2025 Edition

Repowering handbook

Qenergy

Photo : © *Nicolas Dohr*

Editorial

Convinced that repowering plays and will continue to play a decisive role in electricity decarbonization and energy independence in France, QENERGY decided at an early stage to play a leading role in its deployment in France. Thus, in 2016, even before the French administration had defined the framework governing the renewal of wind farms, we decided to start repowering the first wind farm we had developed and built: Souleilla Corbières. With 2 projects presently under construction, 6 projects authorized and for which pre-construction is ongoing, 25 repowering projects under development and 5 signed partnerships with different asset owners, we are proud to be the 3rd most active developer in this market in France, and the first on behalf of third parties. As pioneers in repowering, we pay particular attention to cultivating and sharing our expertise through the publication of white papers, as well as articles and participating in conferences. We are also delighted to lead an inter-professional working group within France Renouvelables dedicated to the development of this activity in France. With this in mind, we have been publishing our Repowering Handbook since 2021. We hope this tool will help you become familiar with wind farm repowering, its particularities, news and challenges. Enjoy your reading.

Laurie Gilbert
Deputy Director of Repowering
and Partnerships QENERGY France

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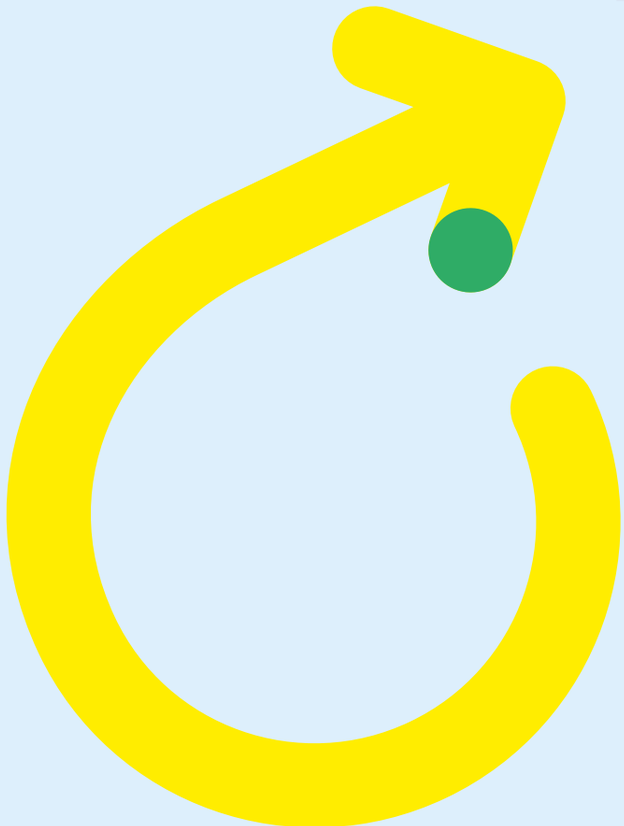

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REPOWERING GLOSSARY

Photo : © Nicolas Dohr

UNDERSTANDING **REPOWERING AND ITS ADVANTAGES**

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From revamping to repowering: what are the differences?

Repowering refers to the renewal, at the end of its expected lifetime, of green energy production infrastructures, such as wind farms or photovoltaic power plants.

Unlike “revamping,” which involves replacing certain components (generators, gearboxes, blades, etc.), “repowering” means the complete refurbishment of the installation (wind turbines, foundations, cables, substation).

In a repowering operation, the foundations of the wind turbines may be dismantled and replaced or simply reused if technical conditions are favourable. In this case, appropriate maintenance will be carried out to ensure their reliability for the entire new life of the wind farm. However, it is very rare for foundations not to be replaced, as most renewal projects involve a relocation of the wind turbines.

The on-site electrical network (connecting wind turbines) is systematically renewed.

The off-site electrical network (between the wind farm substation and the ENEDIS main substation) is never removed, even if the wind farm capacity is drastically increased.

*See glossary (p.56)

Repowering of the Soulelia wind farm
Photo : © *Absoludrones*

The state of repowering in France in 2025

The lifespan of a wind turbine varies between **20 and 25 years**

The first authorization for renewal was granted in **2015**

In 2025, it is **estimated** that more than **560 MW,** or nearly **450 wind turbines,** will have celebrated their 20th anniversary

Since 2020, around **fifteen renewal authorizations** have been granted each year

More than a hundred renewal authorizations have been granted by the French administration **(1 GW)**

90% of authorised **renewal projects** were considered non-substantial*

Did you know?
By early 2025, **French wind farms** represent **23.5 GW** of capacity connected to the electricty grid, for **2,500 wind farms** and nearly **10,000 wind turbines**.

*See page 22

A promising challenge to meet ambitious targets

Convinced by the benefits of repowering for France, QENERGY has decided to develop a model to estimate the repowering potential of each wind farm in terms of constraints and wind resources.

Methodology observed:

