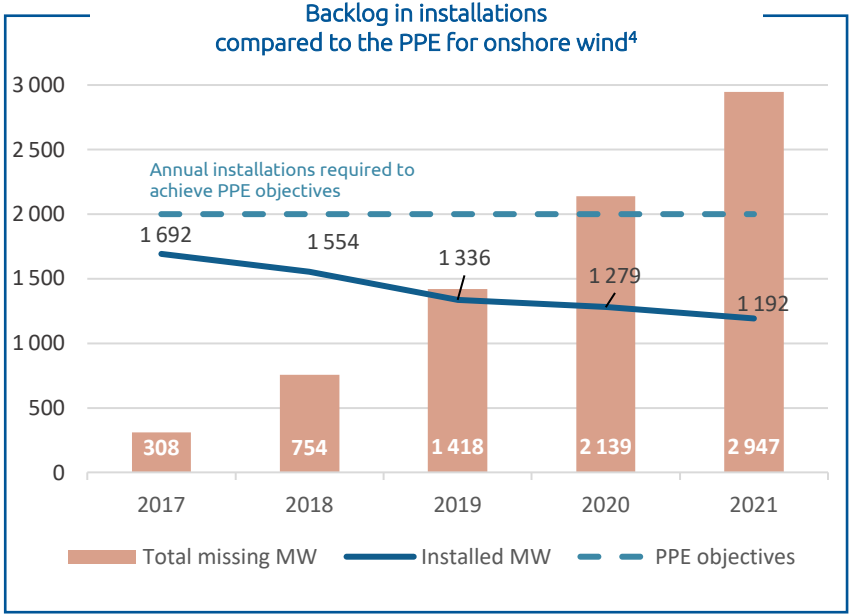
France's 2050 carbon neutrality objective was defined in the PPE published in April 2020,[1] which sets out the objectives of the country's energy transition up to 2028, with **45% increase in wind power capacity over 3 years, up to a level of 24.1 GW**[2].

However, with only 1,191 MW connected to the grid in 2021 and a cumulative capacity of 17.6 GW, **France is truly stalling** and failing to reach the pace of development that it set out to achieve, i.e. an annual increase in installed wind power capacity of **2 GW**.

If growth continues at this rate, we **will achieve 27 GW of installed onshore wind in 2028** instead of the projected 34 GW, i.e. a capacity shortfall of **7 GW**.

Offshore wind is no exception given that in a best case scenario, only **1.5 GW should be newly installed by 2023, instead of the 2.4 GW initially projected** in the PPE.

Backlog in installations compared to the PPE for onshore wind[4]

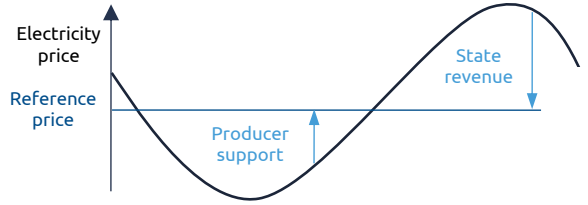


Source: [1]PPE implementing decree, published in the French official gazette on April 23, 2020 & SDES 2020
PPE: Multiannual Energy Programming (*Programmation Pluriannuelle de l'Énergie* – PPE).
[2] Summary report of the French Energy Regulation Commission, January 2022
[3] Où en est l'éolien en mer en France ? [What is the state of offshore wind in France?], Révolution énergétique
[4] FEE data

Wind power, a source of revenue for the State

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

The "additional remuneration" mechanism



€18 billion

in revenue for the French State in the event that the 2035 objectives of the PPE are achieved[2]

€600 million

of loss of revenue for the French State due to non-compliance with the PPE in 2021[1]

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 market-based "additional remuneration" mechanism, which 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 power sector will thus contribute €4 billion to the French State in 2022 (for onshore and offshore wind power) and €3.6 billion in 2023.

Achieving the PPE objectives would allow **the French State to secure a net income estimated at €18 billion by 2035.**[4]

The wind power sector is therefore a net contributor 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] Evaluation 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] Assuming an average price of €200 per MWh until 2025 and €90 per MW between 2025 and 2035

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418 wind turbines[1] installed in 2021

7.7%[2] of French electricity consumption in 2021*

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Installed wind capacity in 2021 is **down compared to 2020**, which saw the installation of 1.3 GW in new capacity. **700 MW of additional wind capacity** should have been installed in 2021. France is thus the only European country that is lagging behind on its annual renewable energy and heat recovery development objectives, risking a fine of €500 million.

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Sources: [1] WindEurope, "Wind energy in Europe in 2021"; [2] Electricity report 2021, RTE and FEE study; [3] Transition-energetique.eco and The Wind Power
* wind power's average coverage rate, RTE's 2021 electricity report

The place of wind power in the French energy mix in 2021

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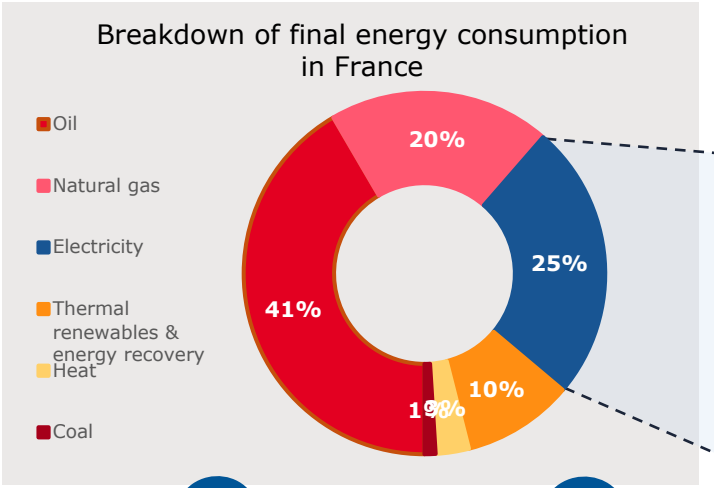
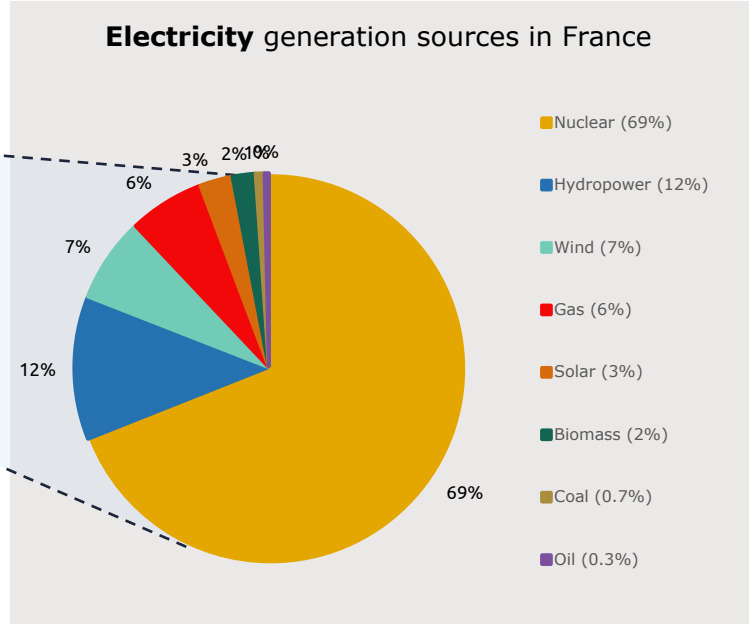
In 2021, wind power accounted for **7%** of France's electricity production.

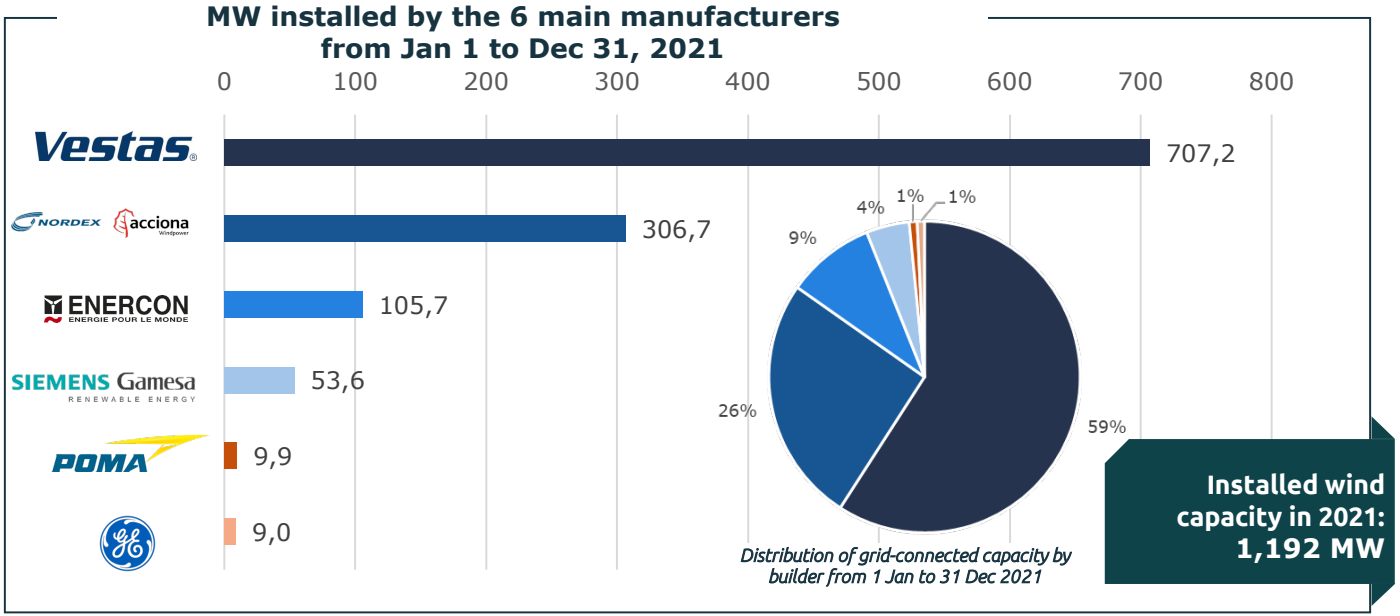




Sources: RTE's 2021 Electricity report and Key energy figures 2021, French Ministry of Ecological Transition

Overview of the French wind market

1.2 GW of wind power capacity was installed in France in 2021

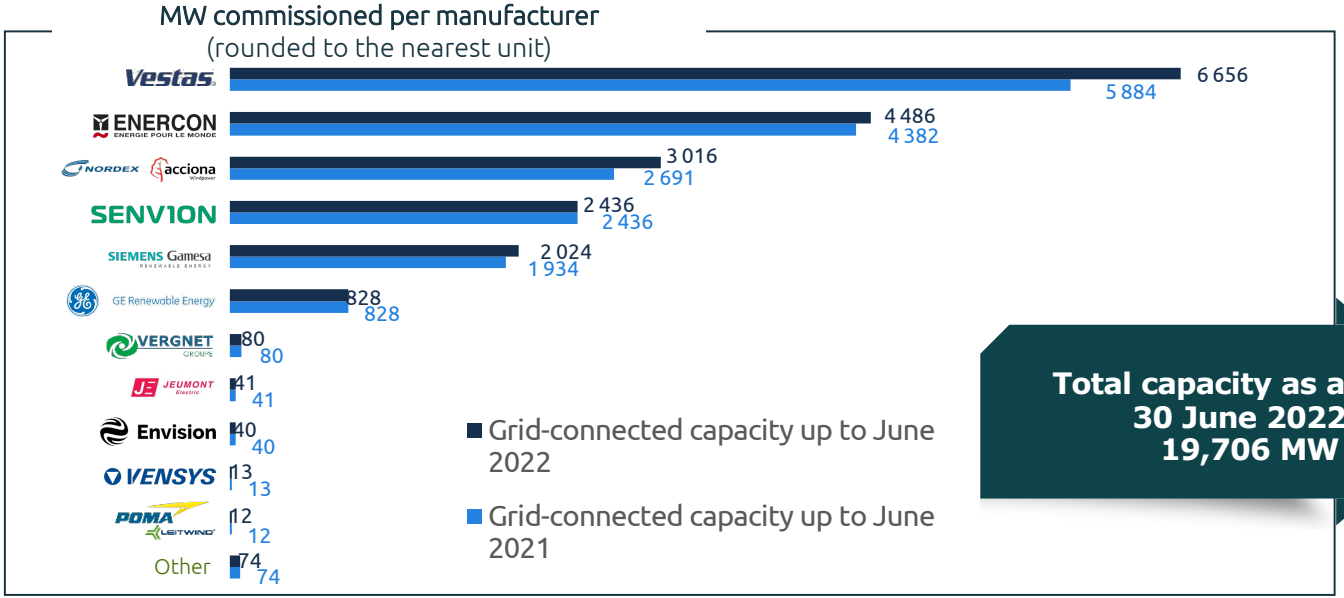


NB: the value for "installed capacity" can differ from the "grid-connected" capacity reported by RTE France as a result of the lag between the connection to the grid and commissioning.

Source: FEE study, 2022

Overview of the French wind market

As of 30 June 2022, there is a total grid-connected capacity of 19.7 GW in France

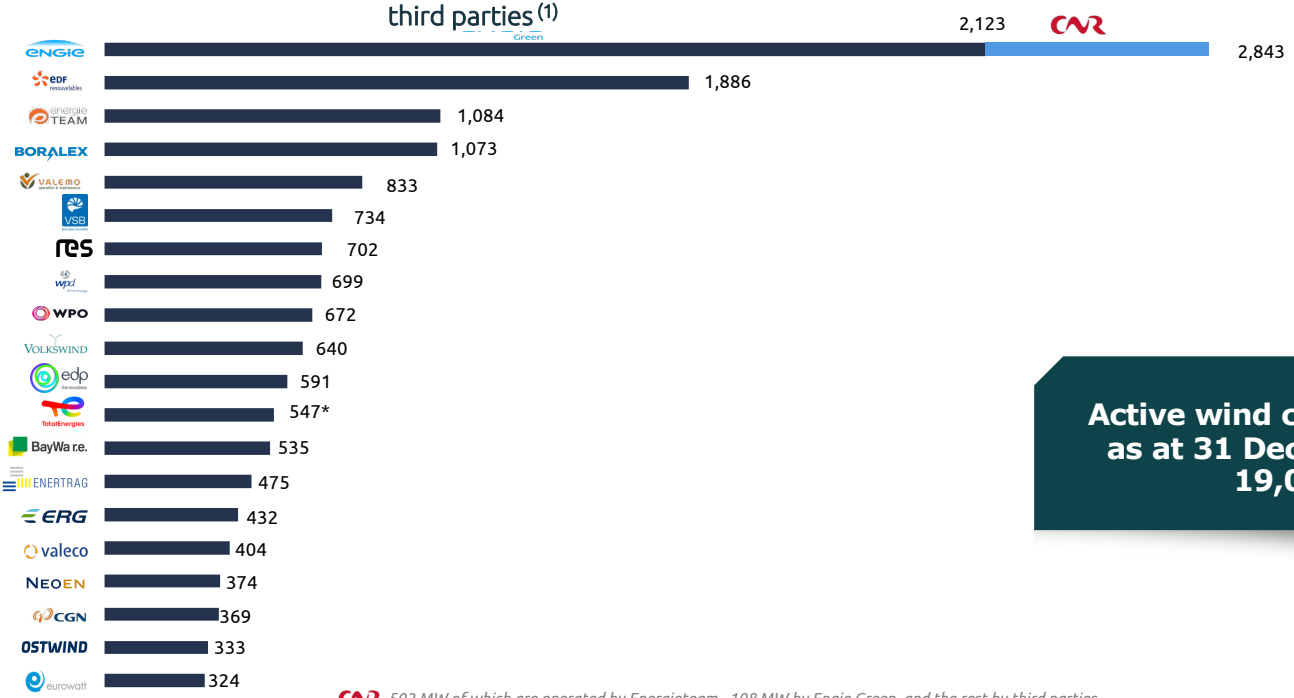


Source: FEE study, 2022

Overview of installed capacity

Top 20 wind operators in France

MW in service that are operated either directly or on behalf of third parties (1)



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

Active wind capacity as at 31 Dec 2021: 19,092 MW

Source: FEE study, 2022

* 2020 figures

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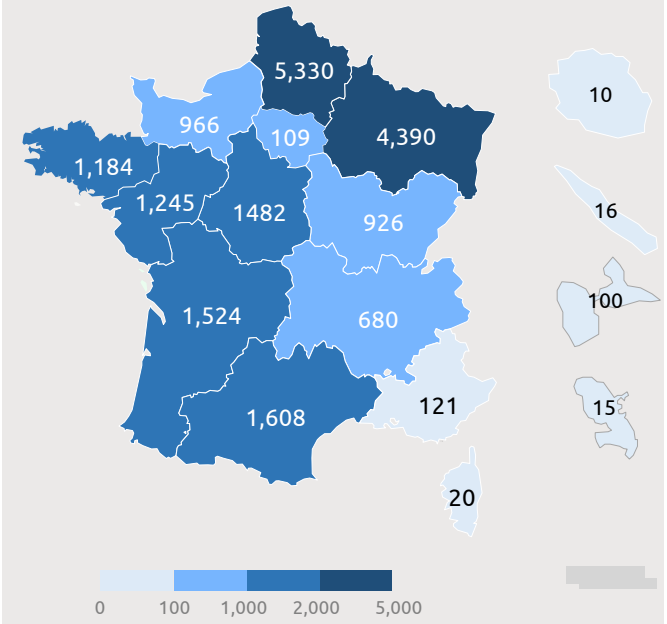
Overview of the wind power market by region

The current distribution of installed MW attests to the dominance of north-eastern and western France

Total grid-connected wind farm capacity per region as at 30 June 2022 – in MW



Source: FEE study, 2022

Wind capacities are distributed over the country, **with almost 1,400 wind farms** located in all regions in mainland France, as well as in overseas territories.

Hauts-de-France and **Grand Est** are the top wind regions. These two regions alone account for **50% of France's grid-connected capacity**. Meanwhile, **Occitanie,** the historical birthplace of the French wind industry, **ranks 3rd nationally**.

Other regions continue to make progress. Thus, the Île-de-France region has largely exceeded **100 MW of grid-connected new capacity** in 2021.

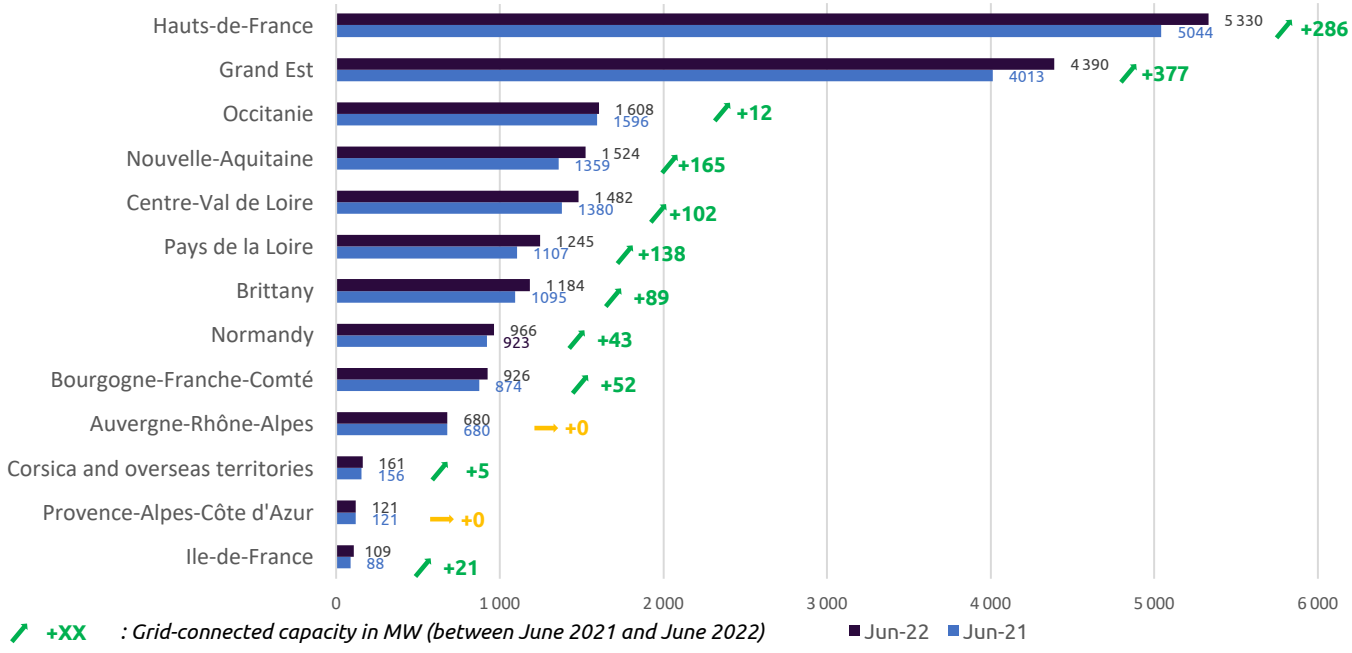
The Nouvelle-Aquitaine and Pays de la Loire regions have seen their installed capacity increase by more than 12% year-on-year, which testifies to the **harmonious development** of the sector that is under way throughout the country.

7 regions out of a total of 13 had more than **1,000 MW** of wind power connected to the grid at the end of June 2021

Developments in terms of grid-connected capacity

France's grid-connected capacity has increased by more than 1 GW, with 5 regions having installed more than 100 MW in 2021

Growth in grid-connected capacity by region



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

The French wind market within the European context

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

Grid-connected capacity (onshore & offshore) in Europe at the end of 2021

Key

Total grid-connected wind farm capacity – MW

500 5,000 10,000 20,000 30,000

Sources: WindEurope, "Wind Energy in Europe in 2021"; RTE, 2021 Electricity report

Focus on the 15 countries with the highest grid-connected capacity at the end of 2021

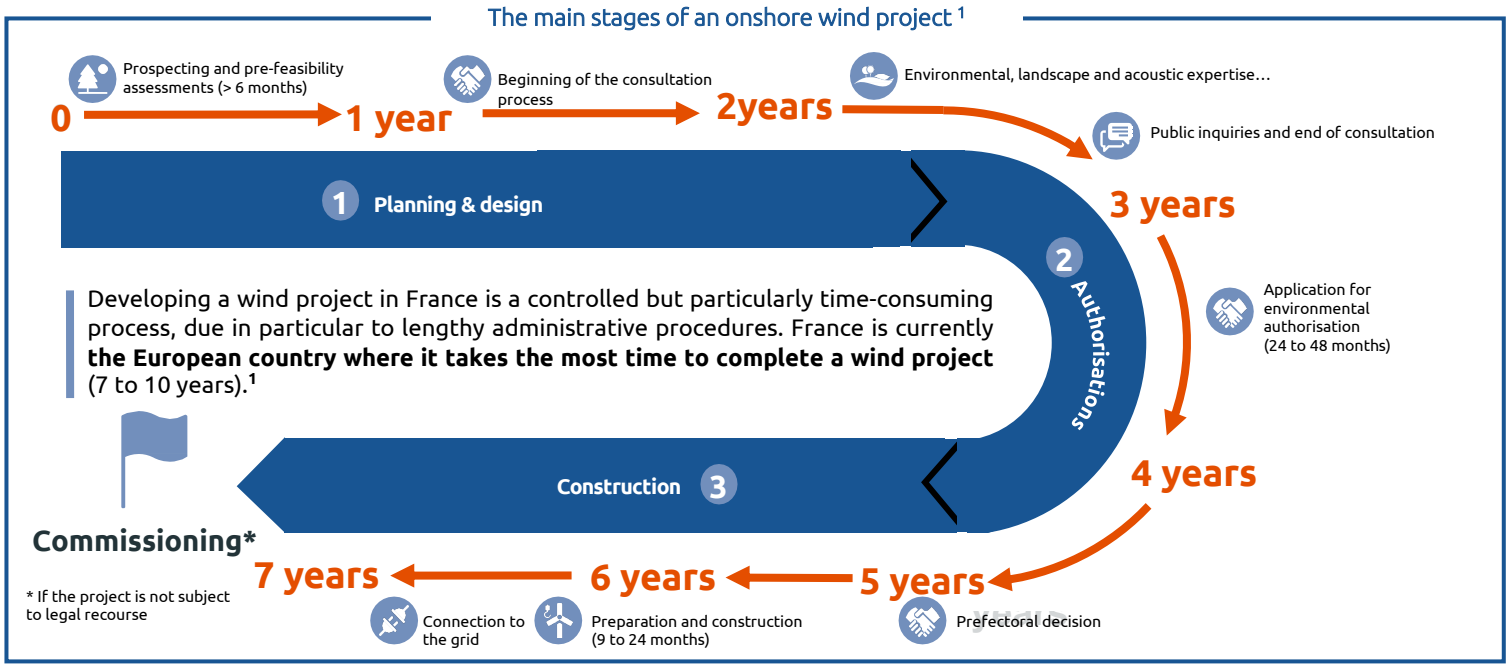
	Country	Combined installed capacity at the end of 2020 (MW)	... of which offshore capacity at the end of 2020 (MW)	Growth between 2020 and 2021*	Combined installed capacity at the end of 2021 (MW)	... of which offshore capacity at the end of 2021 (MW)	% of the electricity mix in 2021
1	Germany	62,627	7,689	1,216	63,843	7,713	23 %
2	Spain	27,264	5	932	28,196	5	24 %
3	UK	24,167	10,428	2,645	26812	12739	22%
4	France	17,949	2	1,132	19,081	2	8%
5	Sweden	9,992	192	2105	12097	192	19%
6	Italy	10,852	0	256	11108	0	7%
7	Netherlands	6,784	2,611	1,381	8165	2986	15%
8	Denmark	6,180	1,703	998	7178	2308	**44%**
9	Poland	6,614	0	- 267	6347	0	9%
10	Portugal	5,486	25	126	5612	25	**26%**
11	Belgium	4,719	2,261	283	5002	2261	13%
12	Greece	4,113	0	339	4452	0	18%
13	Ireland	4,351	25	54	4405	25	**31%**
14	Finland	2,657	71	671	3328	71	9%
15	Austria	3,210	0	90	3300	0	11%

:* 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.

In spite of its large area, France's installed capacity only amounts to one third of that of Germany, contributing to 7% of the electricity mix (compared to a European average of 15%). The electricity mixes of Denmark, Ireland and Portugal, more than a quarter of which are covered by wind power, also demonstrate the **technical feasibility** of managing a power grid incorporating a high share of renewable energies.