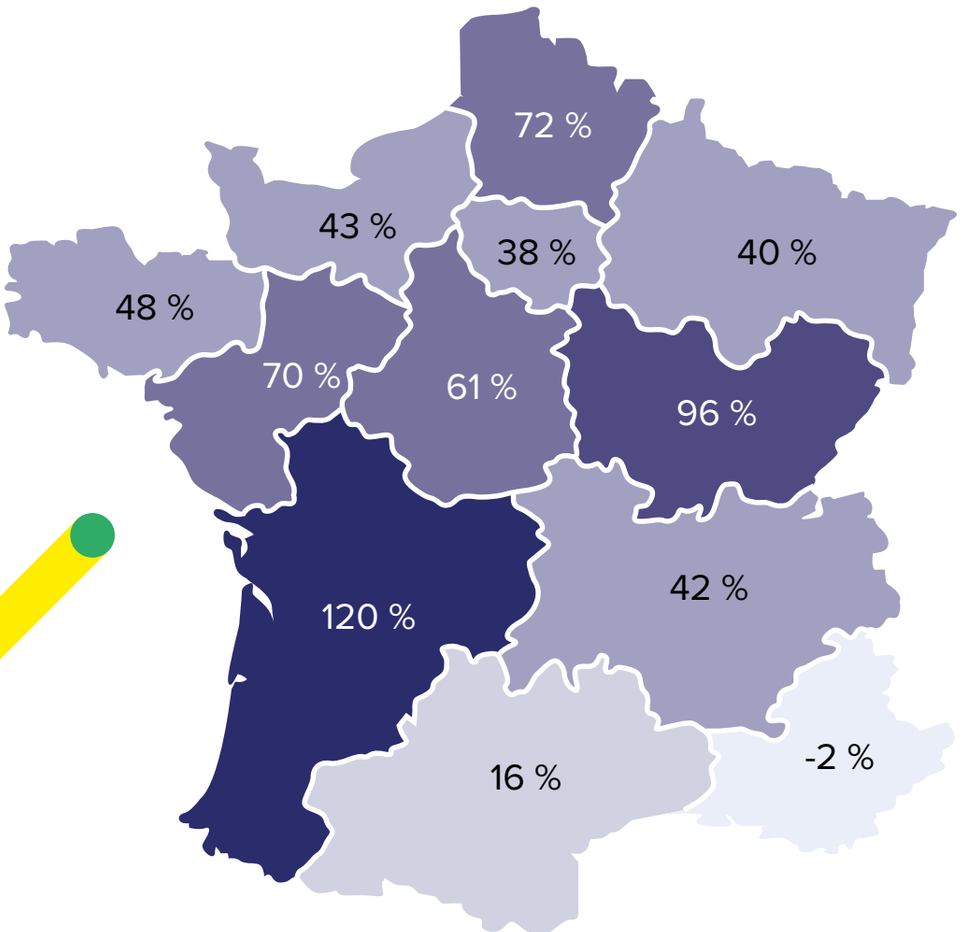
- Analysis of the operating wind farm database in France
- Definition of constraints (aeronautical, radar, environment, landscape, etc.)
- Impact estimation of each constraint on the renewal project
- Estimation of the annual production of the repowered wind farm based on the wind speed on site

By 2035, QENERGY estimates that wind repowering could increase the current installed capacity by:

+3,520 MW
wind capacity in operation

+13,640 GWh/year
annual wind energy production

Annual production increase potential, thanks to wind farm repowering only



Disclaimer - this model is based on assumptions and should be interpreted with caution:
It assumes a complete repowering of the total French fleet by 2035, a scenario that is highly unlikely due to multiple constraints (technical, land-related, social, industrial, etc.).
Other methodological approximations were necessary to estimate the potential.
These results are intended to provide estimations and contribute to strategic thinking, but should in no way be considered firm forecasts or achievable targets at this stage.

The benefits of a repowering project

Particular attention must be paid to all the stakeholders involved in a repowering project.

Asset owners

Reduce maintenance costs

Improve technical availability

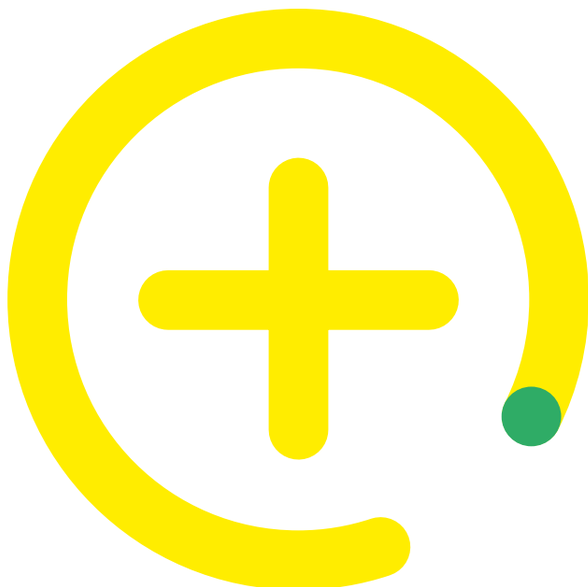
Increase long-term profitability

Landowners

Extend land leases and increase compensation

Optimize the layout

Better integrate the surrounding context



Local authorities and residents

Benefit from the latest technologies

Resize compensatory measures

Increase tax revenue

State

Increase installed capacity and contribute to PPE objectives

Benefit from a fleet that complies with new standards and regulations

Strengthen local acceptance

Did you know?
In its report « *Renouvellement de l'éolien : Quelles stratégies possibles et envisageables en fin d'exploitation pour les parcs éoliens terrestres ?* », **ADEME considers repowering to be one of the key solutions** for meeting commitments in terms of emission reduction and energy mix.

An opportunity to increase local benefits

According to the Ministry for Energy Transition, local authorities hosting a wind farm receive approximately €15,000 in tax revenue per wind turbine per year.

+ 10% total height **=** **+ 50%** local benefits

+ 20% total height **=** **+ 80%** local benefits

+ 30% total height **=** **+ 95%** local benefits

Contributions are directly linked to installed capacity. An increase in size automatically leads to an increase in installed capacity, which effectively increases the benefits received by the territory.

Estimation based on wind turbines with a blade tip height of 150m and a unit capacity of 2MW (standard characteristics of wind turbines meant for renewal).

A wind farm contributes to community life in three ways:

The flat-rate tax on grid companies (IFER) is proportional to the installed capacity.

The property tax on built properties (TFPB) is based on the rental value of elements fixed to the ground (foundations, substations etc.).

The business property tax (CFE) is comparable to the TFPB but only applies to companies.

On average, repowering an infrastucture doubles the local benefits and, above all, improves their distribution among local stakeholders.

Photo : © *Nicolas Dohr*

Repowering France's wind farms is therefore a major challenge in meeting our commitments in terms of decarbonizing energy production, to comply with the Paris Agreements and the ambitious objectives of the PPE.