Construction of a wind farm project

In France, the construction of a wind farm takes twice as long as the European average (3 to 5 years)



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

Construction of a 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]

- Studies of the technical and economic potential by Cerema and RTE
- Work in consultation with local stakeholders
- Preferred areas for offshore wind development were identified
- Competitive dialogue process
- Additional studies by RTE and the winner of the tender

1. Formulating strategies for the wind power deployment on the seaboards
2. Public discussion
3. Call for tenders
4. Authorisations
5. Financing
6. Wind farm construction and connection to the grid

Authorisation request

Public survey

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.

Commissioning
> 10 years

- Installation of the electrical substation and of the power cables at sea and on land for the connection to the grid
- Assembly and installation of the wind turbines

Source: eoliennesenmer.fr

Construction of a wind farm project

Despite ambitious national objectives, significant constraints of various sorts influence wind farm location

Administrative and regulatory constraints

Obtaining the environmental authorisation 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 projected close to a military radar or military air lanes, approval from the Ministry of Armed Forces is required, preventing 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 authorisation is required when changes to the wind farm brought about by repowering are deemed substantial.[2]

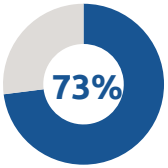
Market constraints

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.

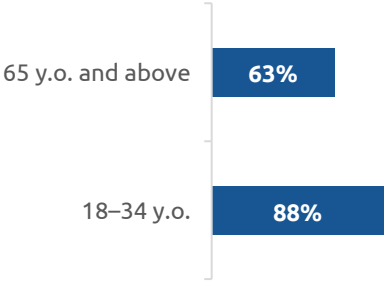
Public buy-in on wind power in France

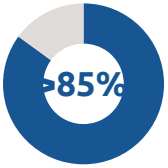
The new generations support the choice of wind power as a necessary solution in the fight against climate change



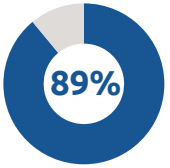
of the French public
has a positive image of wind power

It should be noted that there is a generational gap in the acceptability of wind power within the French population: whereas 88% of adults under 35 have a good image of wind energy, this is only the case for 63% of those over 65.

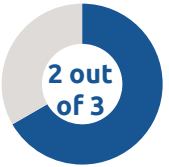




of the French public considers that wind power is a **clean and inexhaustible energy source**



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



2 out of 3 consider that a **wind farm installation** in their local area would be a **positive thing**

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

Public buy-in on wind power in France

Renewable power generation projects involving citizens in the decision process and investment are proliferating in France

There are now **upwards of 200 renewable power generation projects** based on the long-term involvement of residents and local authorities **in their governance and financing**.

This civic energy, where decision-making, financing and initiatives stem from the **grassroots** leverages the local natural resources of the territories involved. It also helps **improve citizen buy-in** to the project into 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]

278
Grassroots renewable energy projects[2]

1048 GWh
produced per year

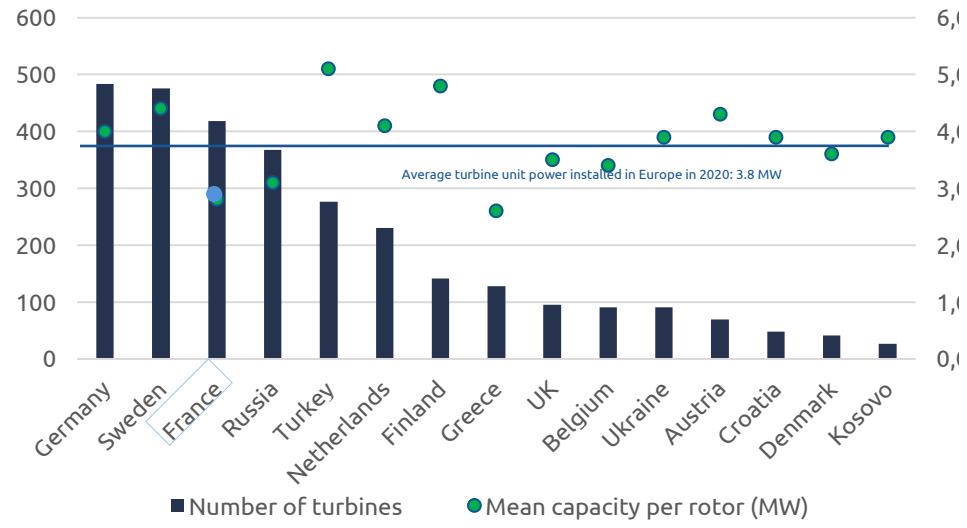
>€100m
collected via crowdfunding for renewable energy projects[3]

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

France installs many turbines, but its installed capacity is one of the lowest in Europe

Average unit power & number of turbines installed in European countries in 2021 (onshore)



Sources: Wind energy in Europe in 2020, *Trends and statistics* (2021)

The unit power of wind turbines installed in France in 2020 nevertheless remains **among the lowest** on the European continent (2.9 MW compared with a 3.8 MW average), though the country ranked No. 1 in terms of the number of wind turbines installed in 2020 (with 418 units).

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.

Onshore technologies are continuing to make progress

There is a trend towards higher turbine capacity, yet it still lags behind the European average (3.8 MW)

Top 10 most installed turbines in 2021

	Model	Manufacturer	Unit capacity (MW)	Rotor size / mast height (France)	Installed capacity (MW)
1	N117 Delta	Nordex Acciona	3.6	117m / 91–120m	149
2	V117	Vestas	3 to 4.2	117 m / 80–116 m	137
3	V100	Vestas	2–2.2	100m / 75–100m	137
4	V110	Vestas	2–2.2	110m / 80–120m	127
5	V136	Vestas	3 to 4.2	136 m / 82–149 m	121
6	V150	Vestas	3 to 4.2	150m / 105–125m	109
7	N131 Delta	Nordex Acciona	3.9	131 m / 106, 114 m	68
8	N117 Gamma	Nordex Acciona	2.4	117m / 91–120m	67
9	E138 E2	ENERCON ENERGIE POUR LE MONDE	4.2	138m / 111m	46
10	V126	Vestas	3–3.6	126m / 87–137m	41

Source: FEE study, 2022

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 2022 (total amount)**

	Model	Manufacturer	Unit capacity (MW)	Rotor size/height	Total capacity (MW)
1	E-82	ENERCON	2.3	82m / 78–138m	1,709
2	V-90	Vestas	2–3	90m / 80–105m	1,612
3	V-100	Vestas	2–2.2	100m / 75–100m	1,607
4	MM-92	SENVION	2	92 m/59 m to 100 m	1,520
5	E-70	ENERCON	2.3	71m / 58–113m	1,499
6	N-90	NORDEX acciona	2.5	90m / 65–80m	854
7	V112	Vestas	3–3.45	112m / 69–119m	774
8	N-100	NORDEX acciona	2.5	100m / 75–100m	685

None of the most installed models in France has a unit power that is higher than the average for European land turbines (4 MW).[1]

Source: FEE study, 2022

[1] Wind Energy in Europe 2021, WindEurope

Offshore wind

Offshore wind power: a booming technology with the development of fixed-bottom and floating wind farms

Two different offshore wind technologies are being developed in France:

Bottom-fixed offshore wind

Fixed-bottom wind turbines are intended for seabed depths of up to 50–60 m and can harness strong coastal winds.
Projected unit capacity: 6-8 MW (AO1/CFT No.1) and up to 12–15 MW (AO3/CFT No.3)

- **4 wind farms** are currently
- **under construction** (1.93 GW),
- **3 wind farms** are **under development** (1.6 GW),
- **2 new wind farms** have been announced (2 GW).

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. Projected unit capacity: 8–10 MW (pilot farms)

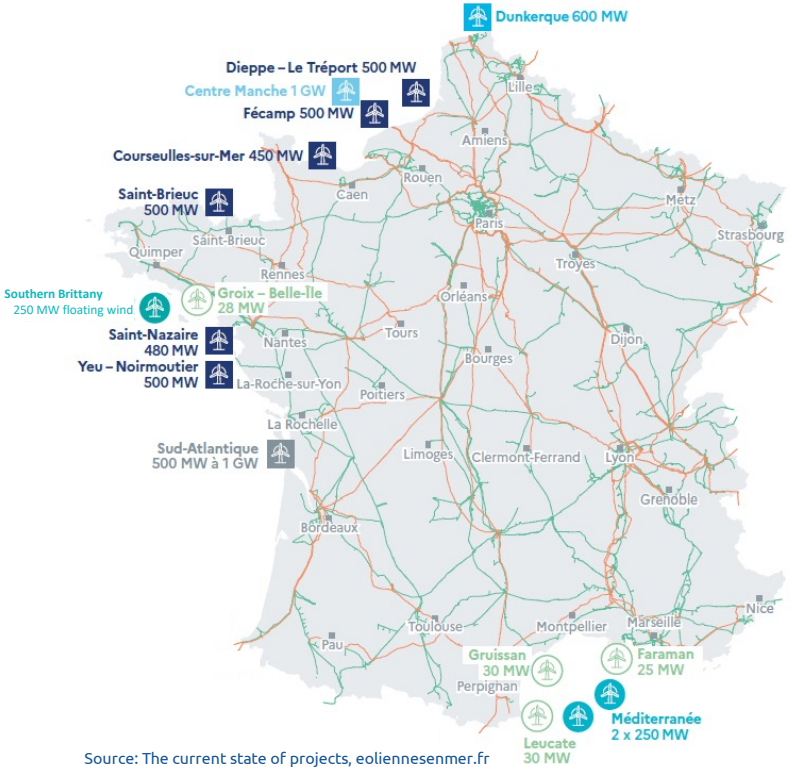
- **4 pilot wind farms** (0.1 GW),
- **3 wind farms** have been announced (0.75 GW),

Offshore wind power is expected to represent **10%** of grid-connected wind power capacity in France in 2023

Source: The current state of projects, eoliennesenmer.fr

Offshore wind

France is strongly increasing its offshore wind capacity with many wind farms planned or under construction



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.**

The construction of numerous bottom-fixed and floating offshore wind projects is planned, amounting to **more than 5.3 GW** in additional capacity by 2028, in line with the objectives of the PPE for offshore wind.

- **Fixed-bottom wind CFTs AO1 & AO2** (commissioning expected in 2022–2026)
- **Fixed-bottom wind CFT AO3** (commissioning expected in 2027)
- **Fixed-bottom wind CFT AO4** (commissioning expected in 2028-2029)
- **Floating wind CFT AO5** (commissioning expected in 2028-2029)
- **Floating wind CFT AO6** (Under discussion, commissioning expected in 2028-2029)
- **Fixed-bottom wind CFT AO7** (Under discussion, commissioning expected in 2029-2030)
- **Floating wind, pilot farms** (testing phase)

Offshore wind

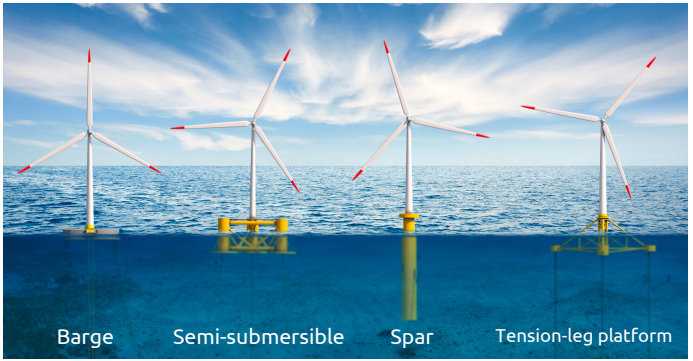
France boasts many advantages as far as offshore wind power is concerned, most notably its extended maritime boundaries as well as its industrial, energy and maritime expertise and port infrastructure, meshed power grid

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 new and future 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 the goal of **increasing the number 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]

Examples of floating offshore wind installations:



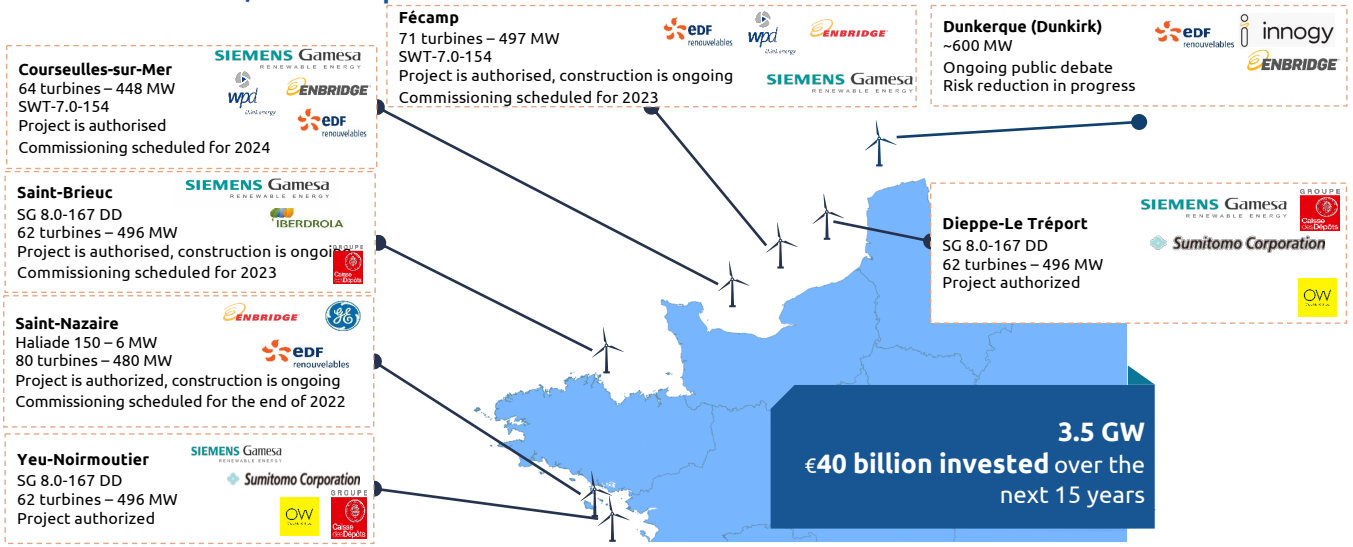
Bottom-fixed wind is the most mature and competitive MRE technology. Fixed-bottom offshore wind accounts for **90%** of the turnover in MREs.

Sources: FEE study, 2021 Observatory for marine energies

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

Offshore wind

Work on the Courseulles-sur-mer wind farm is ongoing, following those in Saint-Nazaire, Fécamp and Saint-Brieuc



The year 2021 saw the **start of construction** of the Courseulles-sur-Mer wind farm. It is the last of the 4 projects awarded during the 2012 call for tenders to reach this stage. Competitive dialogue is ongoing for a **1 GW installed wind farm off the coast of Cotentin**.

Two tender procedures were launched in March 2022 for **floating wind farms** of 250 MW each. In a second phase, these wind farms could be extended and reach 750 MW.[1] One off Port-la-Nouvelle, and the other near Fos-sur-Mer. Construction has started on three pilot floating wind farms.

Sources: FEE study, 2022 Observatory for marine energies
[1] Press release by Jean Castex, France 2030 (14 March 2022)

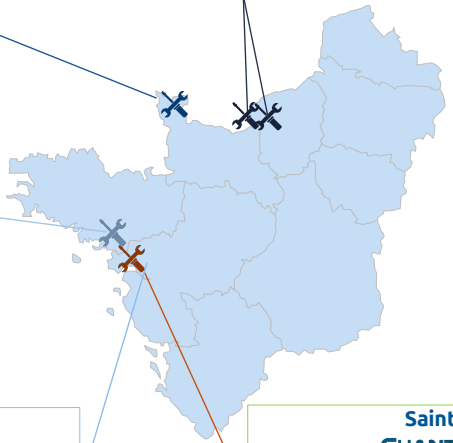
Offshore wind

Offshore wind power is now emerging as an industrial sector and is set to create and sustain many direct and indirect jobs in France.

Le Havre
SIEMENS Gamesa RENEWABLE ENERGY
Manufacturing of blades, nacelles and generators for offshore wind power
750 direct and indirect jobs

Cherbourg
GE Renewable Energy
Manufacturing of blades
350 direct jobs created
800 direct jobs

Montoir-de-Bretagne
GE Renewable Energy
Assembly of 80 nacelles for 6 MW wind turbines for the first French offshore wind farm located in Saint-Nazaire
300 direct jobs
450 direct and indirect jobs by the end of 2020



Nantes
GE Renewable Energy
The site mainly brings together the engineering, purchasing, quality, project management and service departments.
200 direct jobs

Saint-Nazaire
CHANTIERS DE L'ATLANTIQUE
Includes 2 jacket-type foundation production units, transition pieces and electrical substations for the Saint-Nazaire wind farm
280 direct jobs

Fécamp wind farm: start of construction in June 2019; 71 offshore turbines; commissioning in 2023.

Saint-Nazaire wind farm: commissioned in 2022. The nacelles are manufactured in the GE Renewable Energy plant at Montoir-de-Bretagne..

The Saint-Nazaire **Chantiers de l'Atlantique** factory will manufacture the electrical substations for the Saint-Nazaire and Fécamp wind farms.

The **GE Renewable Energy** (LM Wind Power) plant located in Cherbourg currently produces the longest blades in the world for export projects won in the United States and the United Kingdom.

20,000 jobs created in France by 2035 in the offshore wind industry[1]

Source: FEE study
Pacte éolien en mer entre l'Etat et la filière [The offshore wind pact between the government and the industry], eoliennesenmer.fr

Offshore wind

Focus on the factories of Cherbourg and Le Havre

In November 2019, GE Renewable Energy (through its subsidiary LM Wind Power) inaugurated its plant in Cherbourg for the construction of blades for offshore wind power. In mid-2022, the factory was employing more than 750 employees.[1]

In 2022, Siemens Gamesa started production at the Le Havre site. In March, 500 positions were already filled, with another 250 slated to be filled between late 2022 and early 2023. The first blades and nacelles will be delivered to the Saint-Brieuc and Fécamp offshore wind farms.[2]

Offshore wind power represents a promising industrial sector as France will soon hold one third of Europe's offshore generation capacity

LM Wind Power's factory in Cherbourg

The largest blade in the world is manufactured at LM Wind Power's Cherbourg factory

3D representation of the Siemens Gamesa Renewable Energy plant in Le Havre

The GE Renewable Energy plant in Cherbourg produces 107 meter long blades, the largest in the world. These blades are intended for **the world's most powerful wind turbine, the Haliade-X 12MW.** This wind turbine has been selected for the equivalent of 4.8 GW of projects in the United States and the UK.[3]

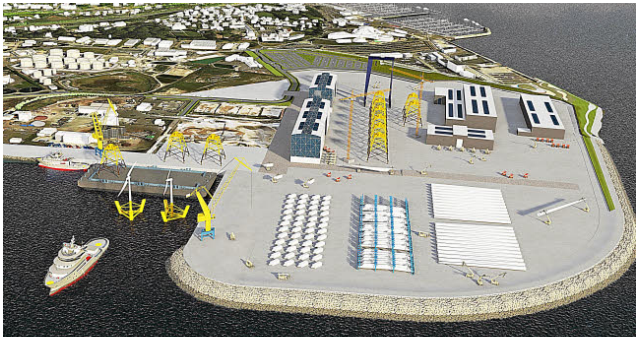
Source: [1] tFEE study, LM Wind Power
[2] Siemens Gamesa a démarré la production de son usine au Havre [Siemens Gamesa has started production at its factory in Le Havre], Ouest France
[3] GE's 12 MW Haliade-X, industrieweb, 13 Nov 2020

Offshore wind

€220 million of investment for the development of the MRE* terminal of the port of Brest intended for marine renewable energies

The industrialization of the offshore wind industry contributes to massive investments in certain French ports. Indeed, the assembly of certain components is done at the dock. To carry out these complex operations, the port infrastructure must be adapted, in particular to allow the handling of very heavy loads (of up to 10 tonnes per square metre). These investments form part of a long-term perspective to establish the know-how of **the French offshore wind industry** and to thus consolidate **its expertise in order to export turbines to Europe and to the rest of the world**.

The Brest port upgrade started in 2017, with the aim of creating a 40 ha polder – an artificial expanse of land reclaimed on the water – dedicated to **marine renewable energies (MREs)**, including **offshore wind power (bottom-fixed and floating) and tidal power.**



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

Source: FEE study

The project represents an investment of **€220 million** from the Brittany Region and its partners. The boom in the MRE sector is expected to generate **400 to 500 direct jobs** at the end of the construction works, **scheduled for 2024**. The Spanish company Navantia has chosen to operate from the port and will set up a jacket foundation pre-assembly unit for the future offshore wind farm in the bay of Saint-Brieuc. This market will mobilize **250 direct jobs over 2 years.**

In addition to the port of **Brest**, the ports of **Cherbourg**, **Le Havre** and **Saint-Nazaire** have also undertaken significant investments to support the development of MREs on the Atlantic coast. The ports of **Marseille-Fos** and **Port-La Nouvelle** on the Mediterranean basin also take that approach. France is very dynamic in this promising **sector offering strong growth potential** in Europe and around the world.

* MREs: Marine renewable energies

Offshore wind

€252 million are being invested in extending the port of Port-La Nouvelle, which is intended among other things for floating offshore wind activities

In 2016, Occitanie was chosen by the French government as a favourable site for two floating wind farms. Wind turbines are slated to be assembled in Port-La Nouvelle, which is **France's third largest Mediterranean port**, before being installed offshore. Out of four pilot floating offshore wind power projects in France, **two are located off Leucate-Barcarès and Gruissan**, facing the Aude coast. Industrial activities related to the construction of offshore wind turbine floats will begin in late 2022, and those related to the assembly of the masts and turbines of the first two pilot farms will begin in 2023 and 2024.

The port extension works started in the autumn of 2019. The Occitanie region has committed to invest **€252 million** in the extension project which includes the creation of a new port basin and a new wharf for offshore wind power.

Construction work should be completed by **2023**. In total, no less than **3,000 jobs** (either direct, indirect or induced) will be created thanks to the activities that will be established in this port in the Aude département. The first stage of the expansion of the port, launched last September, **already** represents **200** full-time equivalent **jobs**. Ten local companies were selected to carry out this project, and five other local companies are taking part as subcontractors.

In order for the port expansion to be exemplary from an environmental standpoint, the regional authorities have set up several bodies, in particular a scientific committee composed of experts as well as an environmental monitoring committee that brings together local authorities, associations and the fishing industry. It has also mobilized more than **€12 million for environmental compensation purposes.**

Development of the port of Port-La Nouvelle

Development of the port of Port-La Nouvelle

Source: FEE study

Lhyfe Optimize performance

Floating wind

Pilot farm at Port-La-Nouvelle

EolMed

Wind farm context and description

The very first floating offshore wind farm will materialise in Port-La-Nouvelle in **Occitanie** and is slated to be commissionned in **mid-2024**. The farm will feature **3 turbines of 10 MW each**.

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 power consumption of a city of 50,000 people.

Various protagonists are involved throughout the value chain:*

Developer	Codeveloper	Turbine	Foundations	Crowdfunding
Qair	TotalEnergies	Vestas	BW ideol	enerfip

Source: Vestas * *Non-exhaustive list*

Capgemini invent | France Energie Eolienne

Offshore wind

The first floating offshore wind projects are being launched

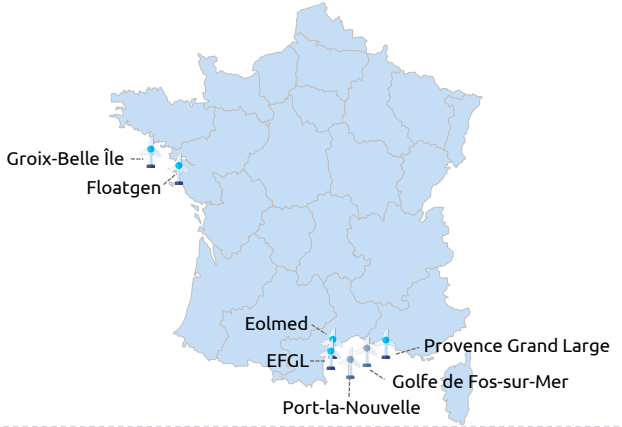
In France, the Mediterranean Sea and the Brittany seaboard have **substantial wind power potential** for the installation of floating wind farms due to their **highly favourable and regular wind regimes** as well as its **bathymetry** (the ocean floors drop very steeply to a depth exceeding 60 m).

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

Project	Characteristics	Industrial partners
Provence Grand Large	3 turbines – 24 MW	
Groix-Belle Île	3 turbines – 28.5 MW	
Eolmed	3 turbines – 30 MW	
EFGL (Golfe du Lion)	3 turbines – 30 MW	
Golfe de Fos-sur-Mer	250 MW	Call for tender is ongoing
Port-la-Nouvelle	250 MW	Call for tender is ongoing

Sources: 2021 Observatory for marine energies

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



FLOATGEN, 1st floating wind demonstrator in France, installed in 2018
Objective: to validate the performance of the combination of a wind turbine and a floating foundation
Capacity: 2 MW (Vestas V-80)
Installation location: Le Croisic
Water depth: 33 m
Power generation: 6 GWh in 2019
Consortium:

Energy savings and wind power

Capgemini invent | France Energie Eolienne

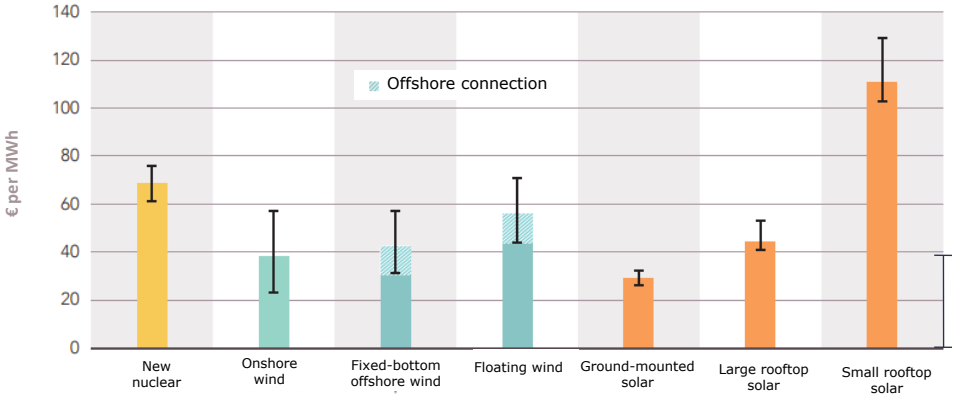
Resilience in the face of the energy crisis

Wind energy at a competitive price thanks in particular to technological developments

The cost of energy production for a given system is measured using the **levelised cost of energy** (LCOE) metric. LCOE takes into account the full costs of an installation over its entire service life. Whether in a current or prospective approach, **wind energy has a competitive price** compared to other sources (between €44 and €71 per MWh for onshore in 2021).

It is also competitively priced when comparing to market prices in September 2022, which could exceed €1,000 per MWh. Wind energy thus provides an effective shield against inflation and contributes to **protecting French consumers' purchasing power against rising prices.**

Production costs for different types of new installations commissioned in 2050[1]



Production costs (including connection cost for offshore wind power), variations in investment, operation and maintenance cost assumptions, with a fixed discount rate of 4% for all technologies

Source: [1] Futurs énergétiques 2050 [Energy Pathways 2050], Chapter 11 on Economic analysis, RTE

Resilience in the face of the energy crisis

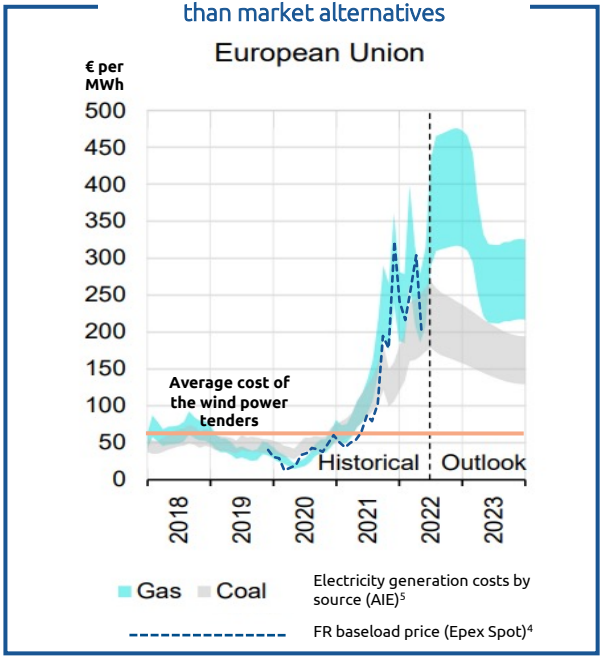
The geopolitical situation demonstrates the interest of developing energy sovereignty at a low cost

Russia's invasion of Ukraine has disrupted Europe and the energy market. Europe is indeed a major importer of energy from Russia. **France** in particular, imports **17% of its gas**[1] and **9.5% of its oil**[2] From Russia.

Due to a steep drop in energy imports, unchanged European demand and sector coupling of electrical power and natural gas, **the price of electricity has increased fivefold** year-on-year. **This shortage of supply is expected to persist over time**.[5] Several short-term measures have already been taken, including price caps, reviving coal-fired power plants, diversifying gas imports, etc.

To reconcile the long-term phasing out of fossil fuels and energy sovereignty, while also protecting consumer purchasing power and Europe's industry, **it is necessary to massively deploy low-carbon energy sources** throughout the country. With a LCOE of €64.5 per MWh[3] in the 9th call for tenders for onshore wind (AO9), **the wind power industry is well equipped to address the multifaceted challenge of transitioning towards a low-carbon energy sovereignty at a low cost.**

Wind power will lastingly be cheaper than market alternatives



Source: [1] Europe1, Fin de l'approvisionnement en gaz russe : la France doit-elle s'inquiéter ? [The end of Russian gas supply: should France be worried?]
[2] Le Figaro, Pétrole russe [Russian oil], 09 March 2022
[3] Price of electricity for the 9th onshore wind tender (AO9)
[4] Baseload price, Epex Spot
[5] IEA, Electricity Market Report, July 2022

Resilience in the face of the energy crisis

Wind power provides a solution for France's energy supply security and to protect the purchasing power of the population

Many nuclear reactors in France are currently shut down in France, for maintenance or due to corrosion problems.[1] Wind and solar power **are the only sources of low-carbon electricity sources that are inexpensive**. Promoting the development of the wind power sector would help **safeguard the purchasing power of French consumers and promote energy supply security**.

However, it is necessary to support project promoters as they have to deal with two major problems:

- **Constrained raw material procurement**, which is impacted by **logistical issues** due to the geopolitical situation. Obtaining required materials for construction currently takes **months**.
- **Changes in raw material prices**, which are due to the **significant lag** between the moment when operators bid on calls for tenders and the moment when the wind farm starts operating. **Changes in raw material prices should therefore be taken into account in the call for tenders** in order to secure the industrial supply provided by turbine manufacturers in the country.[2] For example, the price of steel (used for wind power towers and blades) has risen sharply due to the conflict between Russia and Ukraine.

Source: [1] Nucléaire : un nombre record de réacteurs à l'arrêt [Nuclear power: a record number of reactors are currently shut down], Le Monde, 18 May 2022

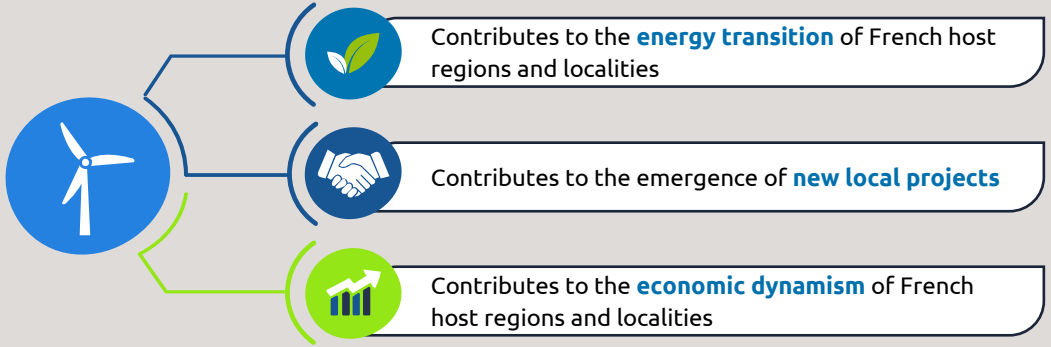
[2] Marine Godelier, 31 May 2022, La Tribune

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.

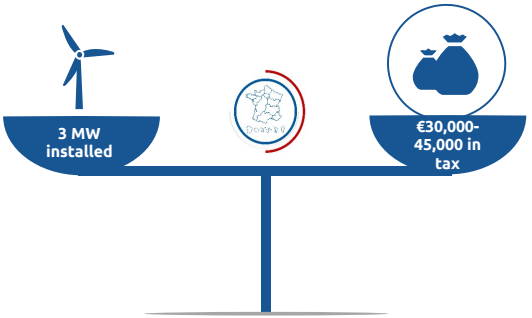


*EPCI = Établissement Public de Coopération Intercommunale – local public service companies

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 (CFE), the company value-added contribution (CVAE), and the flat tax on network infrastructure companies (*impôt forfaitaire sur les entreprises du réseau* – IFER).** These tax revenues are in the range of **€10,000 to €15,000 per installed MW per year (on average €7,500 for the locality, while the département and the region receive a total of €4,500)** and are redistributed between the different local authorities mainly based on the tax regime of the EPCI (public inter-municipal cooperation establishment) of the host locality of the project site.



Zoom on the 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 choice concerning local taxation):

	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	

Economic and fiscal benefits for local authorities

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

Examples of fiscal returns

Number of turbines	Tax revenue over the service life of a wind farm (20 years)*	Average tax revenue*	Distribution**
5	€2.5 million	€125,000 per year	• Localities/EPCI: €85,375 • Département: €35,250 • Region: €4,375
10	€5 million	€250,000 per year	• Localities/EPCI: €170,750 • Département: €70,500 • Region: €8,750
15	€7.5 million	€375,000 per year	• Localities/EPCI: €256,125 • Département: € 105,750 • Region: €13,725

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**.

** Estimate of €12,500 per MW / ** Breakdown according to the IFER standard*

Let's debunk a few misconceptions on 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.

Sources: MMA; Journal de l'éolien

Territorial development

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

Renovation of monuments, transformed 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 departement, 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 Energie Eolienne; [2] Éoliennes et immobilier [Wind turbines and property values], Ademe, May 2022

Consolidating French industry locally

The wind industry is a significant and increasing contributor to the French industrial sector

A rapidly expanding French wind power market...

The turnover of the wind power industry has been expanding continuously: in 2019, it amounted to **€5.8 billion**, which is twice as much as in 2013.[2]

For the sake of comparison:

(France's small household appliance industry generated a turnover of €**3.8 billion** in 2021.[1])

LM Wind Power's factory in Cherbourg (Manche)
Photo: LM Wind Power

... thanks to a highly advanced French know-how

This French know-how is reflected in the fact that **4 out of 12 facilities** for the production of offshore wind power equipment in Europe are located in France and in the Chantiers de l'Atlantique manufacturing platform in Saint-Nazaire.

France accounts for **1/3 of Europe's manufacturing capacities** in terms of turbines, blades and electrical substations.[3]

Certain companies located in France are global leaders in component manufacturing, as for example **Nexans** for cables.

Sources: [1] LSA conso
[2] ADEME, CNEF
[3] Observatory for marine energies 2022

Capgemini invent | France Energie Eolienne

Consolidating French industry locally

The wind power industry creates many non-relocatable local jobs as a result of the establishment of specialized wind turbine component manufacturers

Much of the activity generated by the wind industry happens directly *in situ* and therefore results in the **creation of long-term, non-relocatable jobs in the regions**.

The growth in wind power brings about the creation of specialized, innovative companies. This is the case, for example, of Avent Lidar Technology, which is specialized in the manufacturing of technological components for measuring wind speed (for instance using LiDAR technology).

Jobs related to **engineering and construction are experiencing high growth (+15% in 2021).** This strong momentum, as well as the scheduled development of offshore wind leads us to believe that the weight of the wind industry in France is set to continue expanding.

Offshore wind power is now the primary driver of this growth in wind jobs. This is due in particular to huge investments in the offshore wind industry: **in 2021, more than €2.5 billion were invested in marine renewable energies.**[1]

Sources: energiesdelamer.eu, BloombergNEF

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]

Historical overview

The first corporate PPAs were contracted in the United States, before spreading to Scandinavian countries and then to the rest of Europe.

In France, the first Corporate PPA was signed in March 2019 between Metro Cash & Carry and the 100% wind power supplier Eurowatt. The **3-year** contract, effective from 2021, is attached to a wind farm located in Eure-et-Loir, and involves **23 to 30 GWh**.[2]

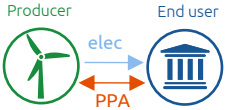
Many corporate PPAs have been negotiated since, for instance the CPPA between France's national railway company, SNCF, and Voltalia, which was signed in 2019 for a period of **25 years** and a capacity of almost **150 MW**. It is one of the 10 most important PPAs in Europe.

These contracts are now being mainstreamed and increasingly more small organizations (such as as manufacturers or service companies) are turning to corporate PPAs.[3]

Sources: [1] Capgemini Invent, [2] Eurowatt, Agregio et Metro signent un premier corporate PPA [Agregio and Metro sign a first corporate wind power PPA, GreenUnivers],
[3] Nous lançons la troisième génération de PPA [We are launching the third generation of PPAs], Engie

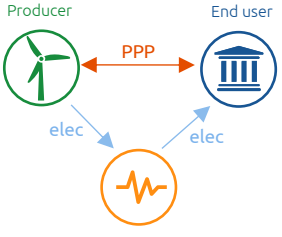
Corporate PPAs

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



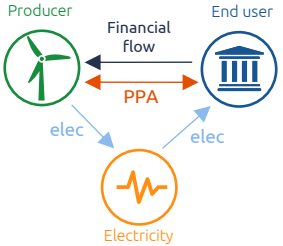
"On-site" physical

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 his utility (who 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. In 2021, no greenfield wind PPA has yet been signed.**

Source: Capgemini Invent

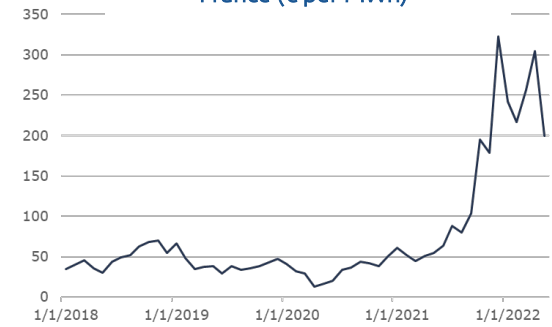
Corporate PPAs

Corporate PPAs offer many advantages for companies wishing to engage in a sustainable approach

Subscribing to a corporate PPA carries several benefits:

- This offers **visibility** to the buyer on their future electricity costs, which, given the volatility of market prices, are very complex to anticipate.
- Entering into a corporate PPA means committing **to clean and renewable energy in the long term**, which could fall under the heading of CSR.[1]

Changes in electricity prices in France (€ per MWh)[2]



Complementarity

Some companies sign several corporate PPAs: some in solar and some in wind. These two sources of electricity are indeed **complementary** given that the daily production profile of wind power is homogeneous, whereas solar power is bell-curved, only generating electricity during the day. On the other hand, solar energy is mainly produced in the summer, while two thirds of wind energy is produced in the winter.[3]

For example, in February 2022, Fnac Darty signed a corporate PPA relating to a solar farm with Valeco, **supplementing a first contract** for the sale of electricity from wind power.[4]

Sources: [1] Capgemini Invent, Développement des Corporate PPA éoliens [Development of corporate wind power PPAs], FEE
[2] Baseload prices, Epex Spot
[3] Fnac Darty signe un second PPA avec Valeco [Fnac Darty signs a second PPA with Valeco], Tecsol, 27 Feb 2022

Jobs in wind power

Capgemini invent | France Energie Eolienne

Key facts and figures

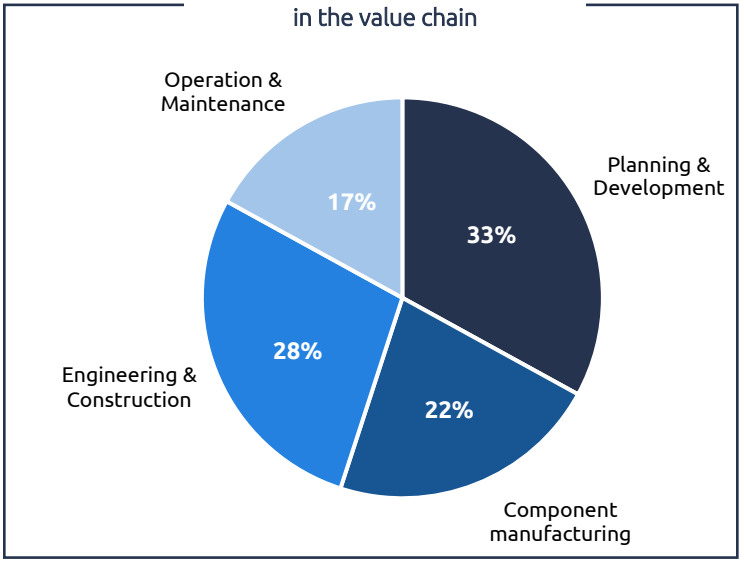
25,500 FTEs
in wind power at the end of 2021

12.8 %
increase in jobs in 2021

In 2021, **wind power jobs have continued increased at a significant pace**, with a growth rate of 13% and a total of 25,500 direct and indirect jobs in France as at 31 December 2021.

As in 2020, offshore wind boosts job growth in the French wind industry. This trend is largely due to the stepping up of the Saint-Nazaire, Fécamp and Saint-Brieuc farms. With an observed growth of more than 20%, offshore wind accounts for approximately 6,300 jobs in 2021.[1] These jobs are primarily created in the Normandy and Pays de la Loire regions.

Distribution and variations in FTEs in the value chain



Sources: [1] Observatory for marine energies 2022

JOBS

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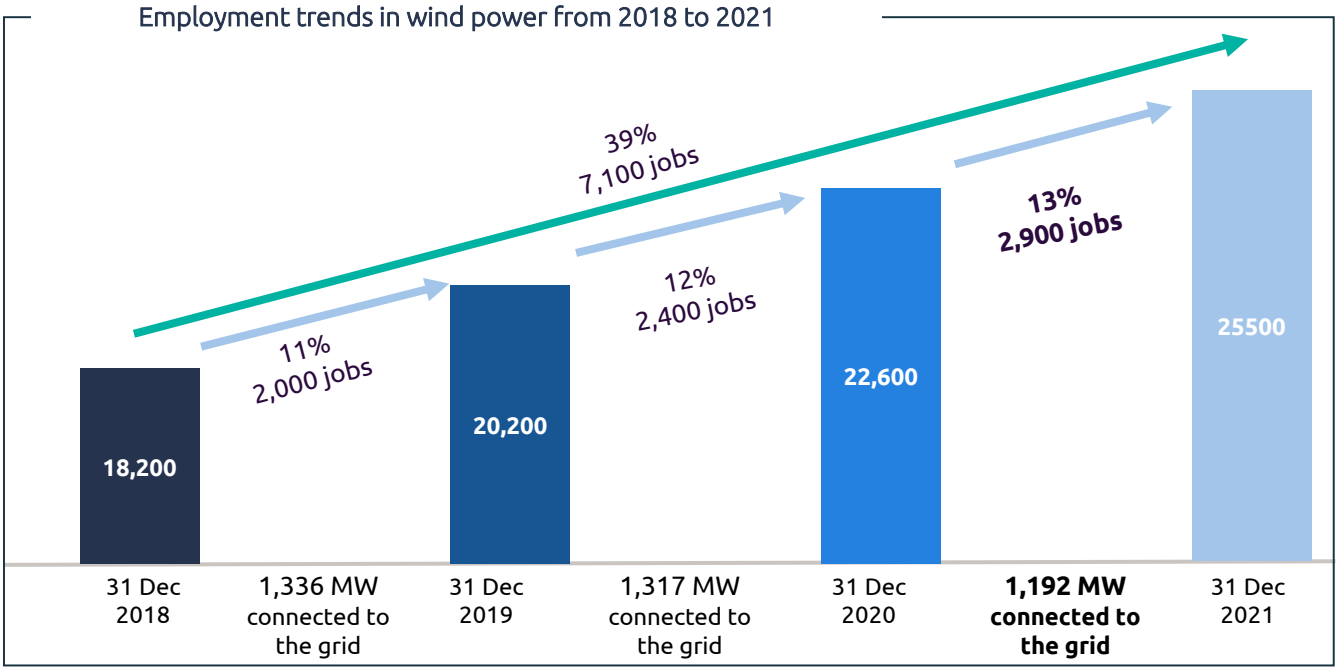
Job growth in wind power in France in 2021

The number of wind jobs continues growing, spurred on by the development of offshore wind



Source: FEE study, data processing by Capgemini Invent

Capgemini invent | France Energie Eolienne

Details by link in the value chain

An activity organized along 4 segments

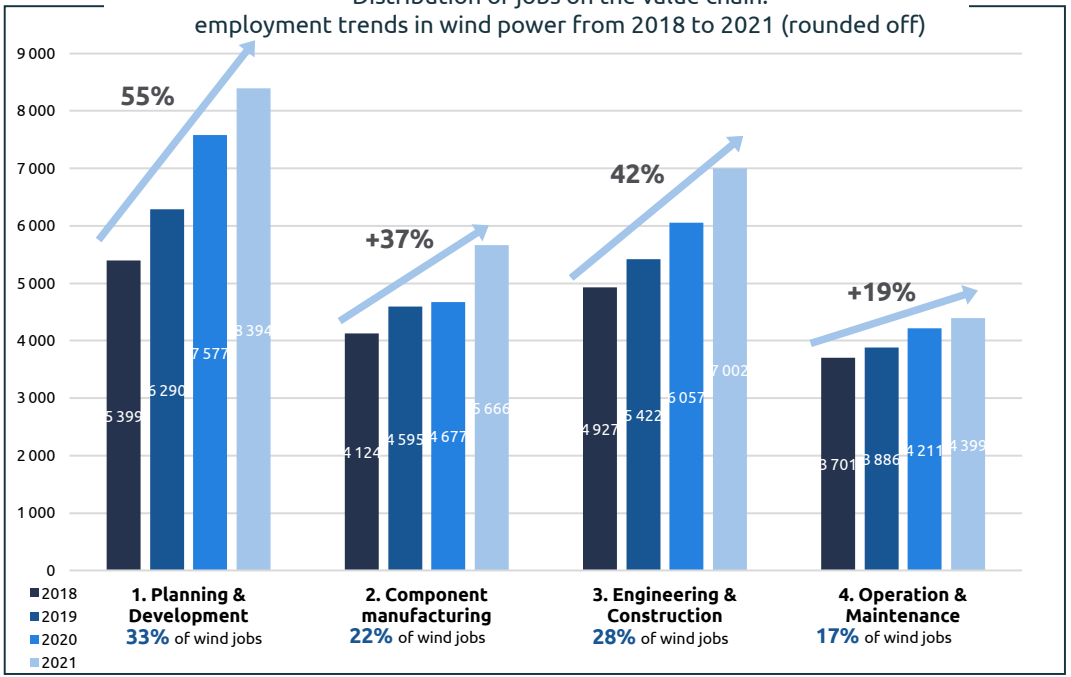
The French wind power industry has businesses operating along the entire value chain, providing wind power jobs within the following key activities:

		% of total jobs in 2020
Planning & Design	e.g. engineering consultancies, wind measurement, geotechnical measurement, technical expertise, performance monitoring, developers, financial institutions	**33%**
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	**28%**
Operations & Maintenance	e.g. assembly, logistics, civil engineering, power grid and wind farm electrical engineering, erection, grid connection	**17%**

Details by link in the value chain

The strong momentum in Planning & Design translates the industry's involvement in achieving the objectives set out in the PPE

Distribution of jobs on the value chain:
employment trends in wind power from 2018 to 2021 (rounded off)



Source: FEE study, data processing by Capgemini Invent

Disclaimer

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.

JOBS

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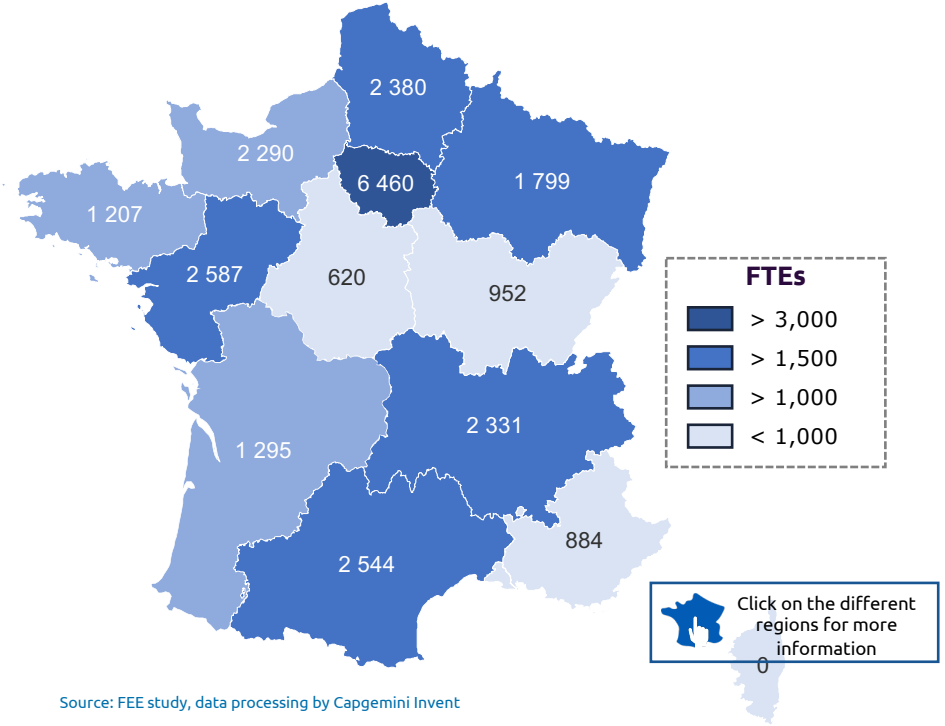
Breakdown of wind jobs by region

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



Top 10 employers*
(FTEs, 2021)

- 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

Source: FEE study, data processing by Capgemini Invent

JOBS

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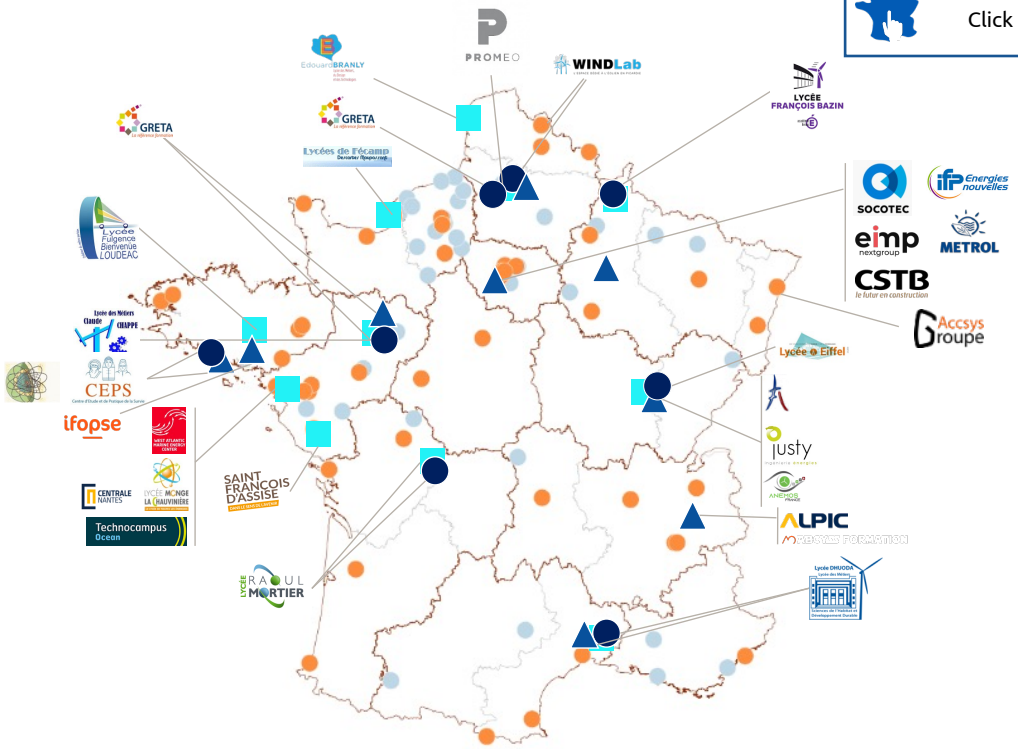
Capgemini invent | France Energie Eolienne

Wind energy training programmes

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

Click on the logos to find out more



Key:

- *BZEE*
- *GWO*
- *BTS MS Option Eolien*
- *4/5 years post-secondary education*
- *+2/+3 years post-secondary education*

JOBS

Capgemini invent | France Energie Eolienne

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

The French wind power sector is developing strongly and is recruiting **several hundred people** each year. The industry is seeking to recruit new talent from a variety of backgrounds. There are training programmes specific to the wind industry at all levels of education, **from high school level (*bac professionnel*) to engineering schools and generalists**.