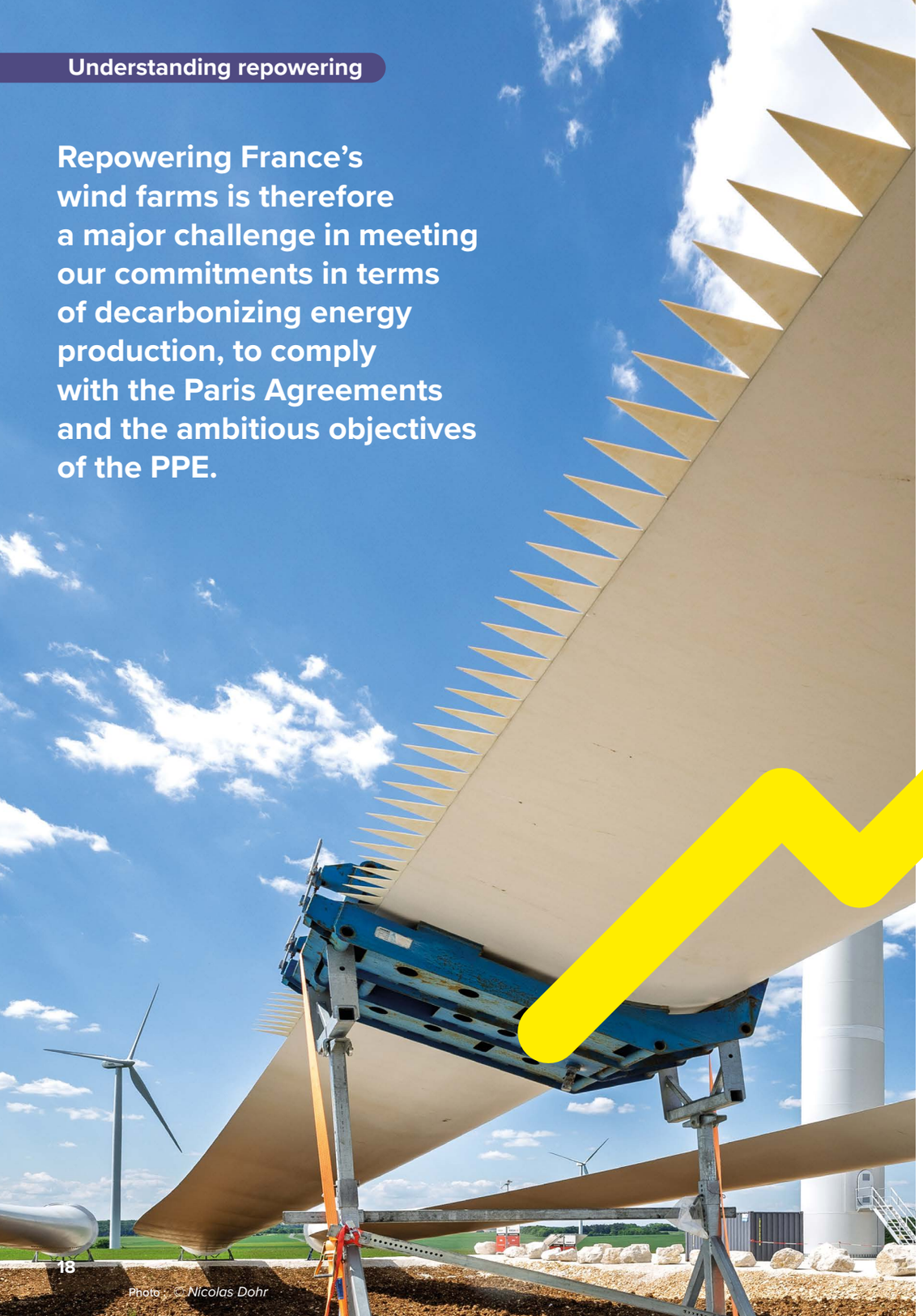


Photo : © Nicolas Dohr

Increasing electricity production through repowering

The first wind turbines were installed in the **windiest areas**, which were the **most suitable** for wind power development.

When comes the time of renewal, these areas maintain their **key advantages** and offer significant **potential** for increasing national carbon-free electricity production.

Did you know?
The *Programmation Pluriannuelle de l'Énergie* (PPE) is a **strategic document for steering** the energy transition in France. It sets out the guidelines and priorities for action for all types of energy on the national territory, in order to achieve energy policy objectives.
Source : écologie.gouv.fr

+ 10%
total height
=
+ 55%
households supplied

+ 20%
total height
=
+ 75%
households supplied

+ 30%
total height
=
+ 100%
households supplied

Combined with technological improvements, repowering is an effective way to decarbonize energy.

Estimation based on wind turbines with a blade tip height of 150 m and a unit capacity of 2MW (standard characteristics of wind turbines meant for renewal).

Photo : © Petzl-Vuedici.org

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The different types of repowering and their timings

The complexity and duration of the repowering process depend on the level of modification submitted to the administration.

3-4 years

Notable

A *Porter à Connaissance* must be submitted to the administration to explain how the dismantling and reconstruction will be carried out.