Working in the wind energy sector has **many advantages**: these **jobs are decentralized** and spread throughout the country following the regional distribution of wind power. They are **stable jobs** (mostly on permanent contracts) that are necessary for the energy transition. Finally, there are many **career opportunities**, both internationally and in shifting from onshore to offshore wind.

2,000 to 2,500 jobs[1]
created per year

> 80% on permanent contracts
in wind power

900 companies[2]
located throughout the country

Sources: [1] 2021 Wind Observatory, FEE
[2] L'éolien, une énergie qui créé des emplois tous les jours [Wind power, an energy that is creating jobs on a daily basis], FEE

Capgemini invent | France Energie Eolienne

Wind energy training programmes

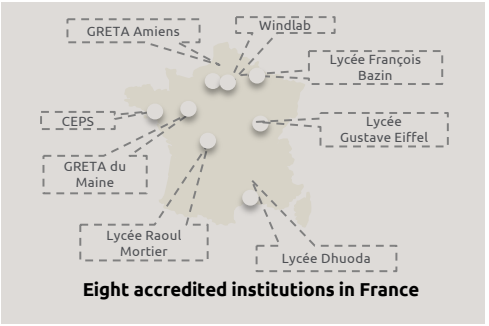
Two international certification programmes are available in France

CLICK ON THE TRAINING PROGRAMMES TO LEARN MORE ABOUT THEM

BZEE - Technician certificate in wind power systems maintenance

- Advanced training in **wind turbine maintenance techniques and safety measures**
- Continuing education or apprenticeship training lasting **6 to 9 months**
- Four of these training centres also offer GWO modules
- More than 320 students were BZEE-trained and certified in France in 2016. They were awarded either the Service Technician for Wind Energy Facilities certificate or the Working at Heights certificate.

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

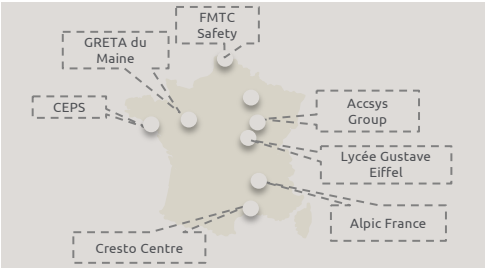


Eight accredited institutions in France

Basic Safety Training Certificate

- Safety-focused training
- Five modules to be completed (over a period of seven days)
- Overall, 25,000 individuals throughout Europe are now certified for between three and five GWO modules.
- Since December 2015, the BZEE certificate has also included GWO modules, including modules on maintenance safety training.

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

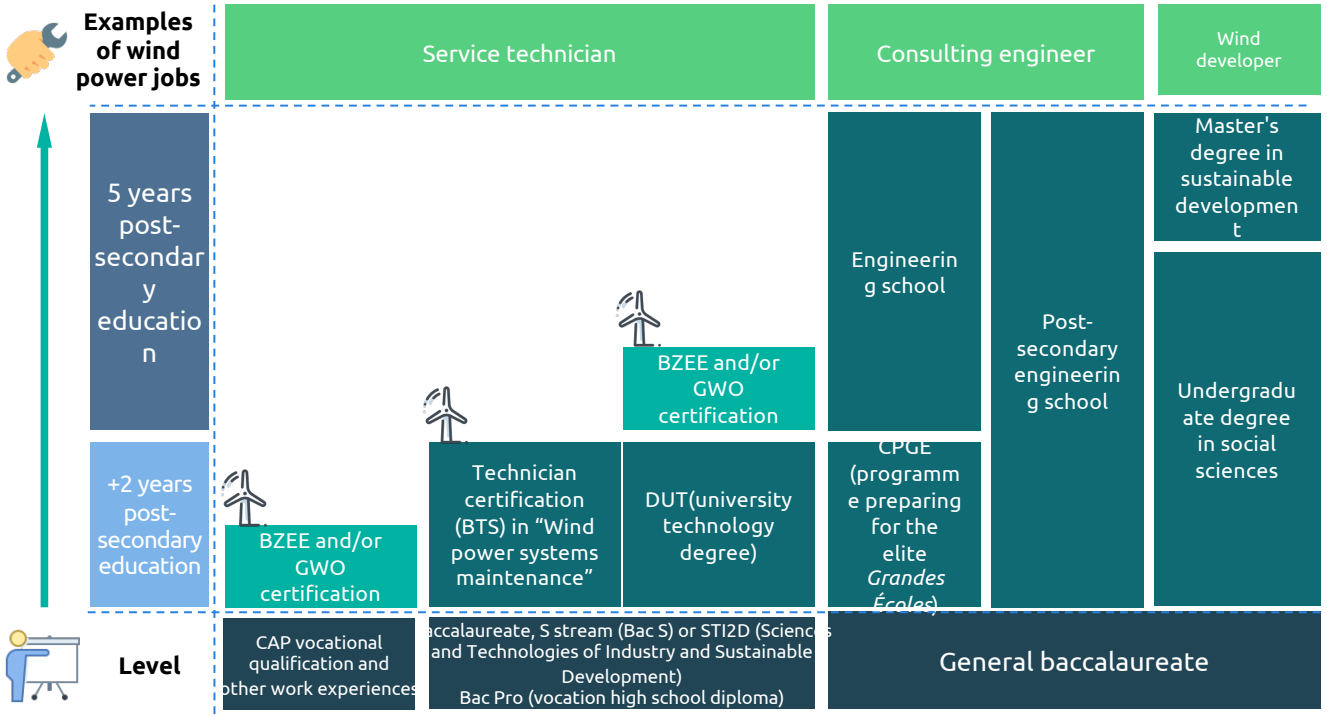


7 accredited institutions in France

Wind energy training programmes

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

Sample student itineraries



Capgemini invent | France Energie Eolienne

Integration in the network – Training

RTE anticipates the future through training activities

The development of wind power is taking place within a **context of technological change** and **evolving skill needs**.

This is leading RTE, and perhaps more generally all players in the electricity sector, to:

- **Develop new solutions relating to automation and flexibility**, primarily based on digital technologies, in order to safely feed these intermittent energy sources into the grid.
- **Prepare and train employees** in activities related to these technological changes, addressing the generalised need for digital skills

Jobs that are in short supply, highly sought after and involving new skills, have already been identified within RTE.

RTE is therefore acting along two complementary directions:

- **Train existing staff** for new jobs types or skill needs.
- **Engage with the academic world** in order to highlight the value of professions linked to the energy transition and contribute to updating the skills developed in technical and engineering degrees.

In order to carry out these actions, RTE relies on its campus, Campus Transfo, which is located in the Lyon metropolitan area and brings together educators and specialists in the field of electricity transmission. Each year, 7,000 trainees benefit in their training and preparation from full scope replica training on a single site (including a replica electrical substation, high voltage line, HV and LV equipment), as well as testing and simulation platforms that address the future of electricity transmission.

Beyond these corporate actions, more collective approaches are being developed. This context is bringing the training centres of RTE and Enedis to consider common courses of action.

Integration in the network – Training

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

To cope with strong business growth of around 10% in 2021 and prospects for continued growth for the years to come, Enedis is stepping up its recruitment efforts: **2,200 employees will be recruited in 2022, including 1,000 on a fixed-term or permanent basis and 1,200 on work-study contracts**. At Enedis, 30% of recruitments on long-term contracts come from work-study programmes.

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

- **Technical challenge:** Transforming Europe's largest power grid into a connected and controllable grid. Its mission is to guarantee the quality and safety of France's electricity distribution network over time. To support this mission, it is actively recruiting electrical technicians (from CAP post-secondary education to graduate degrees)
- **Technological challenge:** Enedis' public service mandate includes facilitating the ecological transition. Its mission: protecting the data of 37 million customers by leveraging the latest technologies. To support this mission, it is actively recruiting cybersecurity engineers, experts in electrical systems (from post-graduate degrees and engineering schools)
- **Ecological challenge:** Enedis will, for example, be connecting 1 million renewable energy producers by 2030. Its mission is to make every effort to concretely reduce CO_2 emissions and thus contribute to achieving carbon neutrality. To support this mission, it is actively recruiting account managers and project managers for connection projects (with a graduate or post-graduate background)

Spotlight on female talent:
Enedis views diversity in backgrounds, experiences and teams as sources of creativity and cross-fertilisation. In 2021, 24.65% of the company's employees were female. Attracting more female talent is a major issue for the company, 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 is also working on fighting against prejudiced attitudes towards technical professions and promoting female leadership, inside and outside the company.

Wind energy training programmes

Focus on a selection of training programmes in wind power

Lycée François Bazin

- **BTS** technician work-study programme
- & **BZEE + GWO** certification
- **16 students per year** in short-term *ad hoc* FCIL training programmes and **12 students per year** in post-secondary technical education (BTS)
- **Partnership** with major players, including **EDF Énergie Renouvelables** as part of the construction of a 61-turbine wind farm in the Ardennes

500–600 graduate students

90% of graduates find a job in less than 3 months

Lycée Dhuoda

- **BTS** technician work-study programme & **BZEE + GWO** certification
- **200–250 students per year** in post-graduate technical degrees (IUT) and **90 students per year** in post-secondary technical education (BTS).
- **Offshore-specific training programmes** are being considered

Opportunity to pursue a BTS under a work-study contract

85% of trainees find a job in the industry

Specialized Master's degree "Experts in renewable energy projects and production"

- **Career opportunities**: Renewable energy project management/development, engineering consultancies, etc.
- **Partners**:

90% of graduates sign a contract in less than 4 months

Specialized Master's degree Experts in marine renewable energies

- **Career opportunities**: Renewable energy project management/development, engineering consultancies, etc.
- **Partners**:

96% of graduates find a job within 1 year, 84% in less than 2 months

JOBS

Focus on the Observatory for marine energies

Key figures for Marine Renewable Energies (MREs) in 2022

6,591 FTEs
in MREs, amounting to +36% in 2021

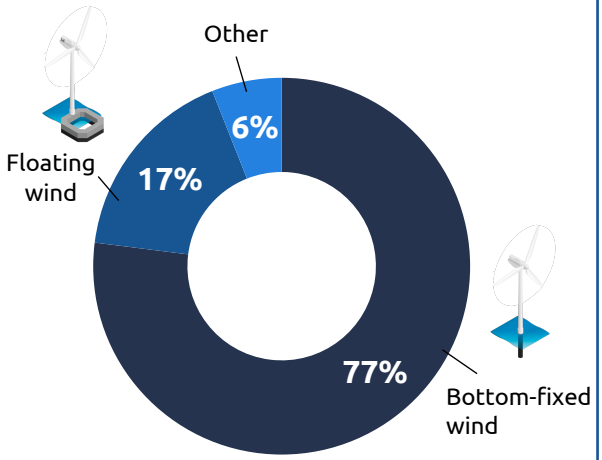
5,075 FTEs
in bottom-fixed wind

1,121 FTEs
in floating wind

€2.2 billion
out of a total €2.6 billion were invested by developer-operators

€1.3 billion
In turnover for service providers and suppliers in the value chain

Breakdown of FTEs within MREs

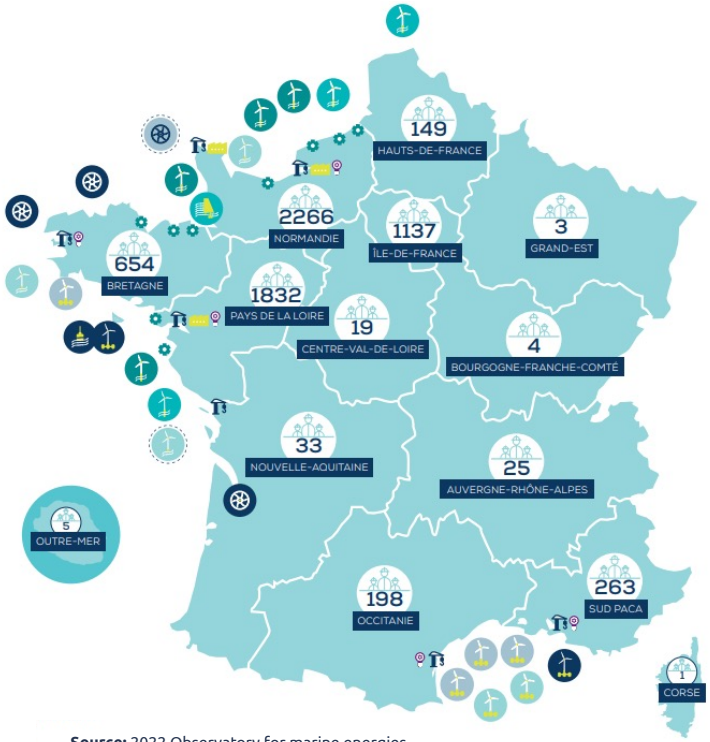


Source: 2022 Observatory for marine energies

JOBS

Focus on the Observatory for marine energies

Very strong growth in FTEs linked to MREs, in particular due to new industrial facilities in the offshore wind sector



FTEs are up in all regions, especially in **Normandy**, where the number of FTEs has more than doubled, increasing from 1,090 jobs in 2020 to **more than 2,200 jobs in 2021**. This is due to key **industries setting base** in the region (GE Renewable Energy's blade factory in Cherbourg and Siemens Gamesa's nacelle and blade plant in Le Havre), but also to the **development of offshore wind farms** (the Fécamp wind farm in particular).

The increase in the number of FTEs is largely due to the boom in **bottom-fixed wind power** and the new calls for tenders in **floating wind power**.

Source: 2022 Observatory for marine energies

JOBS

Focus on the Observatory for marine energies

The companies awarded construction lots for offshore wind speak to the construction of a French value chain

	SAINT-NAZAIRE		SAINT-BRIEUC		FÉCAMP		COURSEULLES-SUR-MER	
	Manufacturing	Installation	Manufacturing	Installation	Manufacturing	Installation	Manufacturing	Installation
Onshore substation	Hitachi, Siemens et GE	Eiffage Energies	Hitachi et Siemens	SPIE	Hitachi et Siemens	Omexom	Siemens	Omexom
Onshore connection	Prysmian	Omexom et Eiffage	Nexans	Omexom	Prysmian	SPIE, Bouygues, SPAC	Prysmian	Sadertelec
Offshore connection	Prysmian	Prysmian	Nexans	Nexans	Prysmian	Prysmian	Prysmian	Prysmian
Offshore substation	Chantiers de l'Atlantique	DEME	Fabricom/ Smulders	Saipem	Chantiers de l'Atlantique	DEME	Chantiers de l'Atlantique	DEME
Turbine foundation	Eiffage	DEME	Navantia	Van Oord	Bouygues TP			
Inter-array cable	Prysmian	LD Travocéan	Prysmian	Prysmian				
Wind turbines	GE Renewable Energy	Jan de Nul GE Renewable Energy	Siemens Gamesa		Siemens Gamesa		Siemens Gamesa	
Commissioning								

As at 31 Dec 2021

Completed

Ongoing

Undeveloped

Source: 2022 Observatory for marine energies

JOBS

Focus on the Observatory for marine energies

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

The **6,591 FTEs in MRE** are spread across various positions (factory workers, technicians, engineers, back office, sales). One of the major challenges facing the industry lies in **recruiting qualified employees** to help develop the sector. Training programmes are therefore essential to ensure that the sector grows sustainably.

Currently, **71 programmes relating to MREs** have been identified, including 9 Master's degrees, 4 undergraduate programmes and 3 DUTs (two-year, post-secondary technical degree). In 2021, **1,454 students** attended these programmes.

With the installation of **large industries,** particularly for offshore wind power, the number of jobs in the MRE sector continues to increase, which makes it a **particularly attractive field** for trainees.

Breakdown of MRE FTEs by position*

* For service providers and/or suppliers to the value chain

Source: 2022 Observatory for marine energies

JOBS

Focus on a wind employment area

Benoît Arrivé, the mayor of Cherbourg-en-Cotentin, provides an overview of how the offshore sector developed locally and what is being done to meet the industry's recruitment challenge

Wind power development is driven by local and regional authorities

Cherbourg-en-Cotentin is now **the leading port for renewable marine energies in France**. This momentum comes from the involvement of three local and regional authorities: the municipality of Cherbourg, the département and the Basse-Normandie Region.

These authorities took part in **European gatherings** around marine renewable energies, **gaining exposure to companies** that were seeking to expand.

Supported by the regional port authority, Ports Normands Associés, they also worked on creating the **right conditions for businesses**, investing almost €100 million to extend the embankments and lengthen the quay.

Recruitment: a major challenge for companies and for the region

Public authorities at all levels have been preparing the **retraining of workers involved in nuclear industry** for the MREs to conclude the Flamanville EPR 3rd generation nuclear reactor **"Grand Chantier" megaproject**.

As for companies, they are running **specific recruitment campaigns** to attract talent to the north of the Cotentin peninsula. In addition to these initiatives, public and private actors are consolidating **local training offerings** tailored to the needs of manufacturers (creation of a school, a centre of excellence, specific training programmes, etc.).

12 years
in commitments related to wind power development

39 ha
dedicated to offshore industrial activities

Almost 2,000 jobs
on the territory in wind power

Driving the industry forward

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

Competitiveness clusters

These bring 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

These bring together public and private stakeholders to facilitate 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

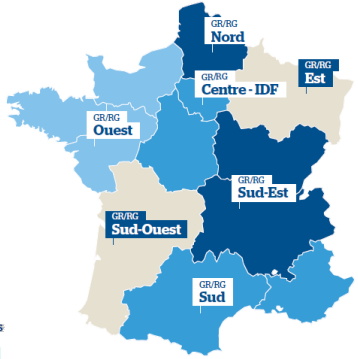
Other relevant actors

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

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

Driving the industry forward

Mapping the actors involved in the industry



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

Key:

- *Competitiveness cluster*
- *Cluster*
- *Other relevant actor*
- *France Énergie Éolienne*

Click on the logos for more information

JOBS

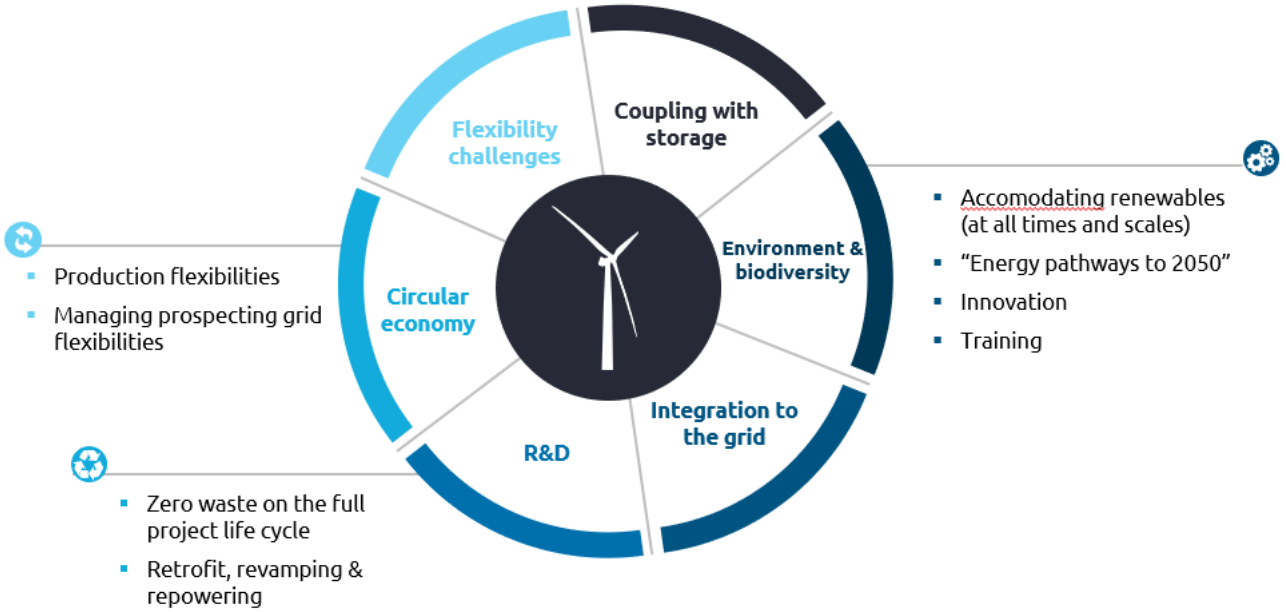
Capgemini invent | France Energie Eolienne

Wind power's great challenges to 2030

Capgemini invent | France Energie Eolienne

Overview of the key challenges

Wind energy faces many challenges in its development



Capgemini invent | France Energie Eolienne

Integration of wind power into the grid

Marianne Laigneau, President of the Management Board of Enedis, presents the solutions that Enedis is developing to massively integrate renewable energies (EnR) within the distribution network

Adapting the grid: a challenge for renewables

Enedis must now transform in order to **accommodate an increasing share of renewables** (which are characterised by their variable and decentralised production) within the grid it operates. The grid is indeed undergoing a **major shift** as it is becoming **bidirectional** (with the expansion of renewables) and **increasingly digital and decentralised**. Due to the magnitude of these changes, Enedis must engage in large-scale investments: its purchases now amount to **€4 billion per year**, **98% of which are sourced in France** and **50% from VSEs and SMEs**. This transformation of the grid is therefore part of a broader approach geared towards **growth, industrialization and sovereignty-building**.

Enedis is undertaking many actions in order to anticipate future transformations

1. Streamlining internal processes in order to **speed up grid connection time**
2. **Investing** in the network (while keeping the costs borne by regional and local authorities under check)
3. Improving grid development **planning**
4. Developing **express source substations** that are justified by the need to connect renewables to the grid
5. Implementing **local flexibilities** to better accommodate renewable energies
6. Optimising the **size of existing sources substations** to facilitate the integration of renewable energies

3.7 GW
of renewable energy capacity integrated into the grid in 2021

5 times more RE
in the grid by 2035

500,000
renewable energy production sites connected at the end of 2021

35 electrical substations
built by 2035

CHALLENGES

Integration of wind power into the grid

Marianne Laigneau, President of the Management Board of Enedis, presents the solutions that Enedis is developing to massively integrate renewable energies (EnR) within the distribution network

Demands for renewable energy coming from within the country

Enedis is **well grounded locally** thanks to its 800 sites, which provide it with a **fine understanding of local realities**.

Throughout the country, Enedis has observed that the expectations of local authorities are always similar, regardless of size, location or political leaning. They have the desire to **produce energy locally** and to **increase the share of renewable energies** in their electricity mix, while also **keeping prices in check** to ensure affordability for end consumers.

Today, most concession contracts between Enedis and local authorities include a **section on the ecological transition**, charting the future installation of renewable power facilities and the development of electric mobility.

> We observe is that the expectations of the territories are the same: more renewable energies, more local production and keeping energy costs under control.
>
> Marianne Laigneau

Integration of wind power into the grid

Xavier Piechaczyk, Chairman of the Executive Board of RTE, presents solutions to enable the proper integration of wind power into the electricity grid in a context of major offshore wind power development

Despite its variability, wind energy contributes to France's security of energy supply

Installed wind power capacity is now significant as wind power has become France's 3rd largest power source. The average statistical contribution of wind power to the security of energy supply is substantive, especially during winter peaks.

The strong penetration of wind power (but also of solar power in the near future) increases variability significantly. This raises new questions regarding how to maintain a continuous balance between power generation and consumption. Flexibilities should be developed, not only in the form of load shedding, but also by broadly embracing the whole range of available solutions (energy storage, hydrogen, etc.).

RTE is adapting in order to keep up with the development of offshore wind power, which requires great industrial, human and financial effort

1. Contribute to the government's **energy planning** and **marine spatial planning** work
2. Take part in **legislative and regulatory work** aiming to streamline and secure the conditions for the development and implementation of maritime connection projects
3. Preparing the **scale-up** with the entire industrial ecosystem
4. Contribute to the **sustainable development** of coastal and maritime areas
5. Within RTE, organise **industrial project management** dedicated to the management of these infrastructure projects

7.7%
of French electricity consumption was covered by wind power in 2021

18 GW
of offshore wind production by 2035

40 GW
in offshore wind capacity commissioned in 2050

Integration of wind power into the grid

Xavier Piechaczyk, Chairman of the Management Board at RTE, stresses the importance of developing wind power in the years ahead

There are various possible pathways for France to achieve carbon neutrality by 2050. The one that was selected involves building 14 new nuclear reactors by 2050. However, the new generation of nuclear reactors, EPR 2, will not be operational, at best, before 2035. **It is necessary to rapidly develop a renewable energy base, which should logically give a prominent place to onshore wind power.**

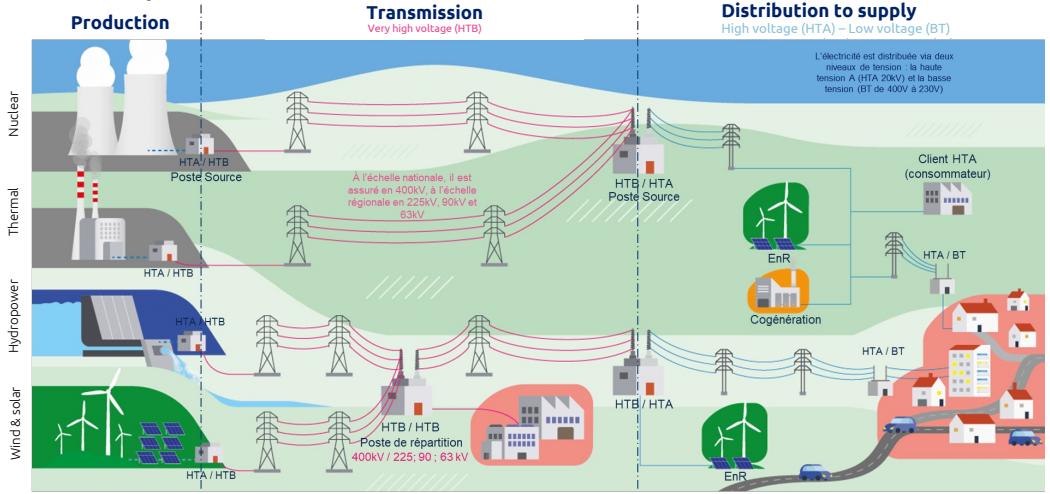
The current energy crisis is acting as an accelerator. It reinforces the need to phase out fossil fuels. The transition was previously driven by the **fight against global warming**, but it is now also necessary to improve France's energy **sovereignty**. Thus, it is imperative that France **simplify its procedures** to catch up and accelerate the development of renewable energies. Finally, that when installed farms are renewed, this results in a significant increase in capacity, **tapping into wind resources more optimally.**

> "Carbon neutrality cannot be achieved without significantly developing renewable energy sources."
>
> Xavier Piechaczyk

Integration into the grid – at all levels

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

General layout of France's electricitv transmission network:



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.

55%

Electricity represents 55% of France's final energy consumption in 2050, compared to 25% in 2021[1]

135 GW minimum

A minimum of 135 GW of installed capacity from wind (offshore and onshore) and solar in 2050, compared to 31 GW in 2021[1]

Source: RTE

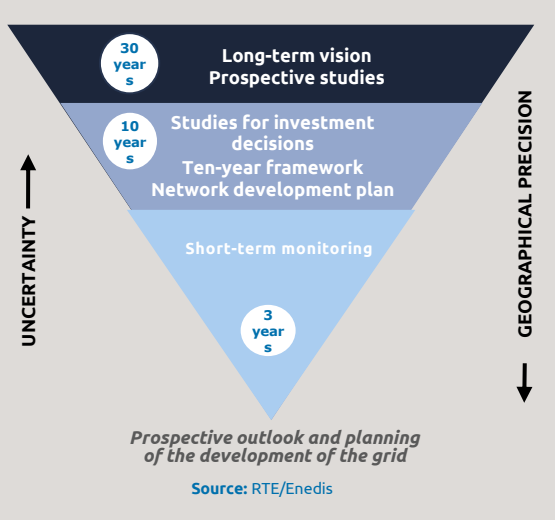
Integration into the grid – at all levels

The integration of renewable energies is being prepared at all geographical levels

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

- **RTE's *Bilan prévisionnel* forecast** is a comprehensive study of the changing dynamics between power generation and use. The Energy Pathways 2050 report published this year examines the impact of 6 energy-mix scenarios.
- 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.
- **TYNDP (Ten-Year Network Development Plan)**, which concerns the European grid and was built in collaboration 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 ten-year planning horizon (as discussed in the following pages).

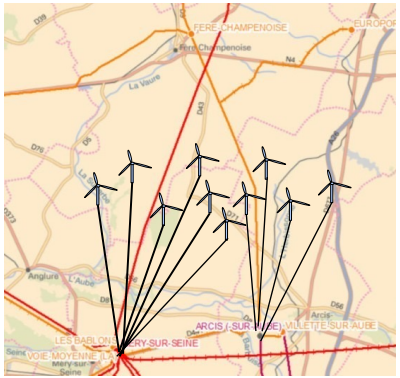
The Network Development Plan introduced by the French Energy Code in transposition of the Clean Energy Package is applicable since 5 March 2021. This is a new document which will present the challenges, methods and orders of magnitude of the investments that must be carried out in the **distribution network** in the medium term (within the next 5 to 10 years), as well as new high-impact themes (flexibilities, renewable energy, electric mobility). Updated every 2 years, it will be prepared together with grid users and organising authorities for public electricity distribution (AODEs) and the national electricity transmission operator, RTE, before being submitted for approval to the French Energy Regulation Commission (CRE) and the Committee for the Public Electricity Distribution System (CSDPE).



Integration into the grid – at all levels

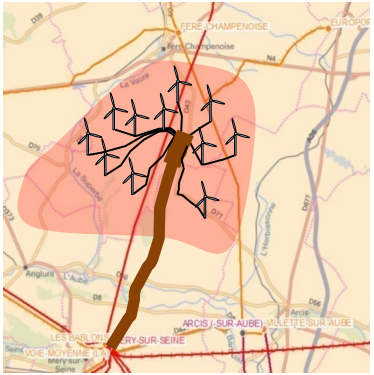
The S3REnR schemes improve renewable energy integration while providing good visibility for all stakeholders

Before



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

With S3REnR regional schemes



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

Objectives of the S3REnR schemes:

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

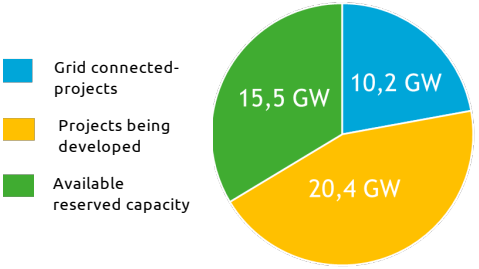
* The "quote-part" fee (k€/MW) corresponds to an infrastructure cost share requirement that is paid by producers when connecting their wind farms to the grid.

Integration into the grid – at all levels

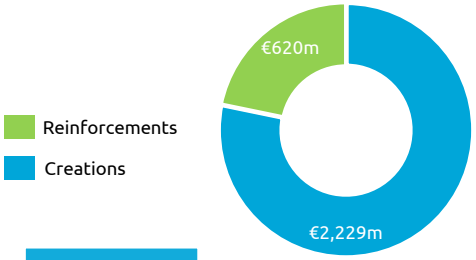
To date, the 18 S3REnR schemes represent a grand total of 46.1 GW in renewable accommodation across the country, with a record year in 2021 with 3,950 MW connected to the grid

Key data for 2021

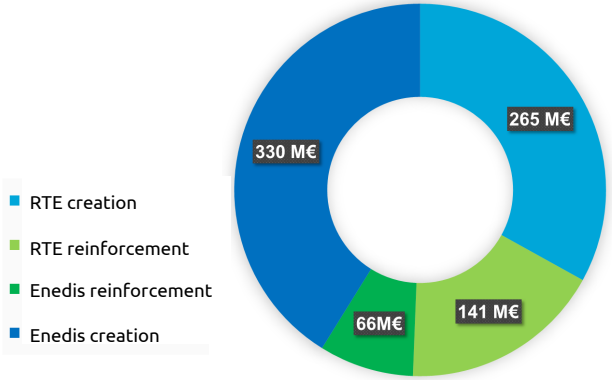
Total accommodation capability reserved for renewable energies



Total investment in renewable accommodation



Total expenditure in renewable accommodation

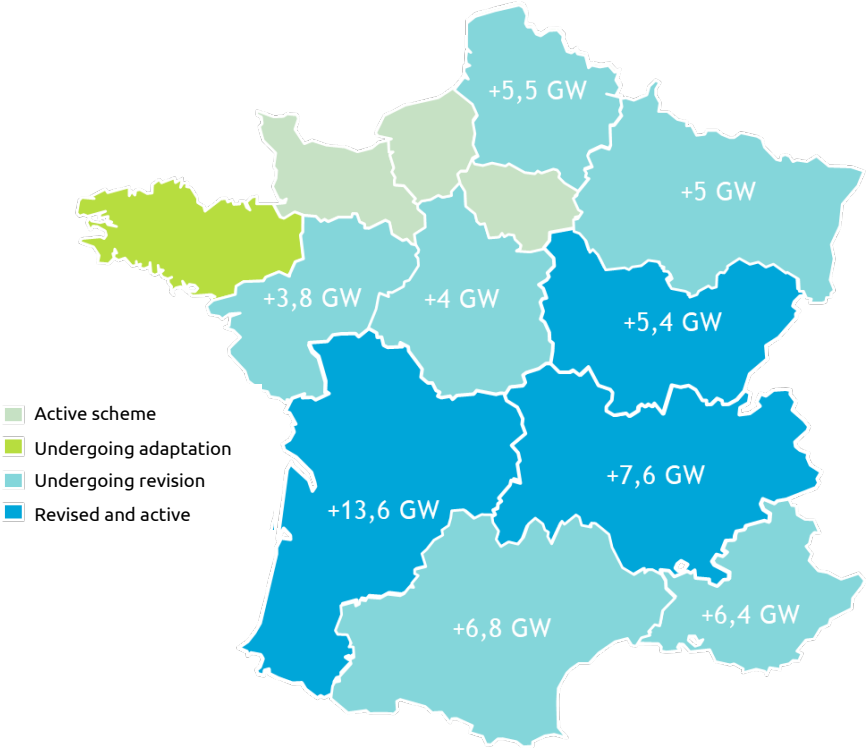


It should be recalled that the creation of the S3REnR are funded by producers through the "quote-part" mechanism: At the end of 2021, the monies spent by grid operators for the S3REnR infrastructure development amount to almost two thirds of the amounts perceived through the "quote-part" financing collected from producers (€616m vs. €409m).

CHALLENGES

Integration into the grid – at all levels

Scheme revisions will allow a significant increase in reserved capacity



58 GW of additional capacity thanks to the scheme revisions:

- +26.5 GW for current schemes
- +22.2 GW by the end of 2022 (with the PACA, GE, Occitanie and CVL schemes)
- +9.3 GW by the end of 2023 (HdF and PdL schemes)

amounting to an estimated €5 billion in investments

Schemes where the revision process hasn't yet been initiated:

- The Brittany scheme is being adapted to release additional capacities before the revision process is initiated.
- The Haute-Normandie, Basse-Normandie and île-de-France schemes have a low completion rate (< 50%).

Integration into the grid – at all levels

Constant exchanges between producers, network operators, CRE and DGEC to improve the existing framework

INSAS, the national authority in charge of monitoring and improving S3REnR schemes, which brings together **federations of producers, grid system operators, CRE and DGEC** has been facilitating sharing around current issues for several years now, as well as making **concrete contributions** to the improvement of the current system through joint work (proposing, monitoring and anticipating studies and administrative procedures, mapping wind power potential, identifying diffuse PV potential more precisely, etc.).

A working group led by the DGEC, has inventoried all current issues in relation to grid-connection and made ambitious proposals

Due to the numerous grid developments and the very strong momentum in renewables, the current system might undergo structural changes. Proposals were made by all stakeholders and DGEC suggested focusing efforts on measures allowing:

- to speed up and streamline the grid connection process
- to change the objectives of the S3REnRs, as well as the ways in which they are drafted, adapted and revised and how their funding is distributed
- to change the missions of the grid system operators in order to facilitate the sharing of data relating to the electricity networks, thus helping optimise connections to the grid
- to specify the conditions under which the network managers have the possibility or the obligation to anticipate certain studies, works or procedures in order to accelerate the connection of new capacities
- to adapt the procedures for public consultation relating to public transmission or distribution network infrastructure in order to articulate the various existing procedures more effectively.

Grid integration – Focus on offshore wind

RTE, the industrial operator of the energy transition at sea

In its capacity as France's electricity transmission system operator, RTE is responsible for bringing the power generated by all offshore wind farms onshore into the main grid and ensuring an optimal management of how this power is integrated onshore thanks to its dense and extensive coverage.

Since France's legal framework was adapted in 2017 and 2018 to capitalise on the learnings from the very first projects and accelerate offshore wind power's development, **RTE has taken part in the public debate (alongside government authorities) in anticipation of the call for tenders and the completion of the baseline environmental studies, funds the connections to the grid and develops the sea-based platform.**

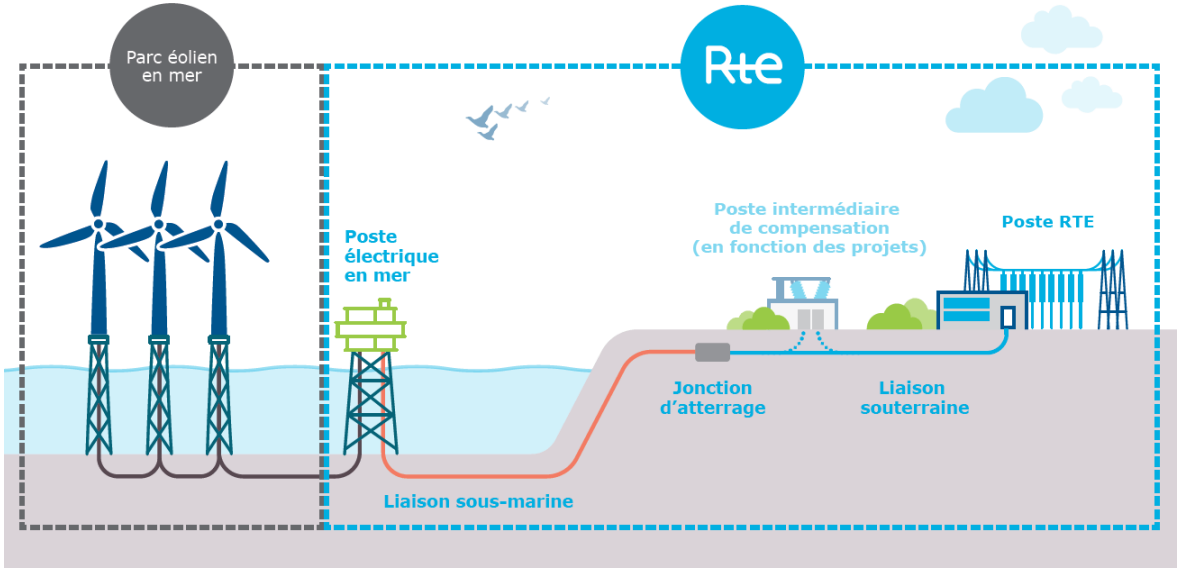
In April 2020, the multiannual energy plan (PPE) set the objective of achieving an installed offshore wind power capacity (in fixed-bottom and floating offshore wind) of between 5.2 and 6.2 GW by 2028 and 10 GW in 2035. **In 2022, the French government announced that these objectives would be raised to 18 GW of installed capacity in 2035 and 40 GW in 2050. These objectives should be reflected in the next PPE, which is scheduled for publication in mid-2024.**

To succeed in this industrial ambition, RTE is positioning itself as a **sustainable developer on land and at sea**, which is reflected in particular in:

- the **anticipation of grid development needs, both at sea and on land**, thanks to joint planning by the French State of production and the grid (amounts, location and provisional timeline for future projects)
- the **application of methods for optimising connection infrastructure** that are conditional on this planning process (connecting several wind farms to the same offshore platform, adapting the size of wind farms to the the capacity that the grid infrastructure is capable of accommodating, standardization, etc.)
- an **offer of co-use services on its offshore platforms** to create additional value for the community
- a **commitment to carry out technological and marine environmental R&D**
- **constant and open dialogue with all marine stakeholders** over the full project life cycle.

Grid integration – Focus on offshore wind

RTE, the industrial operator of the energy transition at sea



RTE installations implemented in connection to offshore wind farm development

Grid integration – Focus on offshore wind

Scaling up the connection of offshore wind farms to the grid

To achieve carbon neutrality in 2050, the massive development of renewable energies is crucial, and offshore wind power will play a very important role in this low-carbon electricity mix. The Energy Pathways 2050 report adopts a figure of between 22 and 62 GW for offshore wind power development, depending on the relaunch of new nuclear power or not. **In 2022, the French government announced a 18 GW target for installed capacity in 2035 and 40 GW in 2050**, which should be reflected in the upcoming PPE.

This ambitious trajectory implies increasing commissioned capacity sixfold between 2025 and 2035 (from 3 to 18 GW) and allocating as much capacity between 2025 and 2028 as has been achieved so far. Finally, to meet these deadlines for commissioning in 2035, it will be necessary to collectively (public authorities, RTE, developers) **reduce project durations by approximately 2 years**.

These different issues require:

- ensuring an **adequate tie-in between energy planning (via the PPEs) and marine space planning (DSF)**, specifying both the projected project capacities, their location and their provisional timeline for completion, thereby optimising how the grid is developed in anticipation at sea as well as on land;
- **standardising connection structures**, allowing purchases to be scaled up, thereby reducing project completion time as well as offering improved visibility for the entire MRE value chain;
- **strengthening the consultation process and project management** in order to ensure that projects are deeply rooted in their host territories throughout their service life, which entails optimised efforts to shed light on any environmental issues associated with these projects, supporting the transition of maritime sectors (including fishing), as well as reflecting on infrastructure development needs (ports, industrial activities);
- **streamlining the administrative side of projects**, including the grid-connection process.

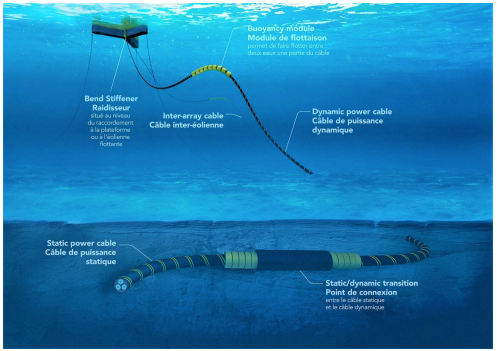
Grid integration – Innovation

Supporting the promising development of floating offshore wind

Fixed-bottom offshore wind (where turbine foundations are fixed to the seabed) is an industrially mature technology that is currently only suited for limited depths and will therefore likely not be sufficient to achieve France's ambitious objectives in terms of offshore wind.

In its Energy Pathways 2050 study, RTE therefore incorporates the need to resort to **floating wind** turbines (which rest on floats that are connected to the seabed through a mooring system), **whatever the carbon neutrality scenario adopted**, at levels ranging from **20 to 70% of France's total offshore wind power capacity**. This technology, which is still experimental, would help overcome depth constraints and thus produce electricity further away from the coast. This is currently the offshore technology that would unlock the most potential globally.

In this respect, and in order to support the wind industry in developing this highly promising technology, **RTE is now engaged in R&D work focusing on addressing the last extant technological barriers** and thereby developing increasingly optimal connection solutions.



To this end, RTE works primarily along **two main R&D areas**:

→ **Floating offshore substations**:

- Relevant for deep sea conditions (>50–60 m);
- An opportunity to:
  - reduce the environmental impact of the connection;
  - Improve buy-in by other users of the sea and people living close by.
- Challenges remain, especially in terms of industrial development: anchoring systems, equipment, dynamic cables;

→ **Extra-high voltage (225 kV) dynamic power cables**, capable of accommodating all movements, both sideways and vertical, of the floating wind turbine.

Technical conditions for a power system with a high share of renewables

RTE-IEA report: a study aimed at identifying the prerequisites for the safe operation of a system with a high penetration of renewable energy

The study was commissioned in 2019 by the Ministry for the Ecological Transition and conducted together with IEA. It examines **the technical feasibility of energy mixes including high and very high shares of variable renewables**.

The report outlines four strict cumulative conditions that the public policies must take into account should the choice be made to aim for a high share of renewable energies by 2050:

- **Evening out the variability of renewable energies,** which will require substantial sources of carbon-free flexibility, such as storage, peak generation units, demand-side flexibility, and so on.
- **Maintaining frequency**, which will involve developing new technical solutions that will have to be incorporated at the manufacturing stage of renewable energy generation infrastructure, as soon as very high instantaneous generation shares are achieved.
- **Providing reserves and operational latitude** to help manage the grid in real time.
- **Reconfiguring the power distribution transmission grid**, which will have to adapt to the changes in energy flows and the new location of power generation units.

The RTE-IEA report is available on rte-france.com

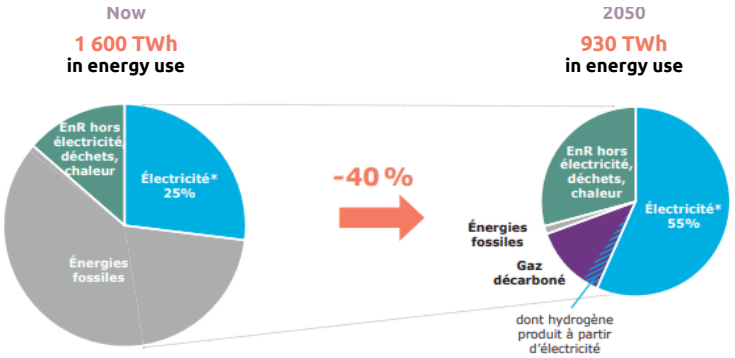
This study highlights the need for testing and large-scale deployment of technological solutions. The related industrial challenges will be commensurate to the share of renewable energies considered at that time horizon, but will imply in all scenarios an **ambitious roadmap binding both the public authorities and industry players**.

This publication marks an important milestone within a broader agenda aiming to draw up and compare long-term scenarios for the transformation of the electrical system with a view to achieving carbon neutrality in 2050.

Energy Pathways 2050

RTE has pondered scenarios to 2050 for its *Bilan prévisionnel* forecast in the course of a research and concertation programme on an unprecedented scale

Figure 2 Final energy consumption in France and in the SNBC



*Final electricity consumption (excluding losses, use from the energy sector and for hydrogen production
Domestic electricity consumption in RTE's reference trajectory = 645 TWh

The study describes the characteristics, issues and key milestones of different scenarios for the future of the electrical system that are consistent with the objective of **achieving carbon neutrality by 2050**. This will involve systematically switching from fossil fuels to carbon-free energies, especially in the transport, construction and industrial sectors.

Consistent with global and European scenarios, **the share of electricity in the overall energy mix is set to increase substantially**. In France's case, the main challenges will be to increase the generation of carbon-free electricity, while also gradually replacing power generation units that will reach the end of their service life within the next decades.

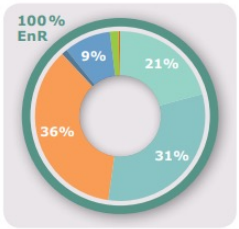
The study compares **six energy-mix scenarios**, with or without new nuclear installations, that could achieve 100% renewable energy by 2050 or 2060. They are analysed from the perspective of three contrasting energy use scenarios built around a baseline configuration, a "sobriety" scenario and another exploring the consequences of "deep reindustrialisation".

All these developments have been analysed from technical, economic, environmental and societal standpoints.

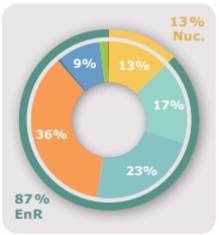
Energy Pathways 2050

All electricity supply-mix scenarios are necessarily based on a greater share of variable renewable energies

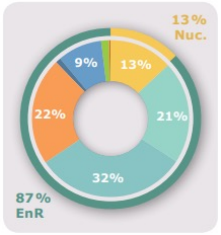
M0
100% RE in 2050



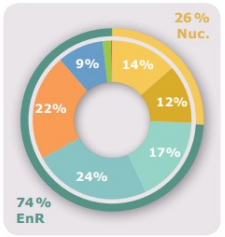
M1
RE diffuse distribution



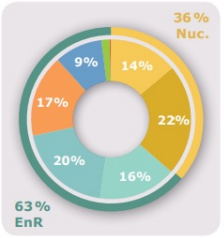
M23
RE large farms



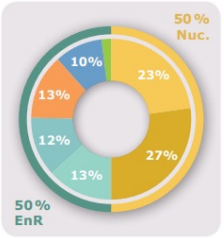
N1
RE + new nuclear 1



N2
RE + new nuclear 2



N3
RE + new nuclear 3



The "M" scenarios
Without new nuclear, 100% renewable achieved in 2050 or 2060

The "N" scenarios
With new nuclear installations

The study unambiguously concludes that **the sustained development of renewable energy sources is essential** to ensure that France **delivers on its climate commitments**. Wind power is shown to have become a **mature technology with low production costs** that can provide large amounts of electricity. A minimum capacity of some 40 GW for onshore wind and 22 to 62 GW for offshore wind appear necessary.

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)

2 Optimising 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
In order 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 works.[1] In this use case, flexibility services are contracted out using market-based solutions.

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

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

[1] Enedis website, keyword: Co-construct flexibilities

Managing variability

Grid operators are investing in long-term R&D projects to help develop a grid that is capable of accommodating increasing volumes of renewables

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
- 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 **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.[1]

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 will also be regularly shared within the framework of the Commission on system and network perspectives (CPSR – *Commission perspectives système et réseau*).
Periodicity: annually.

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

Source: [1] RTE distribution network roadmap for 2021-2024

Managing variability

Optimize performance

RINGO – testing out the services offered by a storage solution

The **RINGO** project aims to test out new flexibilities for the electricity system that will be necessary to accelerate the energy transition. It will focus on identifying "overflows" of renewable electricity and storing them in stationary batteries in order to automatically manage the flows of electricity on the transmission grid.

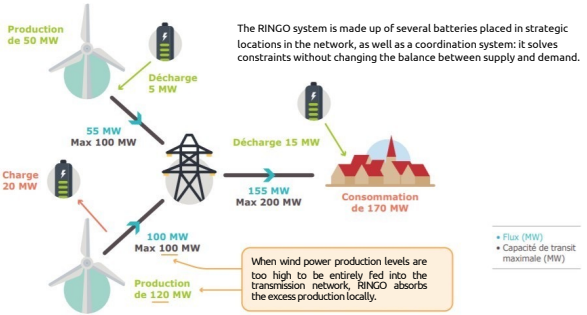
The RINGO project is organised around three pilot sites, each of which entrusted to a different group of manufacturers experimenting with different technologies:

- Vingeanne in Côte d'Or (12 MW and 37 MWh) (which was formally launched in July 2021) by NIDEC ASI.
- Ventavon in the Hautes-Alpes (10 MW and 30.2 MWh) by Blue Solutions (Bolloré group), SCLE SFE and Engie Solutions
- Bellac in Haute-Vienne (10 MW and 30.8 MWh) by Saft and Schneider Electric.

The aim of the project is to demonstrate the feasibility of using large batteries to automatically manage congestion due to peaks in renewable energy production and to build up expertise in working with these batteries. This will ensure that, when independent investors will deploy new renewable energy installations at a large scale, RTE will be able to accommodate and control these flexibilities, and therefore to utilise them to the fullest.

Key data

- **Dates:** Design phase: 2017-2019; Construction phase: 2020-2022, Testing phase: 2022-2024.
- **Budget:** €80m
- **Location:** 3 sites in France
- **Project partners:**



The RINGO system is made up of several batteries placed in strategic locations in the network, as well as a coordination system: it solves constraints without changing the balance between supply and demand.

Hydrogen: a solution to address variability

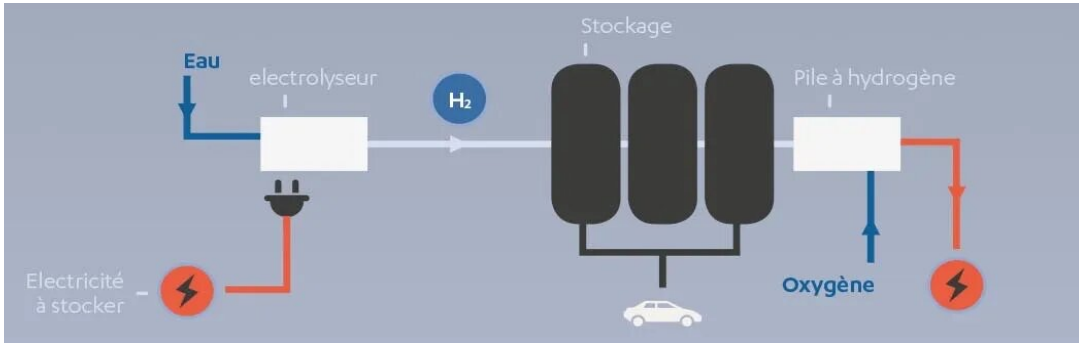
Wind power can be harnessed to produce renewable hydrogen, which in turn will help address wind power variability

Hydrogen energy produced from renewable electricity through **water electrolysis** will offers many benefits.