5-6 years

Non-Substantial

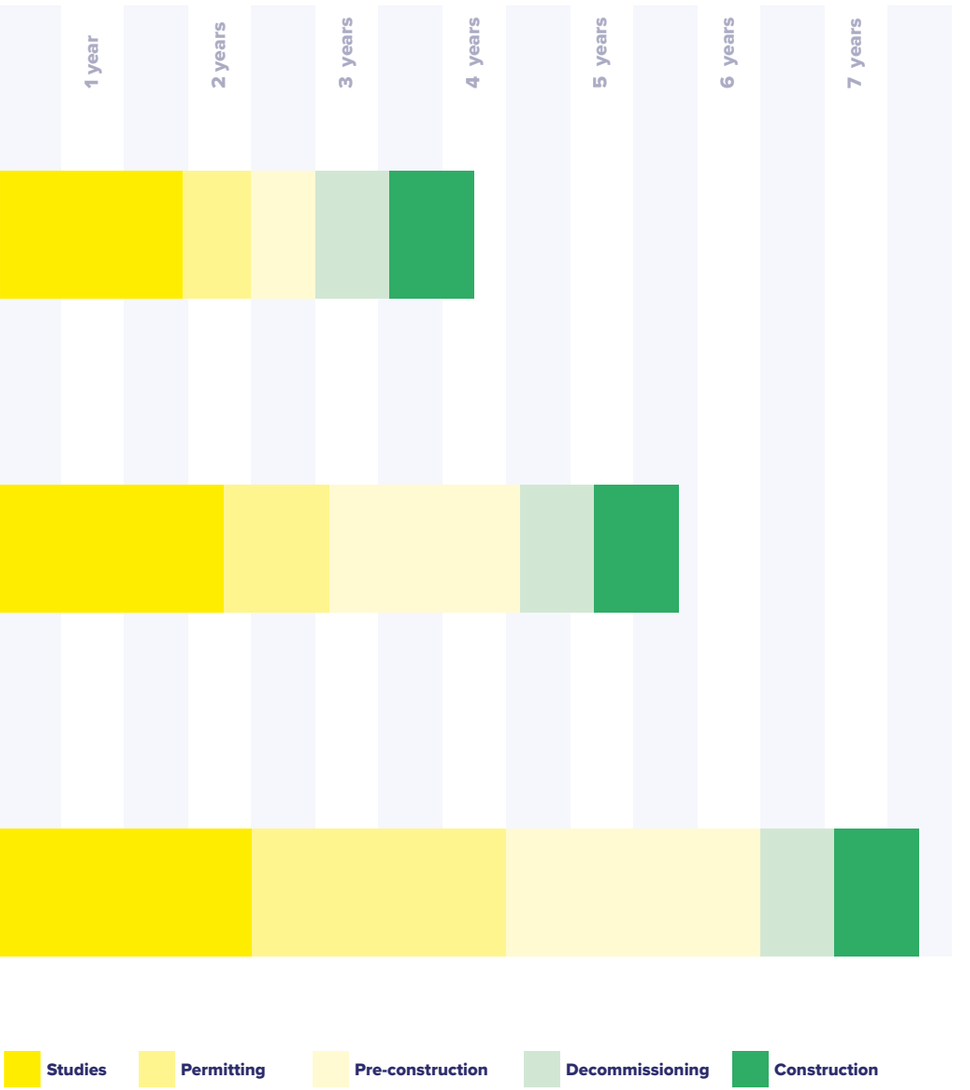
A *Porter à Connaissance* must be submitted to the administration to demonstrate that the impact of the repowering project will be similar to the one of the current wind farm in operation

7-8 years

Substantial

A new *Demande d'Autorisation Environnementale* must be submitted, as for a Greenfield* project.

*See glossary (p.56)



Which parameters define the type of a repowering project?

According to the 11th of July 2018 directive, amended on the 5th of September 2025, the repowering of an onshore wind farm can be classified into three categories: notable, non-substantial or substantial. This classification depends either on the new layout, or on the total height of the wind turbines.

Modification of wind turbines layout

Identical position → **Notable**

Relocation of wind turbines **within the** existing wind farm **polygon** → **Non-Substantial**

Impact analysis on **land clearing not planned in the initial authorization**

Relocation outside the boundaries of the existing wind farm → **Non-Substantial or Substantial**

Impact analysis on **land clearing not planned in the initial authorization**

Modification of the total height of wind turbines

Identical height → **Notable**

Notification describing only the terms and conditions of the construction

Repowering with tip height increase

Less than 33% → **Non-Substantial**

Notification justifying the absence of changes of the impacts

Between 33% and 50% → **Case by case**

Assessment by the prefect examining the additional impacts

Greater than 50% → **Substantial**

New application for Environmental Authorization as for a Greenfield project*

*See glossary (p.56)

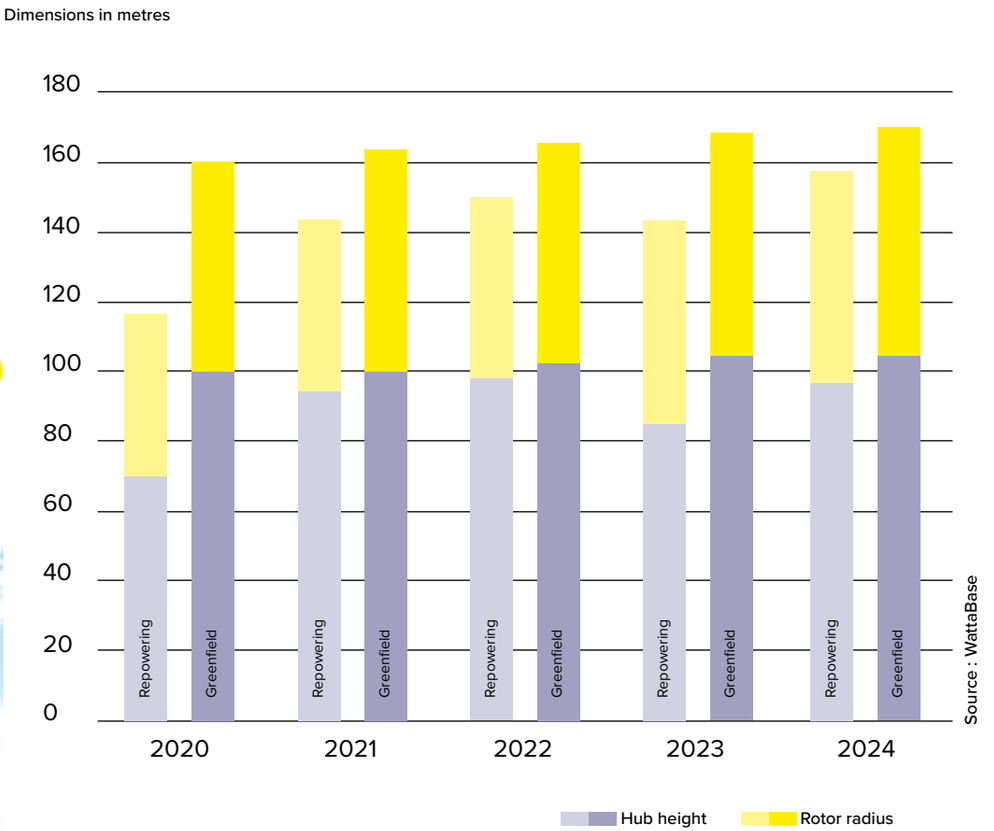
A more restrictive process than it seems

According to the ADEME study on wind repowering, 65% of wind farms installed before 2015 are subject to one significant constraint and 30% to two significant constraints, which limit or even prohibit any repowering project. This sometimes makes repowering projects heavily limited compared to greenfield projects*.