As onshore electrical transmission networks are increasingly constrained, accommodating new renewable or low-carbon electricity sources will require costly upgrades, borne by the whole of society, and when developing large capacity wind farms far off the coast, high-voltage station costing close to one billion euros are required.

Hydrogen **releases only water** when used and can help reduce greenhouse gas emissions in many applications.

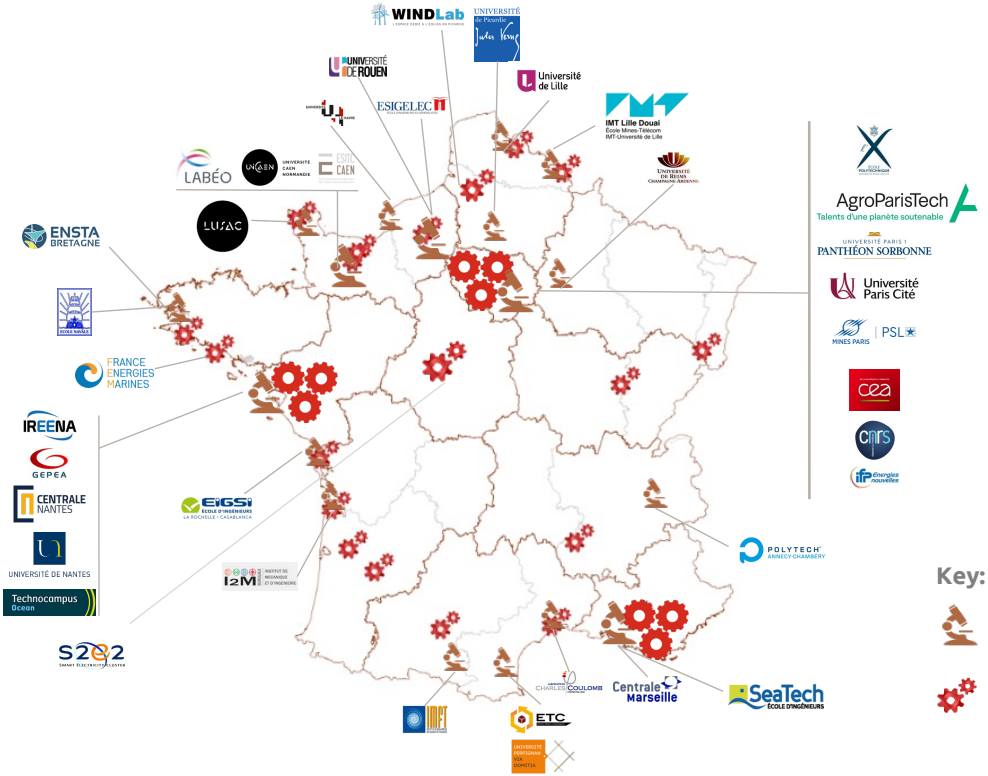
Since wind energy is variable, the offshore electrolysis can e leveraged to **store the power** generated in a long high-pressure pipeline. The mass production of renewable hydrogen would support a variety of uses, including decarbonising industries that are difficult to shift to low-emission energies, heavy mobility, energy storage and addressing the needs of all types of users in Europe that had been relying on the gas transmission network.



Research and development (R&D)

Mapping R&D players

Click on the logos to find out more



Key:

- University or Grande École
- Private R&D operator

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Wind power and landscapes

How wind turbines will fit within landscapes is examined before construction activities

In France, almost 44% of all energy consumed is imported (oil and gas). The means of production of these resources are therefore far removed from the daily life of the French population. The energy crisis we are experiencing has highlighted our **dependence** in this area, however. As a result, we can only achieve our **ecological transition** while having a certain **autonomy** implies having control over our production capacities and therefore producing electricity as close as possible to where it used, throughout the country.

Wind turbines are necessary infrastructure and are set to become as commonplace as high voltage lines or water towers. **Making them fit better into landscapes** will help with that process.

This point is covered by the impact assessment carried out for new wind projects and landscape designers or natural and built heritage conservation groups can be involved to further improve outcomes.[1]

Integrating wind power into landscapes also involves coming up with **landscape narratives** that are consistent with their local territory and with today's environmental challenges. To do this, projects can work on creating momentum at the local scale and **involve local residents** via a local referendum or working groups.

A few figures from France[2]

≈35 000	100 203 km	≈1 500	950 000 km	≈12 000
châteaux d'eau	de lignes aériennes à haute tension	parcs éoliens	de réseau routier (hors autoroutes)	supermarchés et hypermarchés

Source: [1] Transition énegétique : vers des paysages désirables [Energy transition, moving towards desirable landscapes], ENSP, [2] FEE,

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Making the industry biodiversity-friendly

Wind projects are governed by stringent regulations with regard to biodiversity

Wind turbines are subject to the regulations relating to **Installations Classified for Environmental Protection** (ICPE). This is why **very strict measures** on the environmental impact of wind farms apply throughout their life cycle.

During the development of a wind project, a pre-implementation environmental impact assessment is conducted over a period of at least 1 year in order to take into consideration the life cycle of animal species over all four seasons. Depending on the results, different measures following the **Avoid–Reduce–Compensate methodology** are applied. These measures are most often supplemented by **support measures** that are spontaneously implemented on a voluntary basis by industry players.

Avoid
the potential impacts of the project (choosing the location and orientation of the wind turbines, etc.)

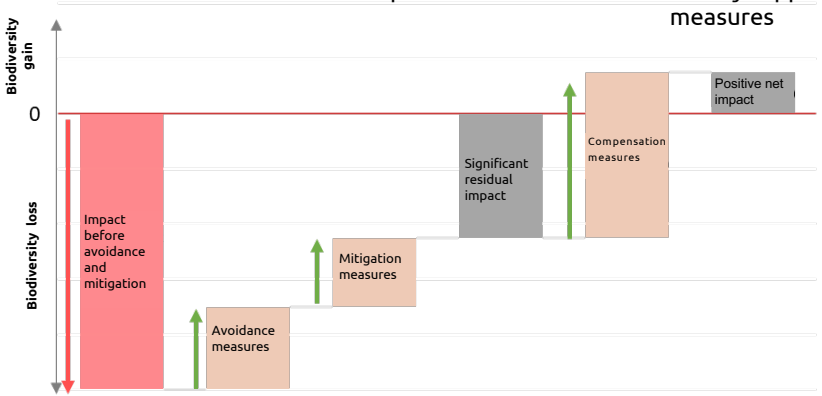
Reduce
the scope of the impacts that could not be avoided

Compensate
residual impacts that could not be avoided or compensated

Support
Avoid–Reduce–Compensate measures by support measures

The construction of a wind farm can only take place if the project guarantees **no net biodiversity loss**.

Finally, **environmental monitoring** is carried out throughout the service life of the wind farm in order to ensure the compliance and effectiveness of Avoid–Reduce–Compensate measures and to adapt them if necessary.



Source: Approche standardisée du dimensionnement de la compensation écologique [Standardized approach to the sizing of ecological compensation], French Ministry of Ecological Transition

Making the industry biodiversity-friendly

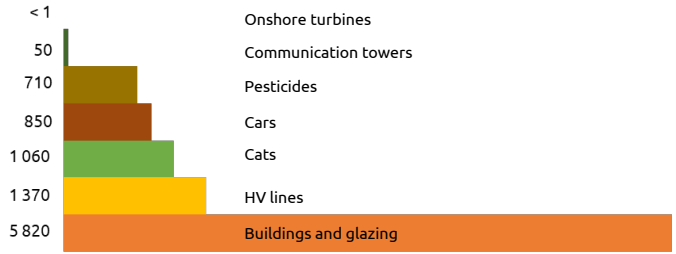
Correcting misconceptions about wind power and biodiversity

WIND TURBINES KILL A LOT OF BIRDS

According to the French League for the Protection of Birds, a wind turbine might cause anything from 0 to 18 bird fatalities per year.[1] It bears noting, however, than wind power-related fatalities are much lower than fatalities caused by glazing, domestic cats or even high voltage lines.

Causes of bird fatalities[2]

Number per 10,000 fatalities



WIND TURBINES DECIMATE BATS

In France, all **bat species are protected**. Wind turbine manufacturers are therefore particularly vigilant on this topic and wildlife **conservation measures** can be implemented to better understand animal populations or reduce fatality rates.

OFFSHORE WIND TURBINES DESTROY MARINE BIODIVERSITY

On the contrary! Though the construction phase may cause temporary disturbances, the base structures of fixed-bottom wind turbines attract species adapted to rocky habitats. In turn, they will attract specialised predators, cascading into what is called the **reef effect**. Moreover, making the vicinity of offshore farms no-fishing zones turn them into **hotspots of marine biodiversity**.[3]

Sources: [1] Eoliennes et biodiversité [Wind Turbines and Biodiversity], LPO (the French League for the Protection of Birds). [2] Canadian Renewable Energy Association
[3] Eoliennes en mer, quel impact sur l'écosystème ? [What is the impact of offshore turbines?], Ocean climat, 20 April 2020

Making the industry biodiversity-friendly

An example of a supporting measure for biodiversity: monitoring Montagu's harriers broods

The L'Enclave, L'Arbre Chaud and La Crémière wind farms (Hauts-de-France) are located in a core area for harriers.

The operators in charge of these wind farms have implemented an **supporting measures** aimed at **protecting harrier broods**. Indeed, these birds have a habit of nesting on agricultural land, which poses a risk to their survival during harvest.

Monitoring is carried out by an wildlife conservation group, Groupe Ornithologique et Naturaliste du Nord (GON). Ornithologists locate harrier nests, assess whether the young harriers will be able to fly from the nest before harvest and, if not, implement protective measures. A 5 m squared fence is placed around the nest, protecting it from harvesting operations. The broods are then monitored until they fledge.

These actions are greatly facilitated by the funding provided by wind operators, who **identify and compensate farmers** who own the land occupied by harrier nests.

Source: Interview with Florent Bastianelli, project manager at GON, in charge of monitoring harrier broods

Circular economy

The operator manages the entire end-of-life process of the wind farm and is responsible for restoring the soil

Wind farm end-of-life management operations are strictly **regulated by law**[1] and include the **entire process of disassembly and recycling** of component waste: At the end of the service life of the wind farm, **the operator must pay for**:

The **disassembly** of the wind turbines and the substation

The removal (excavating) of **all the foundations**, including its slab*

The **removal of cables** up to 10 m around the turbines

During the dismantling of the wind farm, soils are rehabilitated to **comparable characteristics** as those in the vicinity.

To ensure the funding of dismantling operations, the operator provides **financial guarantees from the very start of the project**: **€50,000 for wind turbines** of up to 2 MW capacity and **€25,000 for each additional MW**. Thus, for example, for a wind farm made up of 4 turbines generating 3 MW of unit power each, the operator must secure €300,000 for dismantling costs.

Today, no wind farm in France has ever been abandoned after use!

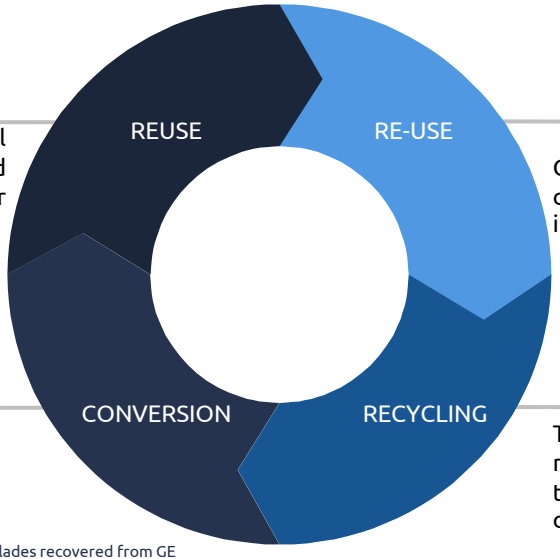
Source: French Environmental Code

*unless the prefect decides otherwise

Circular economy

After dismantling, wind turbine materials are almost entirely recycled or reused

Recyclability obligations are also provided for by law. These obligations are updated on a regular basis. Indeed, starting in 2023, newly filed permission applications will have to ensure **reuse and recyclability rates that will be gradually increased to 95% of the total mass of the wind turbines (including foundations) and 55% of the mass of the rotors by 2025.** Currently, **90% of the wind turbine** and **35% of the rotor** must be recycled.[1]



After undergoing technical verification, wind turbines in good condition are reused in other European markets.

Concrete, steel, carbon fibres are crushed or melted and then fed into industrial processes.

Serves as fuel instead of wood.

The blades replace sand in cement manufacturing.[2] In France, no wind turbine blade can be sent to a landfill or buried.

Source:
[1] French Environmental Code
[2] Veolia gives a second life to blades recovered from GE Renewable Energy wind turbines in cement

Circular economy

Several wind turbine manufacturers aiming for a “zero waste” objective and carbon neutrality across their value chain

Manufacturers are committed to becoming carbon neutral. This requires establishing a strategy based on:

1. Increasing energy efficiency in factories
2. Supplying offices and factories with renewable electricity
3. Renewing the service fleets from thermal to electric vehicles and use low CO_2 emissions transport (sea freight, rail)
4. Increasing the recyclability of wind turbines

Today, though nearly **95% of the mass of wind turbines is recyclable**, one of the problem parts is the wind turbine **blade**. Indeed, wind turbine blades are made of composite materials (fibreglass, carbon, resin), which are difficult to recycle.

There are several ongoing projects aiming to create turbine blades that are 100% recyclable. Siemens Gamesa has thus announced they were introducing the **“RecyclableBlade”**, which is made 100% recyclable thanks to the use of a specific resin.[1]

This inspires confidence in the ability for the wind power industry to meet the challenge to which manufacturers have committed: designing **zero-waste wind turbines by 2040.**

Wind turbine life cycle

Source: [1] Le recyclage des éoliennes en France: mythe ou réalité ? [The recycling of wind turbines in France: myth or reality?], Les Échos

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Circular economy

Several development projects for 100% recyclable blades are emerging: focus on the Zebra project and Siemens Gamesa's RecyclableBlade

Wind turbines currently have a lifespan of around 30 years and are between 85% and 90% recyclable. The industry wants to achieve 100% recyclability rates. Against this background, several projects aiming to create 100% recyclable blades are emerging.

The ZEBRA project (Zero wastE Blade ReseArch)

This project, launched by the IRT Jules Verne, mobilizes both industrial players and research centres.

It aims to demonstrate the technical, economic and environmental feasibility of thermoplastic wind turbine blades, using an eco-design approach to facilitate recycling. This project was launched for a period of 42 months and with a €18.5 million budget.

ZEBRA project, ©credit Manche Drones Production

Siemens Gamesa's RecyclableBlade

In September 2021, Siemens Gamesa introduced the world's first 100% recyclable wind turbine blade into the market. Agreements to implement RecyclableBlades in offshore wind farms have been concluded with RWE, EDF and WPD.

Siemens Gamesa wind turbine blades are made from a combination of materials cast together with resin. The chemical structure of this new type of resin allows for the effective separation of the resin from other components at the end of the blade's service life.

Source: 2022 Observatory for marine energies & EDF renouvelables

Circular economy

The renewal of wind farms could help increase capacity by more than 5 GW by 2030[1]

The 3 forms of wind farm renewal

Heavy maintenance: retrofitting

Consists in the **replacement of certain components** of the wind turbine (blades, generator, etc.) in order to modernize it. This helps increase the service life of the wind farm without changing its **layout or size**.

Redevelopment: revamping

Consists in the **replacement of certain components** of the wind turbine. This replacement results in **changes in the main features of the installation** (wind turbine dimensions, generation capacity, etc.)

Renewal: repowering

Repowering: consists in **completely or partly replacing the installation**, with a view to improving its performance.
This leads to **changes in the main features of the installation** (wind turbine dimensions, generation capacity, wind farm size, locations, etc.).

Renewing a wind farm can help achieve several objectives

1. **Increasing electricity production** in absolute terms by more effectively capturing the force of the wind
2. **Extending service life** by replacing components or **setting up a new, more efficient farm**
3. **Reducing operating costs linked to maintenance** by using more reliable modern equipment

Source: [1] Ademe

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Circular economy

Focus: Beauséjour-La Vallière wind farm – renewing 7 to 9 wind turbines

The repowering of the **Beauséjour-La Vallière wind farm**, which was commissioned in 2009, has been planned by its operator. This could be the very **first repowering project** carried out in Loire-Atlantique.

No decision has yet been taken as to whether the renewal will consist in **completely rebuilding a new farm** or if the wind turbines of the current wind farm will be **conserved** and simply upgraded with new parts.

	Current wind farm	Upcoming wind farm
Wind turbines	9	**7 to 9 wind turbines replaced**
Installed wind farm capacity:	18 MW	**23.4 MW (+ 5.4 MW)**
Electricity use of	7,000 people	**23,000 people 16,000 people**

90% of materials are recyclable

45% increase in electricity generation

30% in additional capacity

Sources: À Pannecé, dans le pays d'Ancenis, un nouveau parc éolien pour remplacer l'actuel [In Pannecé, in the Pays d'Ancenis, a new wind farm to replace the current one], Ouest France

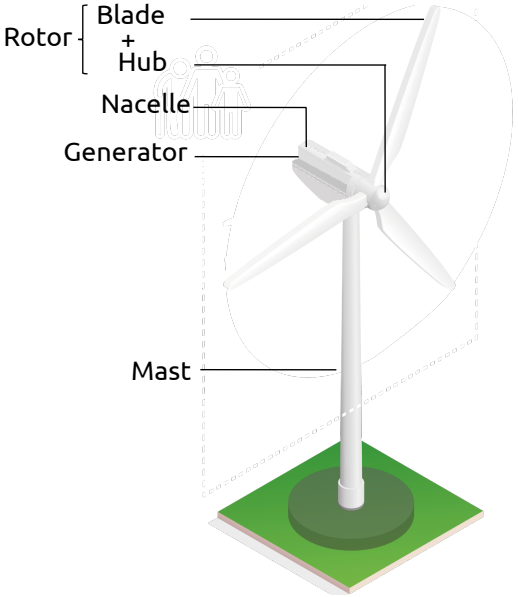
Appendixes

Appendixes

A. How wind turbines operate and wind farm locations are chosen

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 rpm, which, in turn, spins the main shaft and the rotor

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

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

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

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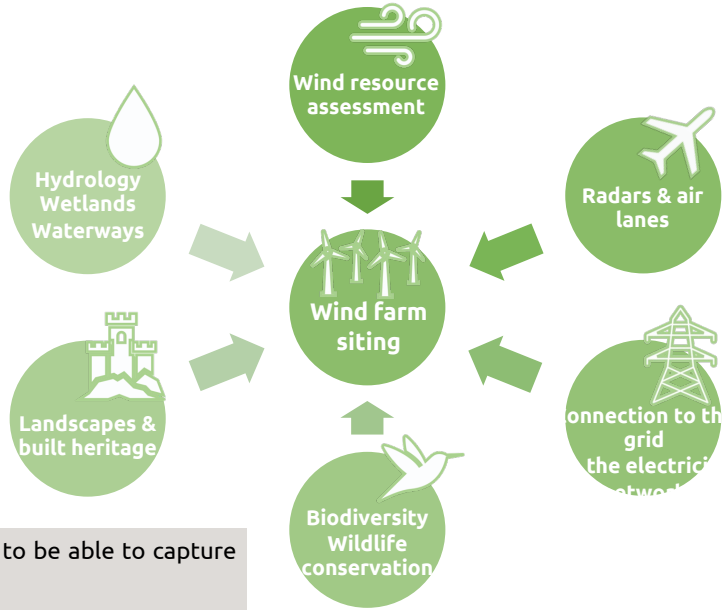
Selection criteria for the location of wind farms

Wind resource assessments are critical to confirm site suitability

The wind, an energy source that must be effectively harnessed

The efficiency of wind turbines depends on wind speed and frequency. A site with winds averaging 30 km/h will generate approximately eight times more power than another site with winds averaging only 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 higher the amount of energy captured.

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

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Appendixes

B. The wind industry: regional maps

Auvergne-Rhône-Alpes

Back to the country map

2,421 jobs (**+11%** compared to 2020)

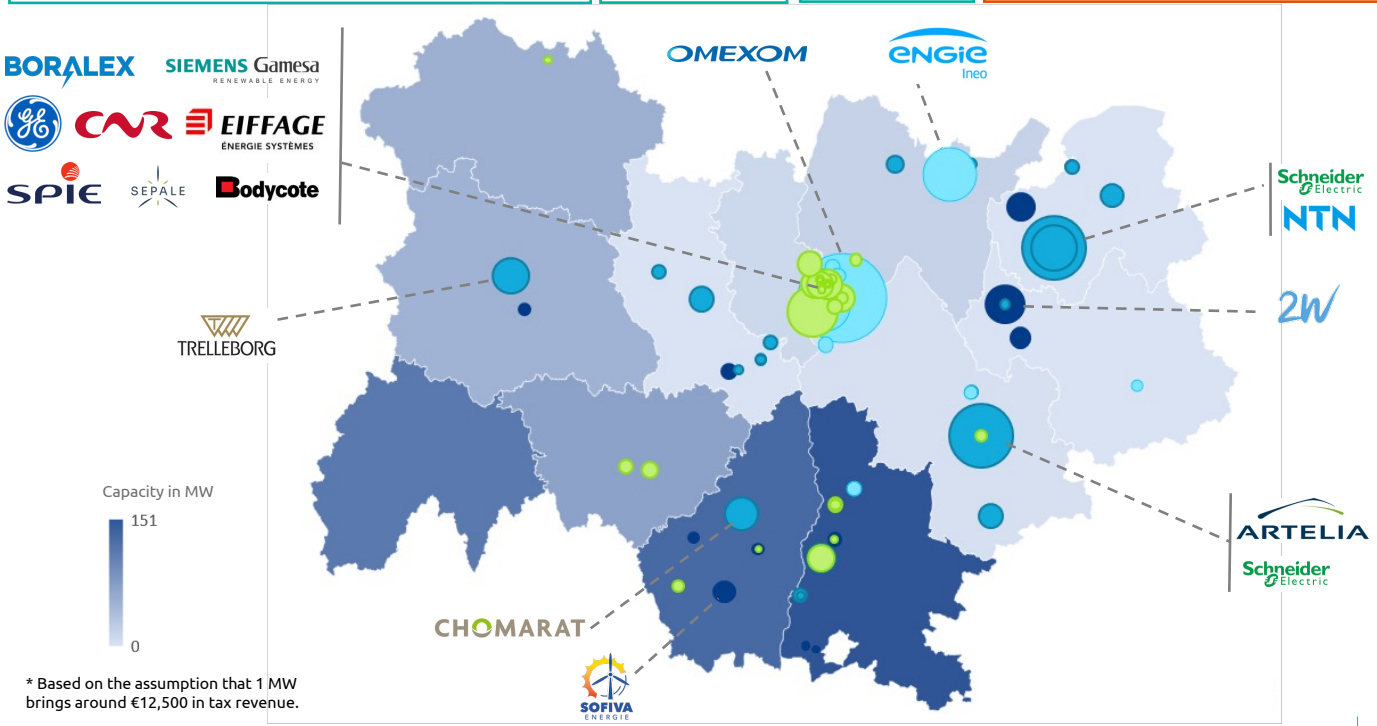
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
481	603	778	559

680 MW installed as at 31 Dec 2021

€8.5 million in tax revenue*

Top manufacturers & operators (MW)

ENERCON ENERGIE POUR LE MONDE · Vestas · SENVION wind energy solutions · BORALEX · EDF renouvelables · Qenergy



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

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Bourgogne–Franche-Comté

Back to the country map

952 jobs (**+10%** compared to 2020)

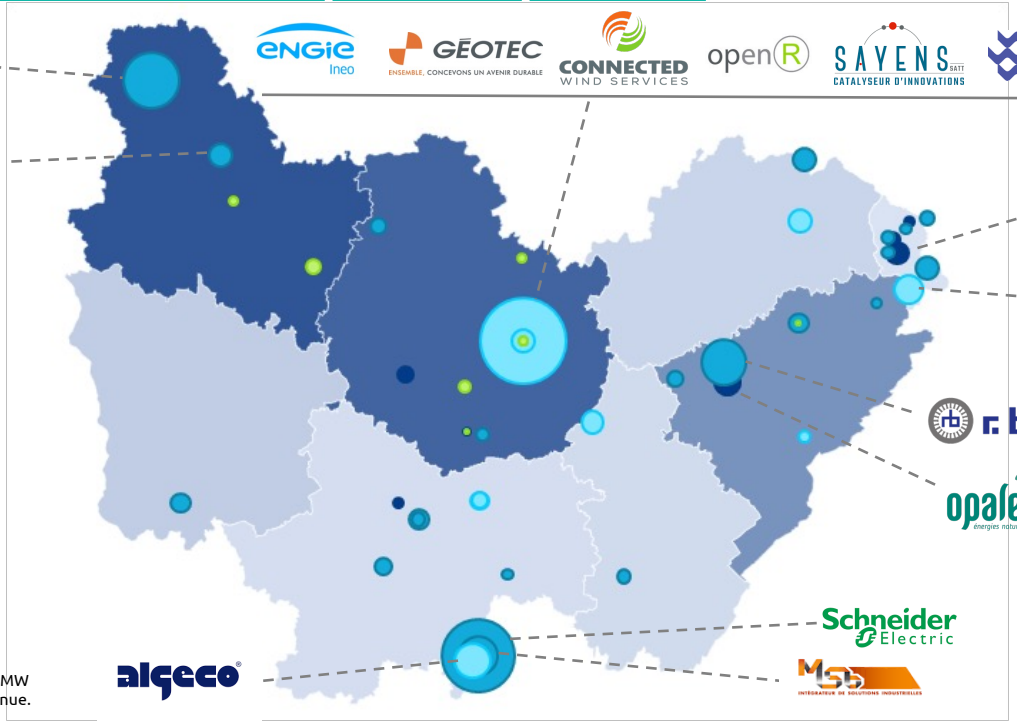
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
204	376	354	18

911 MW installed as at 31 Dec 2021

€11.4 million in tax revenue*

Top manufacturer & operators (MW)

Vestas, SENVION wind energy solutions, GE, VSB énergies nouvelles, wpd think energy, Qenergy



Prysmian Group, ENGIE Ineo, GÉOTEC ENSEMBLE, CONCEVONS UN AVENIR DURABLE, CONNECTED WIND SERVICES, openR, SAYENS CATALYSEUR D'INNOVATIONS, TAUW, SERPOLLET, DeltaBox HIGHLIGHTING INNOVATION, A.E.2.I, Nidec All for dreams LEROY-SOMER, r. bourgeois Precision and Perfection, opale énergies naturelles, Schneider Electric, MSB, alceco

* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

APPENDIXES

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Brittany

Back to the country map

1,207 jobs (**+15%** compared to 2020)

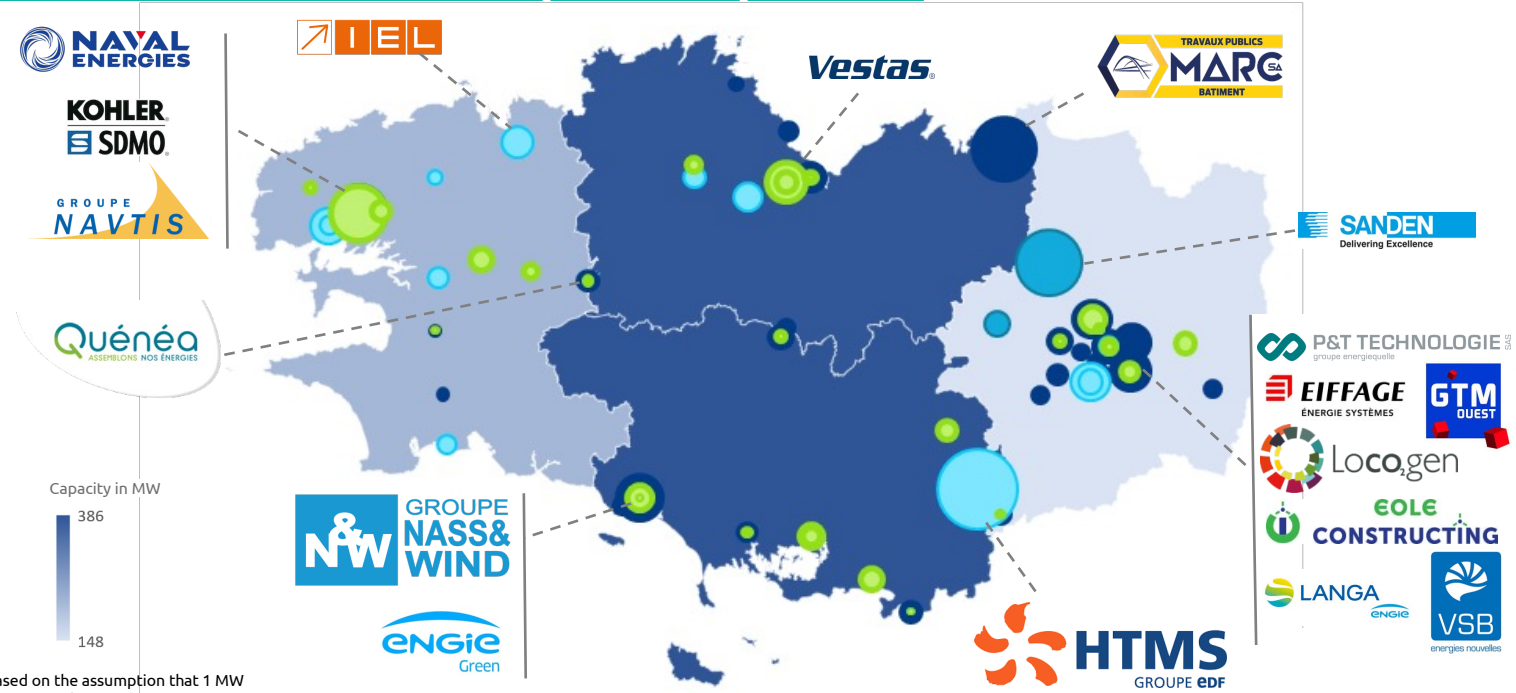
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
494	173	340	200

1,142 MW installed as at 31 Dec 2021

€14.3 million in tax revenue*

Top manufacturers & operators (MW)

ENERCON · Vestas · edp renewables · EDF renouvelables · SIEMENS Gamesa RENEWABLE ENERGY · P&T TECHNOLOGIE



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

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Centre-Val de Loire

Back to the country map

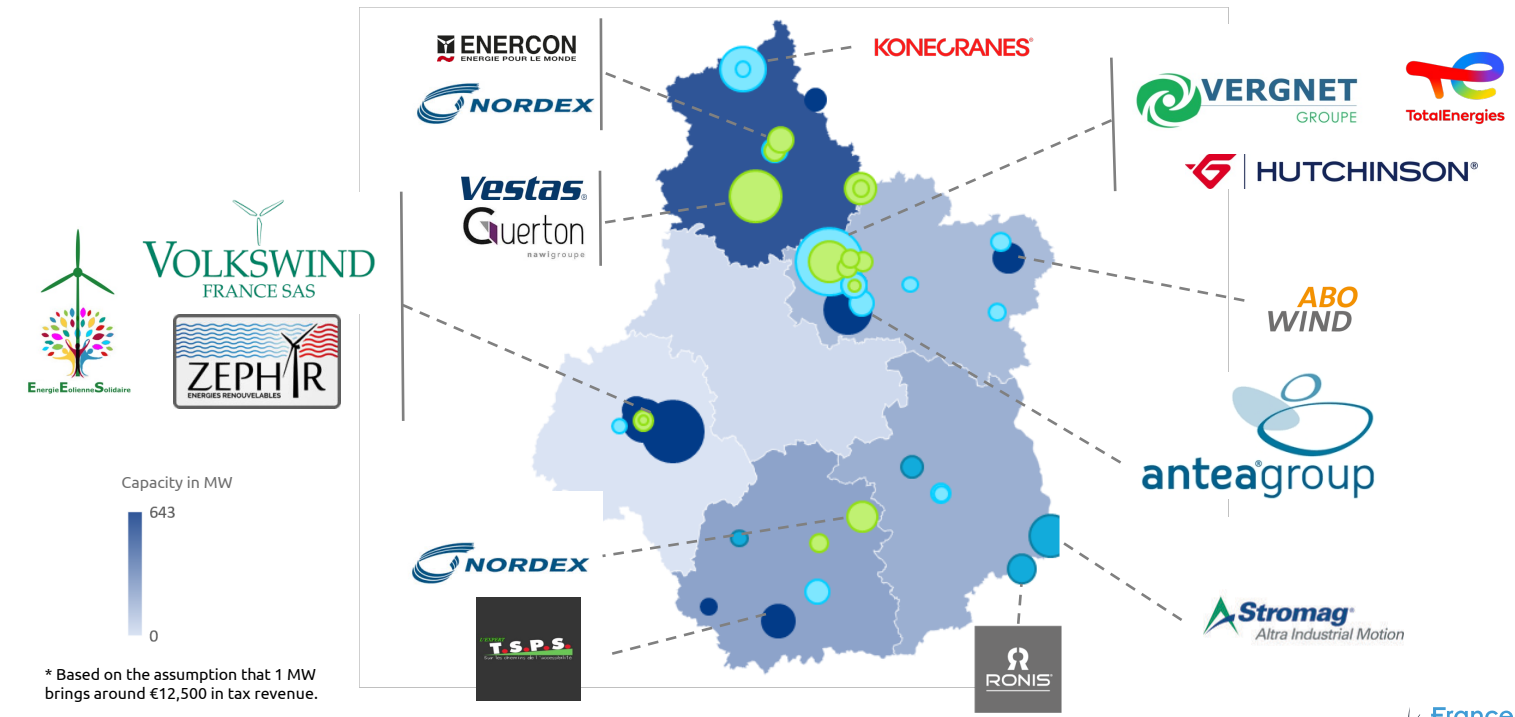
620 jobs (**+7%** compared to 2020)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
197	71	237	115

1,406 MW
installed as at 31 Dec 2021

€17.6 million
in tax revenue*

Top manufacturers & operators (MW)



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

Grand Est

Back to the country map

1,799 jobs (**+10%** compared to 2020)

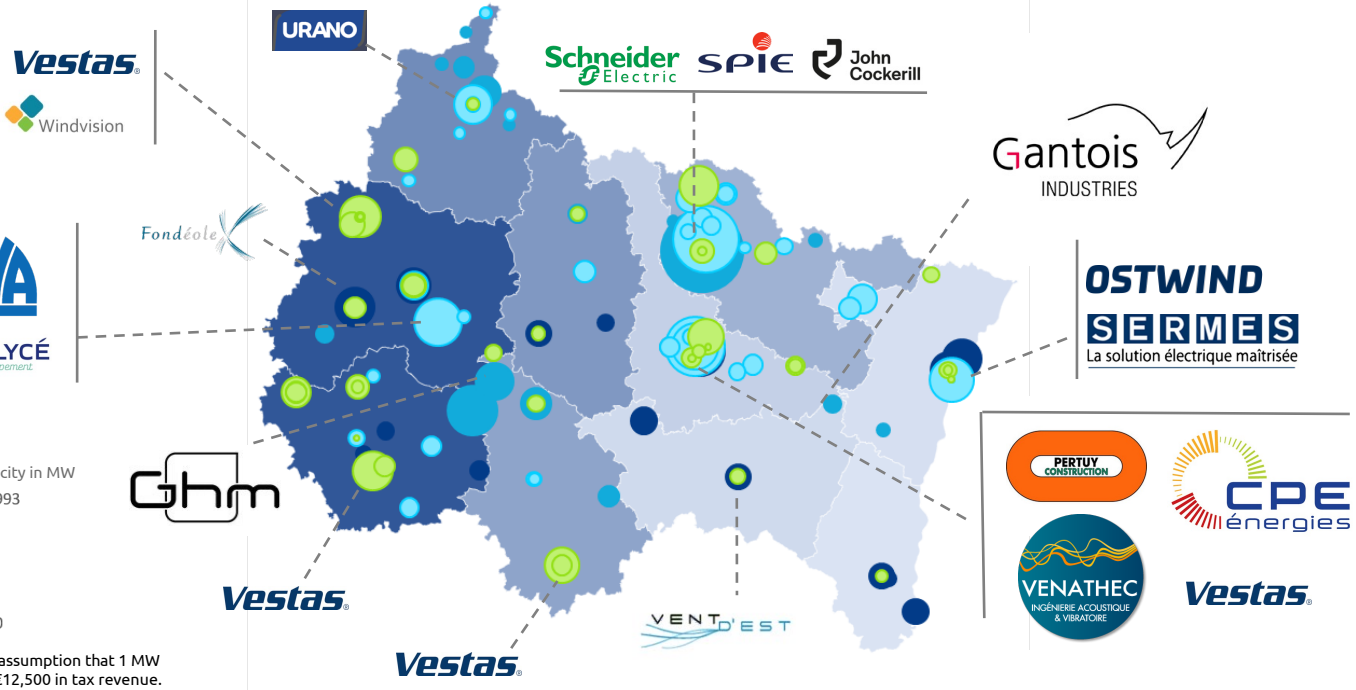
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
442	376	660	321

4,245 MW installed as at 31 Dec 2021

€53 million in tax revenue*

Top manufacturers & operators (MW)

Vestas, SENVION wind energy solutions, EDF renouvelables, VALEMO, NORDEX, NEOEN



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

Capgemini invent | France Energie Eolienne

Hauts-de-France

Back to the country map

2,380 jobs (**+11%** compared to 2020)

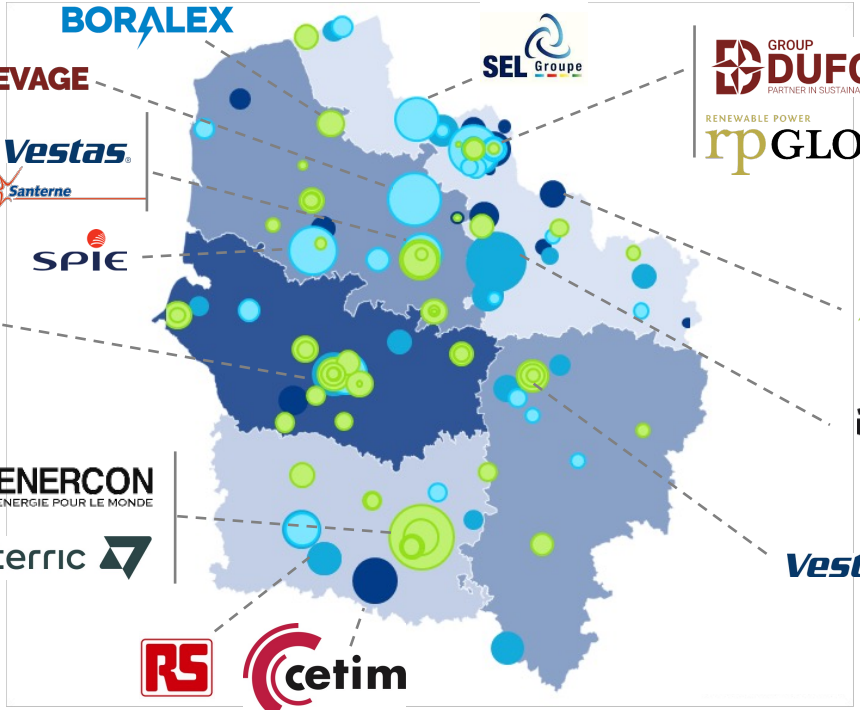
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
581	421	766	612

5,231 MW installed as at 31 Dec 2021

€65.4 million in tax revenue*

Top manufacturers & operators (MW)

Vestas, ENERCON, energie TEAM, BORALEX, NORDEX, EDF renouvelables



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

Capgemini invent | France Energie Eolienne

Île-de-France

Back to the country map

6,460 jobs (**+6%** compared to 2020)

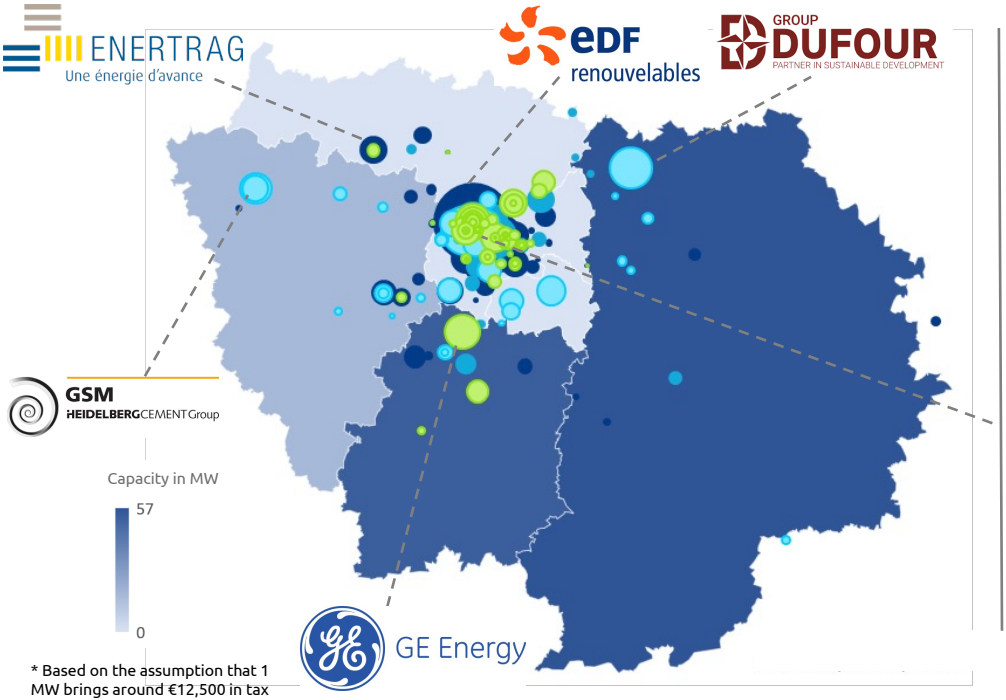
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
3,190	804	1,492	974

109 MW
installed as at 31 Dec 2021

€1.4 million
in tax revenue*

Top manufacturers & operators (MW)

Vestas, Nordex, WPO, Sepale, Vergnet Groupe, Boralex



Nordex, Siemens Gamesa Renewable Energy, Rte, Hutchinson, GE Grid Solutions, edp Renewables, ERG, BayWa r.e., Orféa acoustique, élicio by nethys, Envision, EEF SAS, Neoen, eurowatt, VDN, Greensolver creating value, W.E.B, IFP Energies nouvelles, RWE, OW Ocean Winds, Qair, Syneria

* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

Capgemini invent | France Energie Eolienne

Normandy

Back to the country map

2,290 jobs (**+115%** compared to 2020)

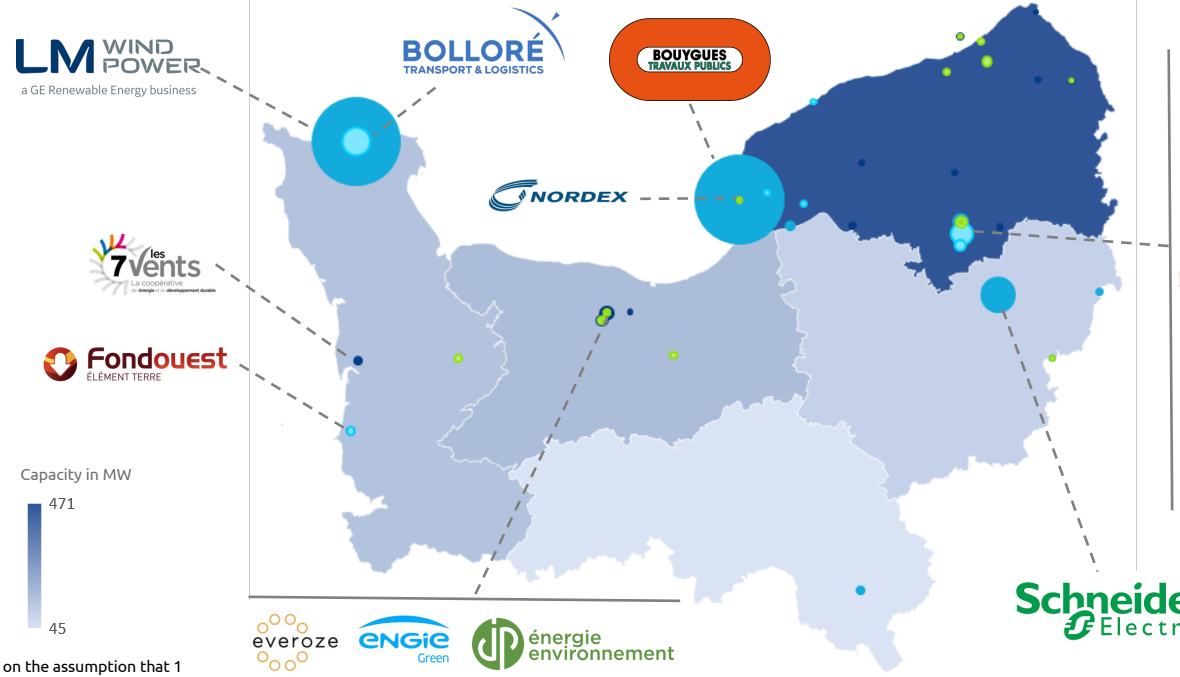
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
227	1,694	283	86

944 MW
installed as at 31 Dec 2021

€11.8 million
in tax revenue*

Top manufacturers & operators (MW)

ENERCON ENERGIE POUR LE MONDE · NORDEX We've got the power. · Vestas · KallistaEnergy · energie TEAM · edp Renewables



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

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Nouvelle-Aquitaine

Back to the country map

1,295 jobs (**+14%** compared to 2020)

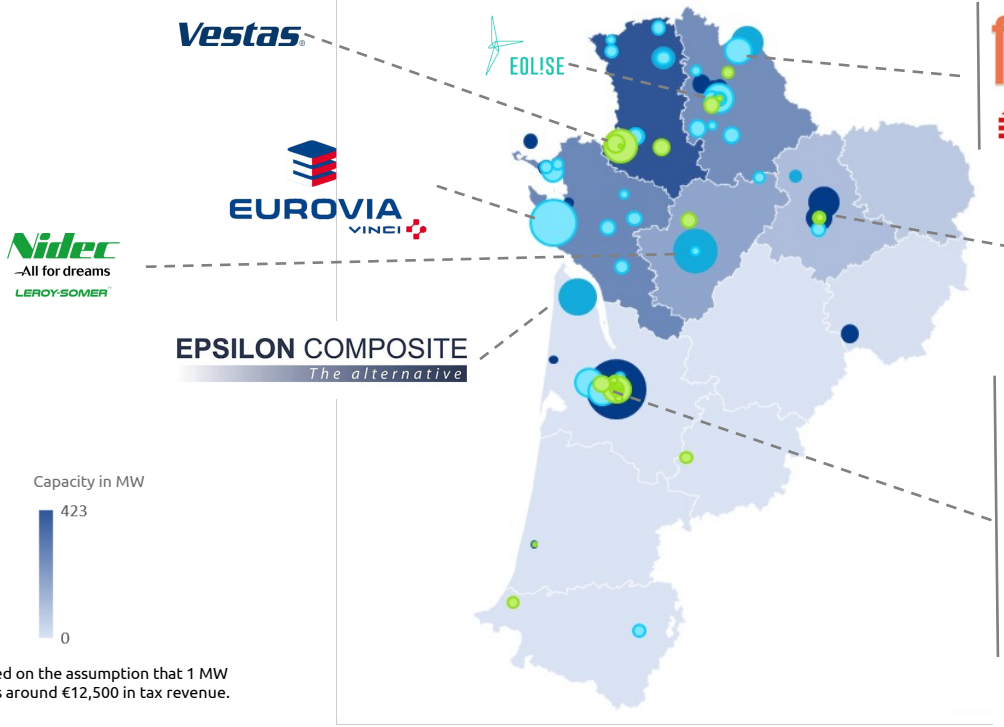
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
460	154	551	130

1,413 MW
installed as at 31 Dec 2021

€17.7 million
in tax revenue*

Top manufacturers & operators (MW)

Vestas · Nordex · Volkswind · BayWa r.e. · Enercon · Valemo



Vestas · EOLISE · Eurovia Vinci · Nidec All for dreams Leroy-Somer · Epsilon Composite The alternative

fpf Fonderie du Poitou Fonte · Eiffage Énergie Systèmes · MCM Levage · encis energies vertes · wpd think energy · Volkswind France SAS · Valorem opérateur en énergies vertes · Valemo exploitation & maintenance GmbH · Cubico Sustainable Investments · CAP INGELEC L'ingénierie qui s'engage · ENGIE Ineo · ENGIE Green

Capgemini invent · France Energie Eolienne

* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

Occitanie

Back to the country map

2,544 jobs (**+22%** compared to 2020)

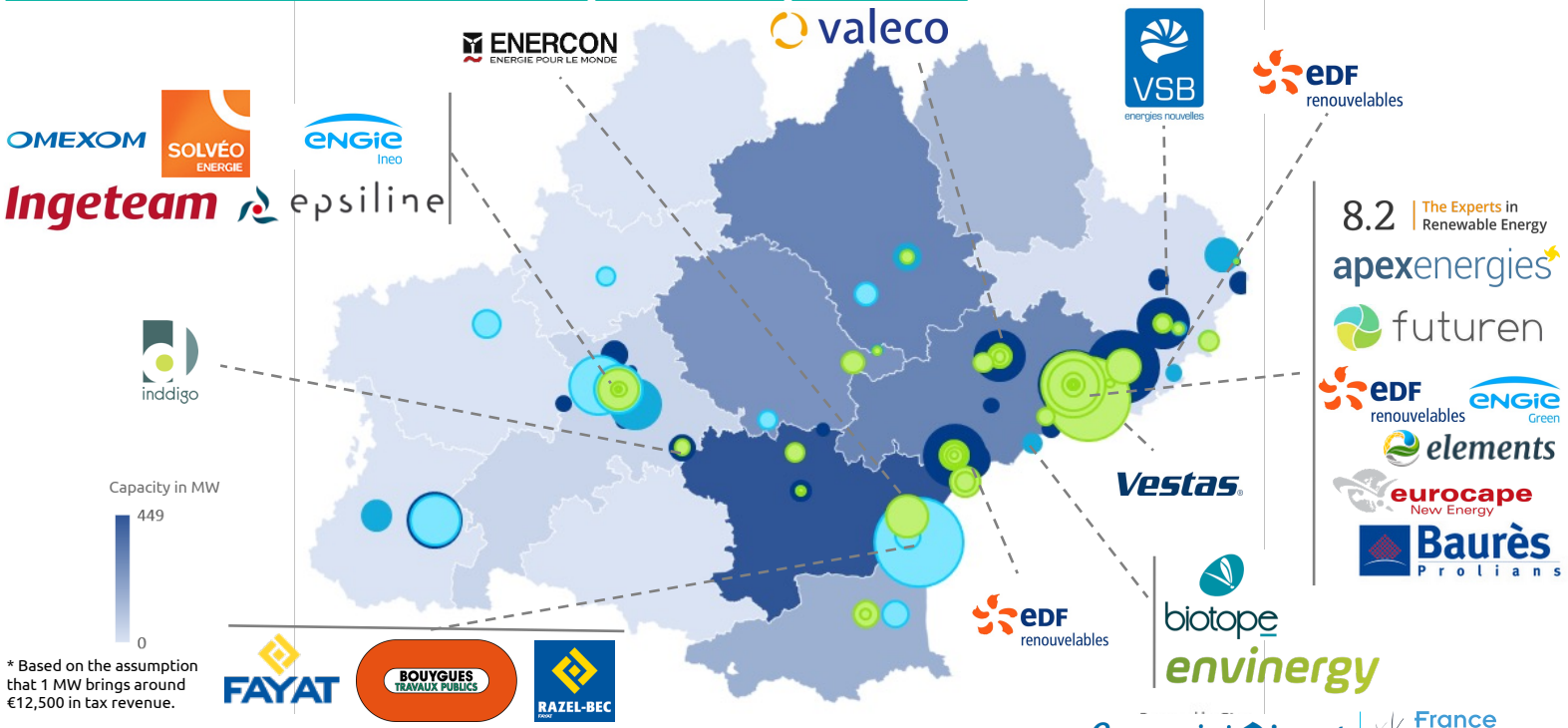
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
1,114	150	751	529

1,603 MW installed as at 31 Dec 2021

€20 million in tax revenue*

Top manufacturers & operators (MW)

ENERCON, Vestas, EDF renouvelables, valeco, SIEMENS Gamesa RENEWABLE ENERGY, qenergy



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

Pays de la Loire

Back to the country map

2,587 jobs (**+15%** compared to 2020)