Significant constraints

- **Civil radar**
- **Aeronautical limitations**
- **Weather radar**
- **Natural environment**
- **Military radar**

Onshore wind power - Average size and type of authorized projects



The challenge of small turbines

Statutory requirements in France set blade tip heights of wind turbines lower than elsewhere in Europe. In a global market driven towards large-diameter machines, the availability of small wind turbines is a major challenge, with few models available.

*See glossary (p.56)

The stages of a decommissioning project

The access roads are being upgraded for cranes and heavy duty vehicules

The blades are laid on the ground

The nacelles are lowered to the ground

The tower sections are dismantled

All components are evacuated

The foundations are crushed using a hydraulic rock breaker

The reinforcement steel is separated from the crushed concrete for recycling

The excavations are backfilled with local earth and the site is restored

Photos : ©*Absoludrones*

Recycling standards

Decommissioning and legislation

According to Article 28 of the Decree dated 26th of August 2011, the decommissioning of a wind farm must include:

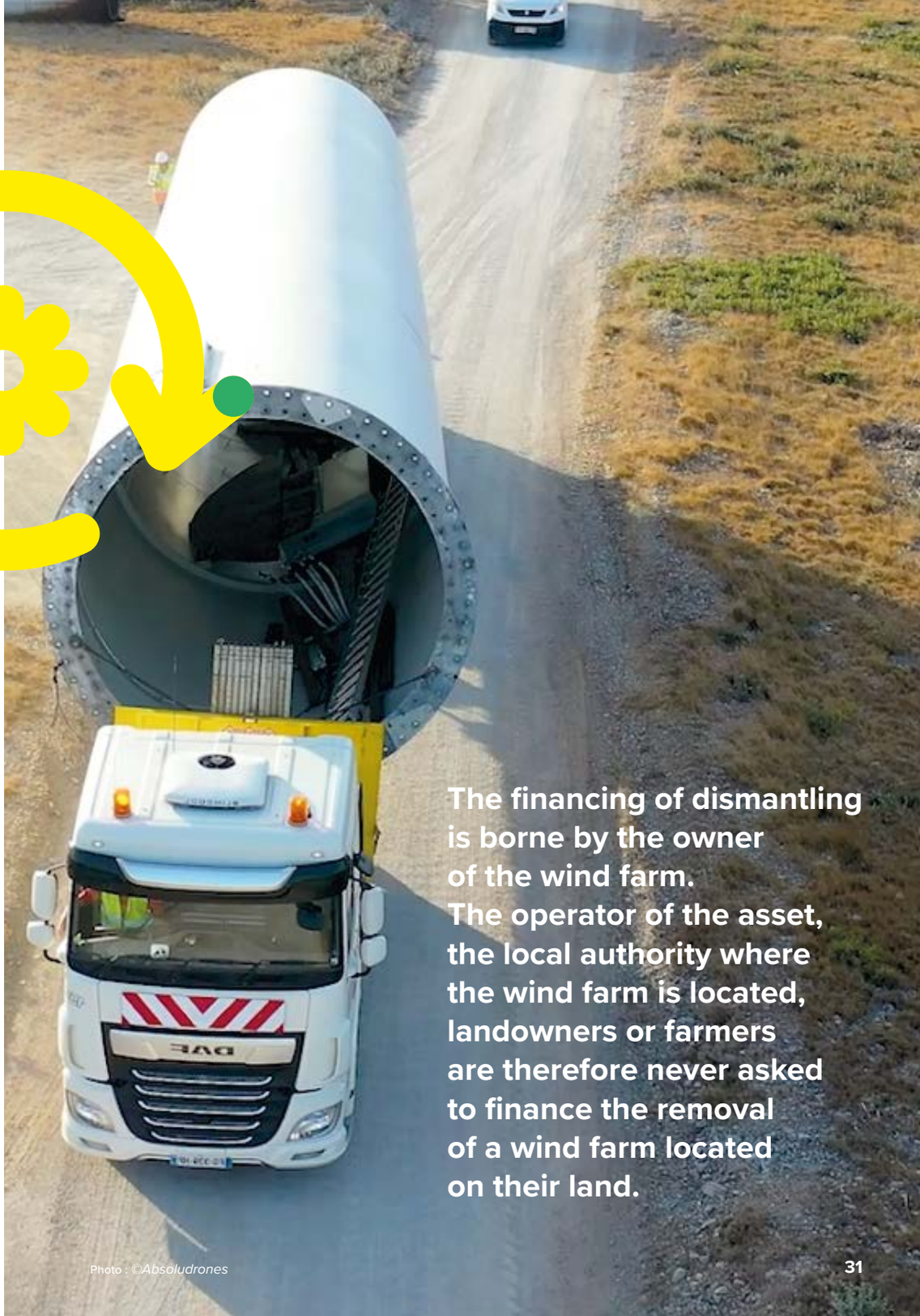
- The dismantling of wind turbines and substations,
- The removal of electrical cables within a radius of 10 m,
- The excavation or removal of all foundations,
- The restoration of the site and access roads.

Recycling and legislation

Permit application submission date	before 1 January 2023	after 1 January 2023	after 1 January 2024	after 1 January 2025
% of total wind turbine weight reused, recycled or valued (including foundations)	**90 %**	**90 %**	**95 %**	**95 %**
% of total rotor weight reused, recycled or valued	**35 %**	**45 %**	**45 %**	**55 %**

Did you know?

Exceptionally, **the lower part** (> 1-2 m) of the foundations may remain in the ground if the study sent to the prefect demonstrates that **the environmental impact** of excavation is **unfavourable**, i.e. that the environmental impact of removal is greater than leaving the land as it is. The recycling rate will then be reduced to 85%.



The financing of dismantling is borne by the owner of the wind farm. The operator of the asset, the local authority where the wind farm is located, landowners or farmers are therefore never asked to finance the removal of a wind farm located on their land.

Photo : ©Absoludrones

Reduce, reuse, recycle

Wind turbines are made up of 90% steel and concrete, 6% resins as well as reinforcing fibres, and 3% copper and aluminium.