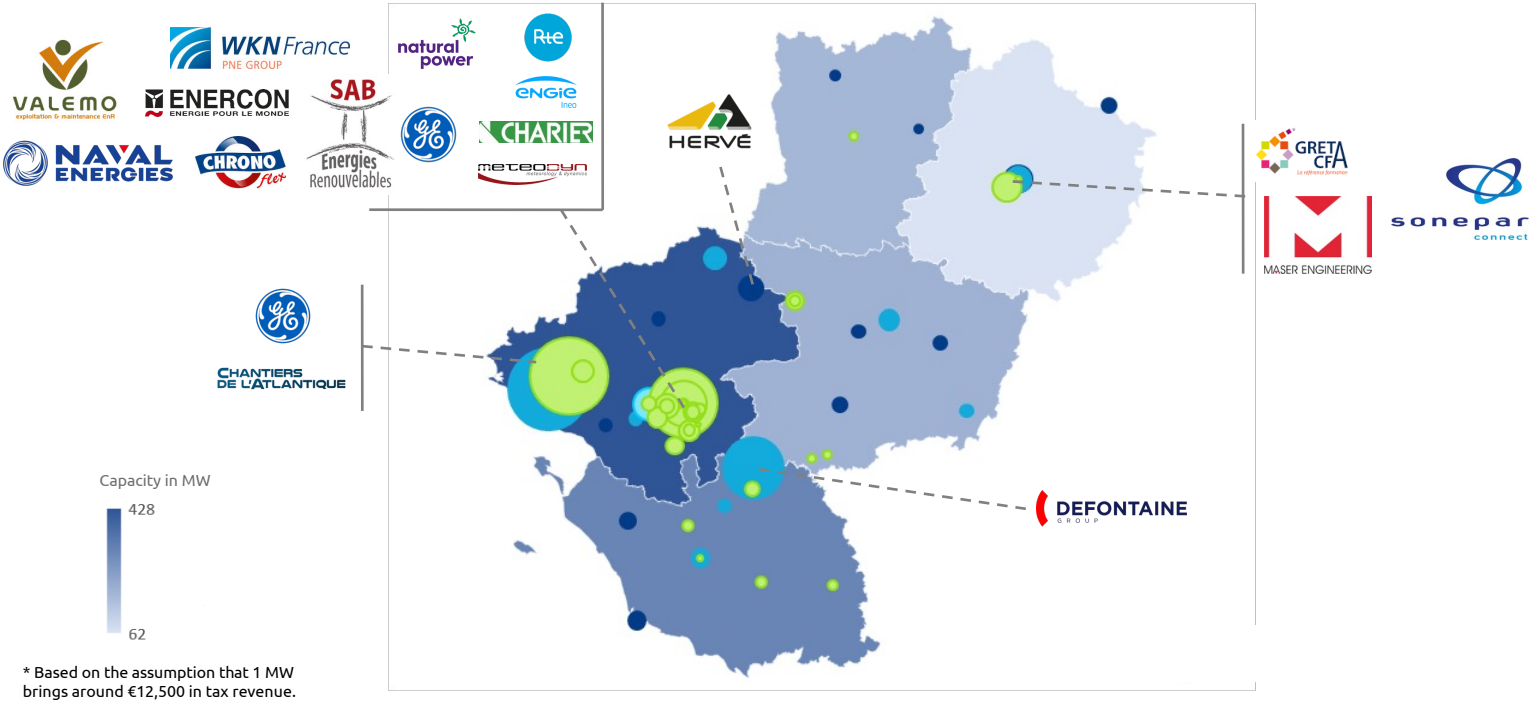
Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
576	657	547	807

1,151 MW installed as at 31 Dec 2021

€14.4 million in tax revenue*

Top manufacturers & operators (MW)

ENERCON, Vestas, NORDEX, energie TEAM, VSB, wpd



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

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Provence-Alpes-Côte d'Azur

Back to the country map

884 jobs (**+13%** compared to 2020)

Planning & Design	Component manufacturing	Engineering & Construction	Operations & Maintenance
366	153	290	75

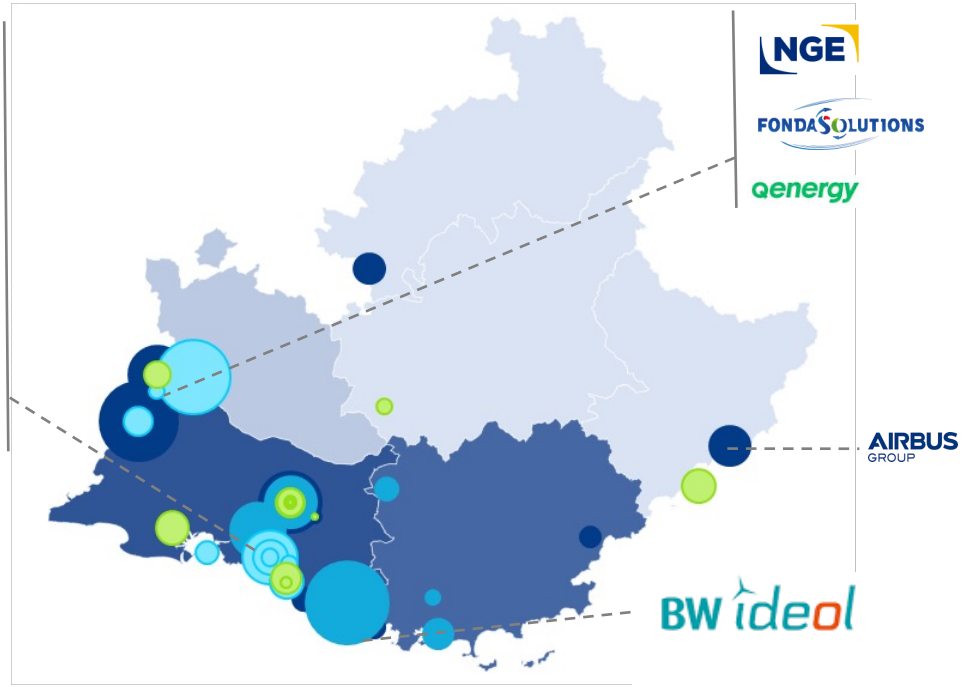
121 MW installed as at 31 Dec 2021

€1.5 million in tax revenue*

Top manufacturers & operators (MW)

Vestas, Nordex, Siemens Gamesa Renewable Energy, WPO, VSB, qenergy

ENGIE Green, DSUD Nergies, DNV·GL, MEDIACO, voltalia, IBERDROLA, Principle Power, juwi, TRANSCAUSSE, Gaïa Energy Systems, RTE



* Based on the assumption that 1 MW brings around €12,500 in tax revenue.

Capgemini invent | France Energie Eolienne

Appendixes

C. Participants in the wind industry by category

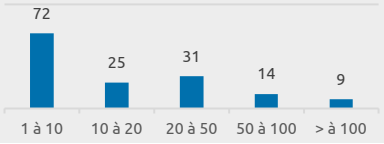
Value chain participants, by category

Developer and/or operator

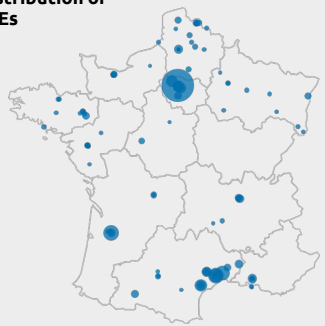
Wind power jobs

- Total wind power jobs: 5,416
- Number of companies: 151

Number of businesses by windpower group

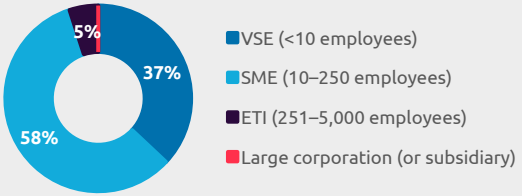


Distribution of FTEs



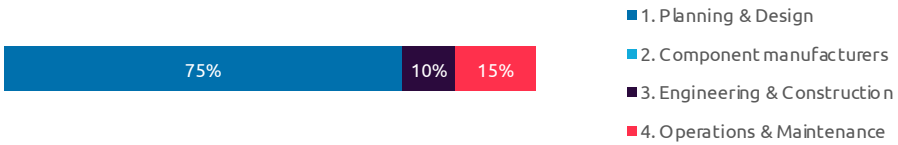
Typical profile

- Majority business type: VSE
- Average creation date: 2004



Wind power activities

Distribution of wind jobs:



Top 10 wind job employers

1. EDF renouvelables	2. ENGIE Green	3. VALOREM	4. BORALEX	5. wpd think energy
6. valeco	7. qenergy	8. énergie environnement	9. TotalEnergies	10. edp Renewables

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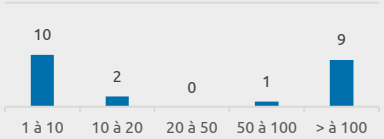
Value chain participants, by category

Turbine manufacturer / maintenance

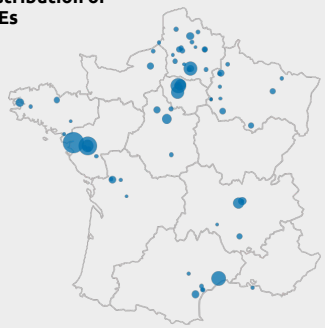
Wind power jobs

- Total wind power jobs: 3,606
- Number of companies: 22

Number of businesses by windpower group

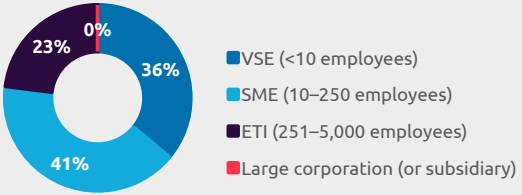


Distribution of FTEs



Typical profile

- Majority business type: SME
- Average creation date: 2007



Wind power activities

Distribution of wind jobs:

Top 10 wind job employers

1. GE	2. ENERCON	3. Vestas	4. Siemens Gamesa	5. Nordex Acciona
6. Naval Group	7. Vergnet	8. Veolia	9. Net Wind	10. Paprec Coved

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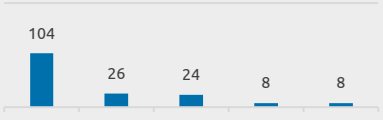
Value chain participants, by category

Component manufacturing

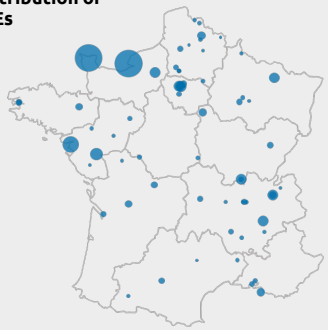
Wind power jobs

- Total wind power jobs: 5,094
- Number of companies: 170

Number of businesses by windpower group

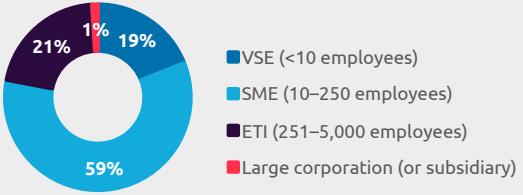


Distribution of FTEs



Typical profile

- Majority business type: SME
- Average creation date: 1985



Wind power activities

Distribution of wind jobs:

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

Top 10 wind job employers

1. Bouygues	2. LM Wind Power	3. Schneider Electric	4. Chantiers de l'Atlantique	5. Rollix
6. Alstom Grid	7. Hutchinson	8. Mersen	9. SDMO	10. Nexans

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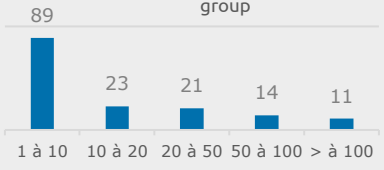
Value chain participants, by category

Civil and electrical engineering / Logistics

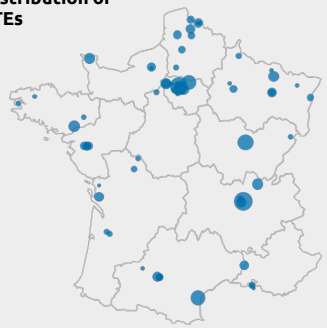
Wind power jobs

- Total wind power jobs: 5,683
- Number of companies: 158

Number of businesses by windpower group

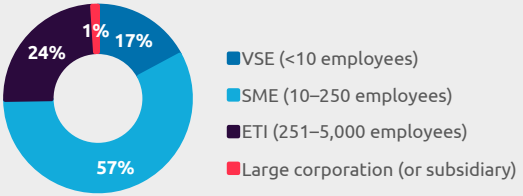


Distribution of FTEs



Typical profile

- Majority business type: SME
- Average creation date: 1999



Wind power activities

Distribution of wind jobs:

Top 10 wind job employers

1. Enedis	2. Engie Ineo	3. RTE	4. Omexom	5. Colas
6. SPIE	7. Bouygues	8. Groupe Dufour	9. Eurovia	10. Holcim

Capgemini invent | France Energie Eolienne

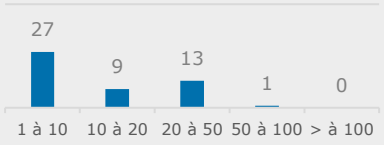
Value chain participants, by category

Maintenance (excluding manufacturers)

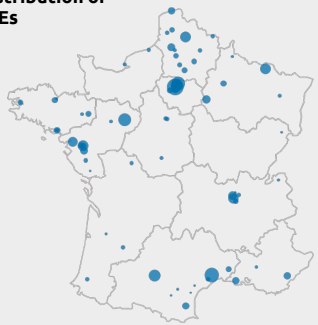
Wind power jobs

- Total wind power jobs: 978
- Number of companies: 50

Number of businesses by windpower group

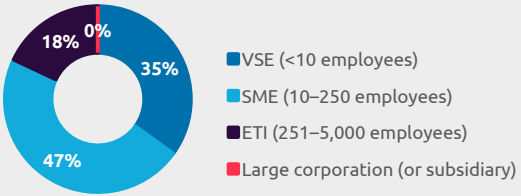


Distribution of FTEs



Typical profile

- Majority business type: SME
- Average creation date: 1992



Wind power activities

Distribution of wind jobs:

Top 10 wind job employers

1. VEOLIA	2. VALOREM	3. NetWind	4. PAPREC COVED	5. cmi
6. ENGIE Cofely	7 heliopales Blade Experts	8. ORTEC	9. Tractel	10. Windparkservice

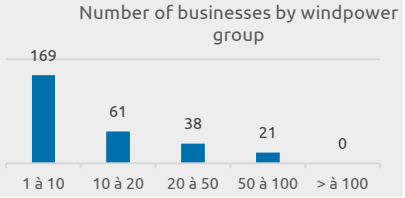
Capgemini invent | France Energie Eolienne

Value chain participants, by category

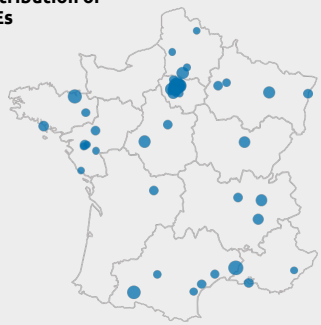
Engineering consultancies, expertise & other service providers

Wind power jobs

- Total wind power jobs: 4,285
- Number of companies: 289

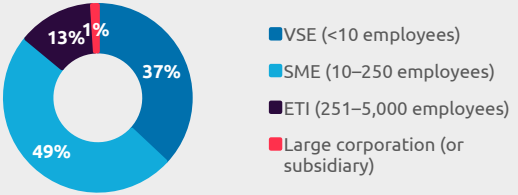


Distribution of FTEs



Typical profile

- Majority business type: SME
- Average creation date: 1995



Wind power activities

Distribution of wind jobs:

Top 10 wind job employers

1. MATIS	2. DEKRA On the safe side.	3. NGE	4. AKKA PASSION FOR TECHNOLOGIES	5. MARC
6. Groupe Qualiconsult	7. TRACTEBEL ENGIE	8. ALHYANGE Acoustique	9.	10. SOFRESID ENGINEERING

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Appendixes

D. Focus on training

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, car 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

Focus on: the ENERCON training centres in Longueil-Sainte-Marie

The international training centre for wind turbine assembly set up by ENERCON in Longueil-Sainte-Marie (in Oise, Hauts-de-France) has been open since January 2018.

This centre required an investment of around **€3.5m**.

Covering an area of 6,500 m², it has **5 trainers, 2 assembly platforms and 2 cranes**. It offers two main areas of training in real field conditions: mast installation; assembly, disassembly and wiring of appliances, nacelles and pales. Training is provided for 3 to 4 MW wind turbines. **350 ENERCON technicians from all over the world are trained there every year.**

These programmes will empower the trainees and help them access new work opportunities. This is particularly true for service technicians, who can then become technical coordinators, expert technicians, HSE technicians or quality technicians.

In September 2017, ENERCON opened another training centre dedicated to maintenance technicians in Meaux, also in Oise. A total of 600 people per year are thus trained in electrical and mechanical accreditations and other training programmes by 6 instructors.

The opening of these training centres for the French wind power industry, which was instigated by ENERCON, is in line with the strategy set forward in the Skills Investment Plan (2018–2022), which provides for the introduction of 10,000 training courses in green jobs.

Appendixes

E. Driving the industry forward

Driving the industry forward

Focus on Tenerrdis

Tenerrdis is the Auvergne-Rhône-Alpes competitiveness cluster that is focused on the energy transition; it aims, through effective innovation, to expand sectors of excellence creating lasting employment opportunities.

Tenerrdis oversees a dynamic network of 300 members (including 244 associate members) and partners:

- **Industry:** Industrial groups (energy companies and end users), SMEs, start-ups
- **Research laboratories and technical centres**
- **Local authorities**

Six strategic areas:

- Renewable power generation and insertion in the low-carbon mix
- Intelligence and cybersecurity of energy systems
- Energy storage and conversion
- Multi-vector micro-networks
- Carbon-free mobility
- Energy efficiency in construction and manufacturing

Tenerrdis works with members of the cluster and their partners on issues related to new energies:

- **Supporting innovative projects** that are mostly collaborative (at a regional, national or European scale) and supporting access to public and private **funding**
- Its work to enhance and **promote the industrial sectors** of these new forms of energies, including internationally
- The **coordination** of stakeholders opening up the full range of required technical skills (materials, weather forecasting, aging of facilities, storage, hybridization)

Key data for 2020:

- 244 members, 15 new members, 59% are SMEs, start-ups or VSEs
- 58 members involved in the wind power sector
- 948 funded or accredited projects
- 379 projects & demonstrators funded
- 3,071 followers on Twitter, 2,720 on LinkedIn

Sources: Tenerrdis

Driving the industry forward

Focus on Cemater

To support companies in their development and in achieving sustainability, the **Cemater** group offers them **support** on various topics: skills and know-how upgrading, commercial development, recruitment, innovation, pooling within companies and so on.

Cemater's member companies have made a commitment to comply with a **code of ethics** that guarantees an optimum level of quality to their clients. The components of Cemater's code of ethics are based on the following elements:

Consulting/advice
Education
Mutualisation/pooling
Adaptation
Transparency
Engagement/involvement
Respect

Sources: Cemater

Driving the industry forward

Focus on the French Maritime Cluster

The French Maritime Cluster (CMF) brings together all the protagonists in the maritime ecosystem, from industrial companies to services and maritime activities of all kinds with the objective of ensuring the sustainable development of maritime activities. Today, it is made up of more than 430 entities: companies of all sizes, competitiveness clusters, federations and associations, laboratories and research centres, schools and training organizations, communities and local economic players, as well as the French Navy. FEE is a member of CMF.

CMF is at the service of its members, acting as a facilitator for the development of their businesses and the emergence of new innovative projects. It supports its members in the sustainable and responsible development of their activities and projects, in France and internationally.

Since 2007, CMF has been instrumental in promoting and defending the MRE sector among decision-makers, as well as in creating synergies between operators in the maritime and energy industries.
Since 2017, CMF has created the Observatory of the energies of the sea (*Observatoire des énergies de la mer*), to which FEE contributes. View the results of the 5th edition on www.merenergies.fr

France has the world's second largest marine territory in the world: French overseas territories give the country 97% of its 11-million sq. km. EEZ (Exclusive Economic Zone). Fully aware of the opportunities offered by Overseas France (especially as regard the development of MREs), CMF has developed clusters there: Guadeloupe, Réunion, French Guyana, Martinique, French Polynesia, New Caledonia and Saint-Pierre et Miquelon.

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 co-hosted 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 co-hosted 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 2021 will be held from 16 to 18 November 2021** in Marseille.

FOWT 2020 was held from 7 to 8 September 2020 in Marseille.

Topics covered

Funding, insurance, zoning, regulatory frameworks, environmental impacts, technological innovation, etc.

All these topics are covered during the seminars in order 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.

Among the keynote speakers of the 2020 edition: Giles Dickson (WindEurope), Laurent Michel (French Ministry of Ecological Transition / DGEC) and other major market players such as Ideol, PPI, SBM Offshore, EDF EN, Equinor, Shizen Energy, Engie, Naval Energies, the Carbon Trust, Siemens Games and more.

More information on www.fowt-conferences.com.

Key data on the event (2020 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 academic day (online) • 800+ participants • 28 nationalities represented • 500 B2B meetings / Meet the Buyers

Driving the industry forward

Focus on the Neopolia Offshore & MRE Cluster

The Neopolia Éolien Offshore & EMR Cluster (Neopolia Offshore & MRE Cluster) brings together more than **105 industrial companies** that combine their know-how in order to find innovative answers to the needs of the **marine renewable energies** (MREs) market. The cluster is part of the **Neopolia network composed of 5 clusters** that are present in the **Pays de la Loire region**.

Its role is to strengthen partnerships with the major players in the renewable offshore wind market, to build a **network of skills**, to act as a driver of the renewable offshore wind industry in the Pays de la Loire region by bringing together the players of the industry, to manage R&D projects and to market comprehensive and collaborative industrial offers.

Neopolia EMR offers several integrated solutions at the service of MRE projects including:

- **Project development engineering**
- **Offshore installation support**
- **Operations & Maintenance**
- **System Health Monitoring**
- **EPCI* bottom-fixed or floating wind**

- Neopolia Éolien Offshore & EMR will be a partner of the FEE's National Wind Power Conference, which will take place on October 13–14 of this year.

* EPCI = Engineering, Procurement, Construction, Installation

Driving the industry forward

Focus on Pôle Mer Méditerrannée

The Mediterranean area has significant potential for wind power and is yet to be exploited in France. However, bathymetric conditions are suited only to floating offshore operations.

Pôle Mer Méditerranée is active in the regions of Sud Provence-Alpes-Côte d'Azur, Occitanie and Corsica and is involved in six strategic action areas:

- Maritime defence, security and safety
- Naval industry and boating
- Marine biological resources
- Environment and coastal development
- Ports and maritime logistics and transport
- Marine energy and mineral resources (which includes offshore wind).

It hosts **59 funded projects and 82 accredited MRE projects** and has a **total budget of €188.62M.**

Its 3 cross-cutting themes are:

- the ecological transition;
- digital transformation;
- robotics.

Now boasting more than 438 members (laboratories, large corporate groups, ETIs and SMEs), Pôle Mer Méditerranée has been actively identifying all potential participants in the floating wind sector since 2013. It has thus identified 582 potential participants, including 60 confirmed participants in the regions of Sud-Provence-Alpes-Côte d'Azur, Corsica and Occitanie. 266 are already members of Pôle Mer Méditerranée.

Pôle Mer Méditerranée also **co-hosts the international Floating Offshore Wind Turbines (FOWT) conference**, along with the Marseille-Provence Chamber of Commerce and Industry and France Énergie Éolienne.

Sources: Pôle Mer Méditerranée

Driving the industry forward

Focus on: Pépinière Entreprises Énergies Renouvelables (80)

The Pépinière d'Entreprises Energies Renouvelables is a business incubator which is geographically positioned in the Hauts-de-France and Normandy regions. It contributes to the development of onshore and offshore wind farms and other renewable marine energies through its operational actions with SMEs ,as well as its products and services.

Directing the CCI Business renewables brokerage platform between prospective buyers and suppliers in renewable energies

- 2060 members in fixed-bottom wind, floating wind, tidal barrage and tidal stream
- Active on all of continental France's seaboard
- Co-organizing events

Accompanying the diversification in wind power and MREs

Personalized expert support for industrial SMEs from the Normandy and Hauts-de-France regions among potential contractors, including 25 local companies via the Windustry facility, working from the Oust-Marest incubator (in the Somme and Seine-Maritime départements) or at international trade fairs.

Cohosting and co-organizing events on wind power on a national or interregional scale

- FEE/Éole Industrie event at the regional Chamber of Commerce and Industry in Lille and a Technical one-day Operations & Maintenance event at the renewables incubator, Pépinière EnR
- Windustry France meetings
- International SEANERGY conventions in Le Havre, Cherbourg, and Dunkirk
- Business event on offshore wind with 15 international contracting authorities and 50 regional companies at the Chamber of Commerce and Industry in Dunkirk
- Corporate day in Dunkirk/CUD Promotion of awareness of MREs at the Pavillon des Maquettes in Dunkirk (April 4, 2019)

Driving the industry forward

Focus on: École Centrale de Nantes and the SEM-REV platform

École Centrale de Nantes is one of the main French academic institutions specializing in Marine Renewable Energies (MREs). It provides a full range of training programmes in MREs for all levels, particularly in engineering.

SEM-REV is an ocean platform managed by the LHEEA laboratory and intended for R&D projects. **It is the first European sea trials base combining several technologies** related to offshore wind and wave power. Furthermore, it is connected to the national grid.

The SEM-REV sea test site and the laboratory's test basins are one of the components of the THOEREM research infrastructure, which brings together the testing resources of Ifremer, Centrale Nantes and Gustave Eiffel University on the MRE theme.

THeoREM listed on the 2018 national research infrastructure roadmap

The site hosting **FLOATGEN, France's first offshore wind turbine**, which has been generating power since September 2018, is located in a reserved 1 km² area off Le Croisic in the Pays de la Loire region. FLOATGEN is connected to the medium-voltage grid operated by Enedis. An onshore research base also hosts researchers and engineers.

The **activities carried out around technology testing** include:

- hosting and conducting **national and European research projects**, in particular aiming to improve performance and reliability
- collecting **environmental data** (marine weather, physical and biological, and so on)
- **operation and maintenance** of the infrastructure
- **the study of the environmental impact** of the MREs employed (on wildlife, sediment flows, and so on)
- the **security and monitoring** of maritime space.

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 that are active in France on newly installed capacity (between 1 July 2021 and 30 June 2022). The "Top manufacturers & operators" lists in the appendices are based on this work.
- Survey of dismantling or repowering operations

Cumulative installed power is updated

Mapping

How the companies appearing on each regional map are selected:

- **Top 10** (Île-de-France) **or Top 15** (other regions) employers in the region.
- Head offices of **companies with more than 5 FTEs that answered the survey** and don't appear in any regional Top 10/15 ranking.

Estimated number of jobs

Breakdown of surveyed wind jobs by link in the value chain

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

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

Companies that weren't surveyed in 2021: estimated data

Companies surveyed in 2021, but not in 2020: actual data

Companies surveyed in 2020 and 2021: actual data to establish a growth rate for estimated data

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