Steel, concrete, copper and aluminium are very easy to recycle or reuse. The problem lies more in the composite material blades. For these, the most common treatment is:

- Incineration for energy production,
- Crushing for conversion into pellets for cement production,
- Reusing of blades by architects or designers to make street furniture.

A number of R&D projects are underway to improve the recyclability of blades, such as:

The development of a method for processing shredded material so that it can be reused as composites. More than 500 blades have already been processed.

Several Dutch architectural firms are working on transforming blades into street furniture: benches, playgrounds, bicycle storage facilities, etc.

IRT Jules Verne, in partnership with several industrial companies (Arkema, ENGIE, SUEZ, etc.) is working on thermoplastic blades that are fully recyclable.

The industry is also working on wind turbine refurbishment in order to install dismantled wind turbines from one site to another after a complete refurbishment. Improvements and upgrades to second-hand wind turbines can also be implemented to enhance their initial performance (software upgrades, blade equipment, last generation sensors, etc.).

Did you know?
Wind turbine blades are made of fibreglass or carbon fibre, just like boat hulls, kayaks, windsurf boards, some tanks, certain car bodyframe parts, many aeronautical components, etc.

All these industries therefore face the same recycling issues.

The French challenge
Wind turbine manufacturers are gradually officially phasing out «small wind turbines», threatening feasibility of wind farms with low height constraints. The reuse of dismantled wind turbines, after refurbishment and modernisation, could help meet part of the french market demand, given the rising number of repowering projects.

Creation: Atelier d'Eole

What are the challenges for securing the future of wind power?

Challenges at the end of a wind farm's life

- Communicate with the relevant authorities about the constraints associated to the repowering and recycling issues;
- Ensure operation of the wind farm until repowering,
- Guarantee energy sale at the end of the feed-in tariffs.

Next challenges of the wind industry

- Improve regulations to unlock the potential of repowering and benefit from the latest technologies, rather than reduce installed capacity due to lack of solutions.
- Be able to connect repowered installations and their additional power to a growing but still undersized electrical grid.
- Develop recycling and re-use solutions, by continuing R&D and partnering with other mature industries.
- Consolidate the service provider's market and refurbishment industry players.
- Communicate about the recertification of refurbished wind turbines.
- Move towards more environment friendly materials for new installations, such as recycled fibre blades, «green steel» towers and low-carbon cement for foundations.
- Raise awareness among investors, funds and insurers about different business models.

QENERGY
FROM PIONEER TO LEADER IN REPOWERING

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>1 GW
Under development

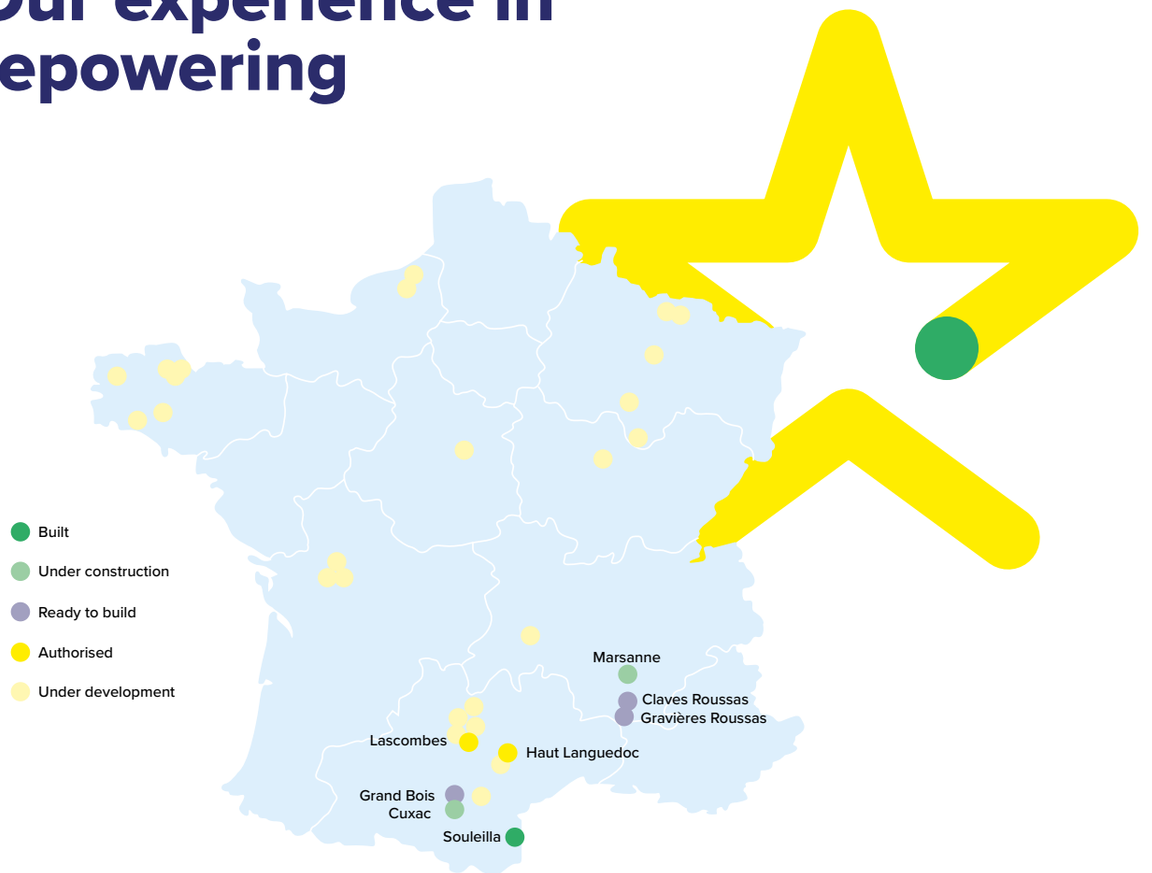
Second developer
in terms of authorised capacity

5 partnerships
Signed with different owners

Leading developer
in terms of authorised capacity
on behalf of third parties

Photo : ©*Absoludrones*

Our experience in repowering



24 MW
built
1 project

88 MW
authorised
2 projects

84 MW
under construction
or ready to build
5 projects

825 MW
under development
25 projects

Our repowering projects, their location, tip height increase and type:

BUILT

Souleilla Corbières	Treilles	Aude	+0%	Identical

UNDER CONSTRUCTION

Cuxac	Cuxac-Cabardès	Aude	+27%	Non substantial
Marsanne	Marsanne	Drôme	+34%	Substantial

READY TO BUILD

Grand Bois	Caudebronde	Aude	+27%	Non substantial
Roussas Claves	Roussas	Drôme	+30%	Non substantial
Roussas Gravières	Roussas	Drôme	+30%	Non substantial

AUTHORISED

Haut Languedoc	Murat-sur-Vèbre, Cambon et Salvergues	Hérault	+26%	Non substantial
Lascombes	Broquiès	Aveyron	+60%	Substantial

UNDER DEVELOPMENT

25 projects

QENERGY France and repowering

2016 First investigation on repowering

2017 Initiation of the first repowering projects for third parties

2018 First authorisation and first tariff secured

2019 First contracts signed for third parties (3 customers - 7 projects - 100 MW)

2020 130 MW submitted for repowering authorisation
Acquisition of a wind farm for repowering

2021 First repowering tender won (1 customer - 8 projects - 350 MW)

2022 First authorisation for substantial repowering obtained (25 MW)
First dismantling for renewal (24 MW)

2023 Contract signed with a 5th partner
Threshold of 100MW of authorization reached

2024 2 tenders won (2 customers - 14 projects - 330MW)
1GW currently under development reached

As a leading player in the field of repowering, we have been working for nearly ten years to structure and share our expertise, in particular through the publication of studies, the writing of technical articles and participation in conferences. True to our approach of consultation process and contribution to the wind industry development, we have also been leading the inter-professional working group dedicated to repowering development within France Renouvelables. It is with this same perspective that we have been publishing our Repowering Handbook since 2021.

Focus on...

Souleilla-Corbières: Our first repowering project

The project was launched in 2016, dismantling was completed in 2022 and industrial commissioning took place in 2023.

In 2018, this repowering project secured a new 20-year feed-in tariff and extended the wind farm's operating life by an additional 25 years.

Challenges overcome

- **Technical constraints:** Exclusion zone of a weather radar, strong and very turbulent winds.
- **Environmental constraints:** Presence of a couple of red kites requiring the implementation of compensation measures.
- **Procurement issues:** Authorised dimensions not compliant with the ones available in manufacturers' catalogues, requiring wind turbines to be specifically designed for this site (with calibration and certification).
- **Type of renewal :** Identical repowering.

16
wind turbines
Identical

24 MW
installed
+15 %

80 m
total height
Identical

71 GWh/year
production
+18 %

Local benefits

+26 k€/year
increase in tax revenues for local authorities

+80 k€/year
in property income for the municipality where the farm is located

DISCOVER
THE SOULEILLA REPOWERING IN VIDEO

Photo : © AbSoludrones

Focus on...

And our first dismantling

Photo : © *Absoludrones*

99.4 %
of the weight of the wind farm was recycled or reused.

The wind turbines

- The best components were **sold** as **spare parts**.
- The **steel parts** (tower, nacelle) were **recycled**.
- Part of the blade tips were **donated** to a local artist for creation **of works of art**.
- The remaining sections of blades were **sold** to create **furniture** (tables, chairs, lamps, etc.).

The foundations

- The foundations have been **completely dismantled**.
- **100%** of the extracted steel was sold for **processing and reuse**.
- **26%** of the concrete extracted was used for the **new foundations**.
- The remaining **74%** was sold to a local construction company for **reuse near the site**.

The electrical network

- **55%** of the electrical network was removed and recycled.
- Only the cables located under the access roads remained in the ground as **environmental impact was negative**.
- Commitment exceeded legal requirements, as **1.9 km** were removed compared to the **0.3 km** required by regulations (10m around the wind turbines).

Focus on...

Lascombes: Our most ambitious repowering project

The project was launched in 2019, dismantling will be completed in 2027 and industrial commissioning is scheduled for 2028.

In 2025, this repowering project secured a new 20-year feed-in tariff and extended the wind farm's operating life by an additional 30 years.

Challenges faced

- **Technical challenges:** Weather radar coordination zone and lateral zone of an RTBA*.
- **Environmental issues:** 4 PNA* with significant challenges related to wind turbines installation.
- **Urban planning issues:** Extension of 2 wind turbines.
- **Timeframe:** Repowering divided in two stages due to changes in Météo France regulations.
- **Type of repowering:** Non-substantial, turned into Substantial.

4
wind turbines
Doubled

16.8 MW
installed
+890 %

150 m
total height
+60 %

35 GWh/year
production
+775 %

Local benefits

+ 127 k€/year
increase in tax revenues for local authorities

+ 97 k€/year
budget increase allocated to support and compensation measures

*See glossary (p.56)

Focus on...

Marsanne: Our most collaborative repowering project

Commissioned in 2008, the project will be decommissioned in 2025. Industrial commissioning is scheduled for 2026.

In 2024, this repowering project secured a new 20-year feed-in tariff and extended the wind farm's operating life by an additional 30 years.

Challenges to be faced

- **Technical challenges:**
  Defense radar coordination area, VOR* coordination zone and strong as well as turbulent winds in forested areas.
- **Environmental issues:**
  Creation of a new layout in natural areas and EBC*.
- **Urban planning issues:**
  PLUi* not compatible, requiring a *Déclaration Préalable Emportant Mise en Compatibilité* (DPEMC) [preliminary declaration of compliance].
- **Type of renewal:**
  Substantial, as repowering considered 2 lines of 3 wind turbines instead of 1 line of 6 in the first place

6
wind turbines
Identical

25 MW
installed
+110 %

150 m
total height
+40 %

82 GWh/year
production
+100 %

Photo : © *Petzl-Vuedici.org*

*See glossary (p.56)

Local benefits

+ 108 k€/year
increase in tax revenues for local authorities

Crowd funding
with financial contribution from Marsanne Town Hall

Environment
Compensation measures: tree planting, nesting boxes, senescence zone

Consultation
Workshops organised throughout the development (hunting association, heritage association, etc.)

Heritage
EUR 30,000 for preservation and enhancement of the Saint Félix priory, a 12th-century church

Tourism
EUR 30,000 to redesign the access roads to Marsanne together with Montélimar Tourism Office

Focus on...

Claves and Gravières: Our most tailor-made repowering project

The project was launched in 2018, dismantling will begin in 2026 and industrial commissioning will take place in 2027.

In 2025, this repowering project secured a new 20-year feed-in tariff and extended the wind farm's operating life by an additional 25 years.

Challenges ahead

- **Technical constraints:** Weather radar coordination area and Defense radar coordination zone.
- **Environmental issues:** ZNIEFF1* and APB* with emblematic species.
- **Urban planning issues:** Partially forested in EBC*.
- **Procurement issues:** Dimensions authorised compatible with a single wind turbine model in France
- **Type of renewal:** Non-substantial with variable tip heights.

12
wind turbines
Identical

27.6 MW
installed
+31 %

93 - 120 m
total height
+0 à 29 %

73 GWh/year
production
+30%

Local benefits

+44 k€/year
increase in tax revenues for local authorities

+63 k€/year
in property income for the municipalities where turbines are located

*See glossary (p.56)

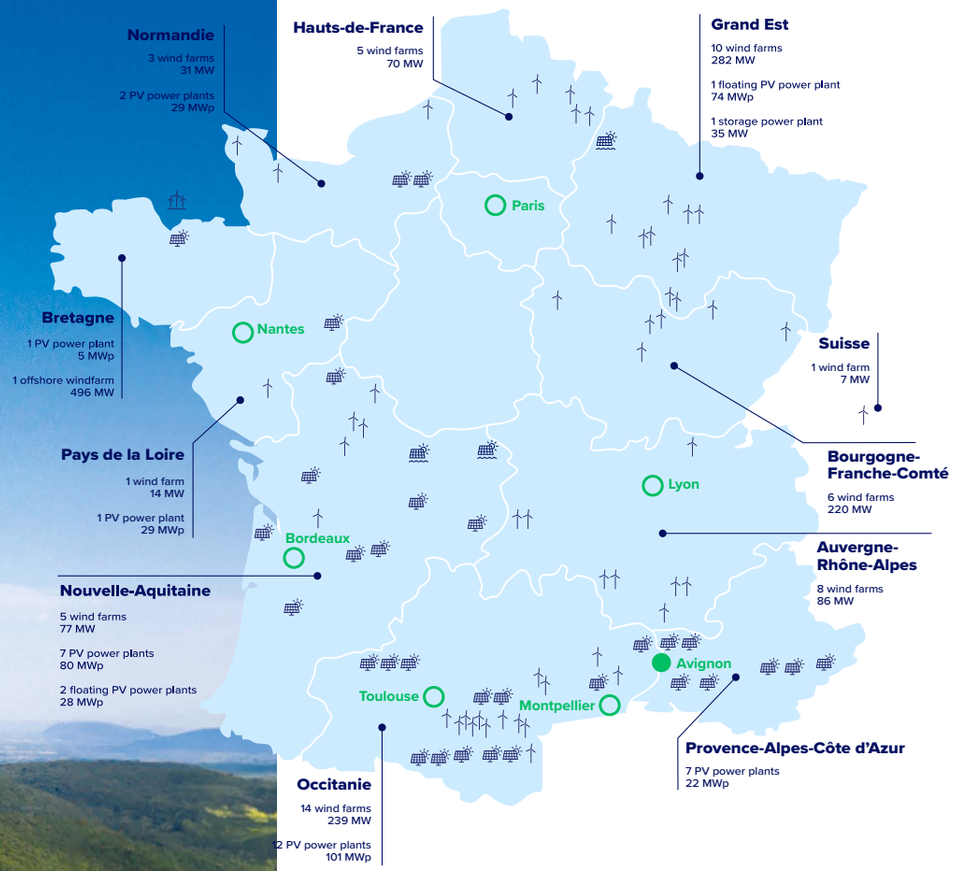
QENERGY France

26 years
of experience

300
employees in France

7
offices in France

Marsanne wind farm
Photo : © *Petzl-Vuedici.org*



Power production units developed and/or built by QENERGY France

Glossary of terms related to repowering

APB / APPB	Biotope protection orders (APB) or prefectural biotope protection orders (APPB)
EBC	Classified Wooded Areas
GW **GWh/an** **MW**	GigaWatts Gigawatt hours per year MegaWatts
Greenfield project	Project to create renewable energy production infrastructure
Intrasite electrical network	Electrical cables connecting wind turbines to the wind farm's delivery substation(s)
Lifetime Extension (LE)	Process for operating a wind farm with extension of the technical lifespan of wind turbines by replacing major or minor components, with a view to improving their performance
Off-site electrical network	Electrical cables connecting the wind farm's substation(s) to the main substation owned by the local network operator (ENEDIS or others)
PLU / PLUi	Local Urban Development Plan Inter-municipal Local Urban Development Plan
PNA	National Action Plans aimed at conserving or restoring endangered species of wildlife and flora
Porter à Connaissance (PAC)	Repowering authorisation application file informing the administration of the potential impacts of the proposed project
PPE	Multi-year Energy Programme
Repowering	Energy production infrastructure renewal at the end of their life cycle
Revamping	Replacement of certain major components of an energy production infrastructure
RTBA	Very Low Altitude Network, a set of restricted areas intended for fighter jet training flights at very low altitude and very high speed
Run To Destruction (RTD)	Process of operating a wind farm without heavy corrective maintenance until the end of the technical life of the wind turbines
Supplementary Prefectoral order (APC)	Decree issued by the Prefect modifying the initial wind farm to allow its renewal
TFPB	Property Tax on Built Properties
VOR	Omnidirectional radio beacon used by air navigation (comparable to radar)
Wind farm platform	Space used during construction for the assembly of wind turbine components, then during the maintenance phase for heavy operations
ZNIEFF	Natural Area of Ecological, Faunistic and Floristic Interest

Notes

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