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Repowering existing Wind farms will help reach Renewable electricity targets faster

Repowering represents a huge market potential: 25% of the Wind power needed in Europe by 2030 can be filled with Repowering

Climate Analysis Center | CONSULTING FOR GOOD

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Executive summary

At the end of the life span of onshore wind turbines, which is between 15 to 20 years, each of the project's stakeholders are consulted and must make a choice: either the project is permanently dismantled, or it is possible to work on a **renewal called repowering,** or the wind farm can continue to be operated, but this leads to rising costs and a reduction in benefits. In the first case wind turbines have to be **decommissioned.** The process of renewing an aging wind farm, with the aim of increasing the power capacity or efficiency of the farm is a **key lever** to **reach the objectives in terms of installed renewable capacity**.

Benchmark of the repowering opportunities in Europe

Europe must install 250 GW of wind power by 2030 to meet its goals*, while repowering emerges as a viable option as it can represent additional 65 GW up to 2030. It is possible to add new wind farms, but above all it is necessary to renew existing onshore wind farms, not only to avoid losing production capacity, but to significantly increase their production by capitalizing on the wind resources with more powerful machines, reducing the number of turbines on the territories. Repowering also allows a reduction in operating costs related to maintenance due to more modern and reliable machines.

Managing the end of life of wind farms based on a French case study

Repowering actively participates in the energy transition by significantly increasing the connected capacities without contributing to the saturation of exploitable sites on the French territory. 3,565 wind farms will reach the end of their life in 2025 in France, for an investment in repowering of 18 billion euros. Dismantling the old windfarms is also a business opportunity for the upcoming years, as wind turbines repowering could generate up to 30 million tons of recoverable waste by 2030 in Europe. Lastly, repowering is an opportunity to create non-relocatable jobs for the dismantling of existing wind turbines, their recovery and the installation of new ones.

The major challenges surrounding a repowering project

Repowering projects install larger wind turbines that are about twice as efficient and create jobs, but it requires regulatory authorizations. The timeframe required for a repowering project is shorter than the installation of a new park, especially thanks to the local acceptance already needed from the previous windfarm. However, a repowering project is never guaranteed up front and can face regulatory challenges.

*According to the directive 557 of July 2021 amending the Renewable Energy Directive (REDII) in order to meet the 2050 goals set by the European Green Deal

GENERAL OVERVIEW OF THE WIND MARKET

Repowering will account for a significant share of new wind installations. As early as 2020, new wind capacity coming from repowering could represent nearly 3 GW annually & should reach 6 GW per year by 2025.

Anticipating the exit from purchase obligation for developers

The life span of onshore wind turbines is traditionally set by the manufacturer for **15 to 20 years.** At the end of this period, each of the project's stakeholders is consulted and must **make a choice: to permanently dismantle the project, to continue the operation, or to work on a renewal called repowering.** Repowering is the **replacement of old machines to improve performance, resulting in changes of the main characteristics of the installation (turbine size, power, park extension, locations, etc.).**

Dismantling

- Wind turbines are progressively decommissioned when the revenues no longer cover the increase in maintenance costs
- At the end of the operating cycle, wind turbine are dismantled, the site is cleared of all project-related equipment and lands returned to their original use

Continuation of operations

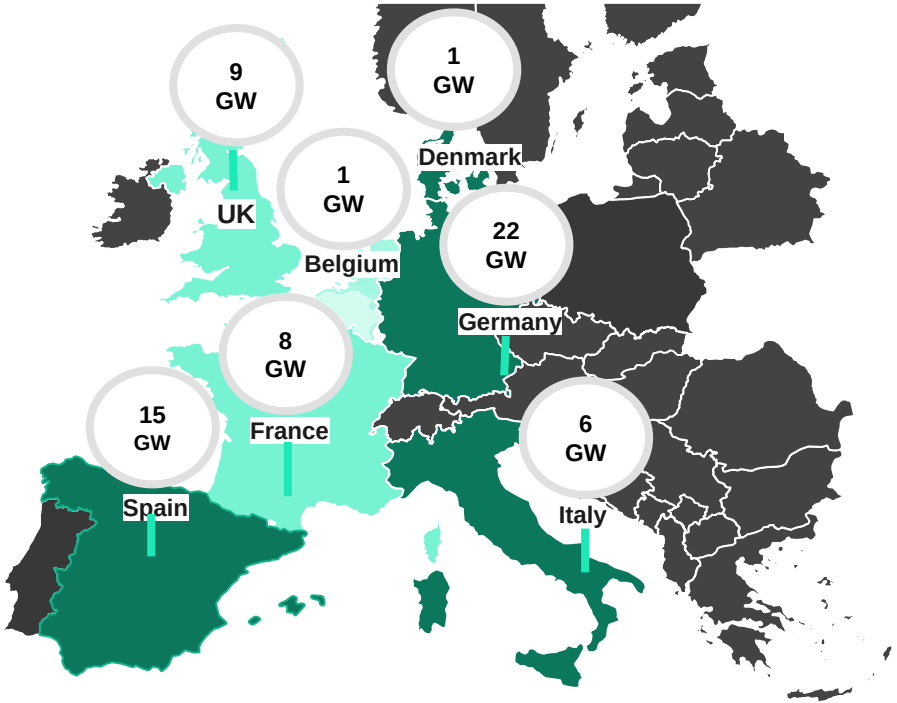
- Steadily rising maintenance costs
- Gradual reduction in the profits & loss of remuneration benefits after 20 years
- Performance decrease to be controlled

Repowering

- Installation of more efficient equipment
- Costs similar to the development of a new project & dismantling costs of the old plant

The end-of-life of a wind farm must be anticipated, on average **more than 4 years before the decision to stop the production** of the farm to define an end-of-life trajectory. In practice, a renewal is a **long-term project**, which begins with the monitoring phase of the operational status of the existing wind farm, the market conditions at the end of the remuneration supplement (varying according the country) and on the applicable regulatory framework for a possible renewal with an eligibility for a X-year purchase contract (remuneration supplement).

Market disparities in the aging of national wind farms in Europe lead to various repowering opportunities



Power qualified for repowering by country by 2030

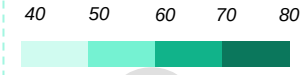
Overview of the 220 GW of installed capacity in 2020 in Europe

The UK has relatively young wind farms (70% of UK wind park is less than 10 years old), following by France (over 50% of the park). The age pyramid of wind farms in operation shows **clear disparities between Member States, with a huge gap between Germany, Italy and Spain and its old parks and the other members.**

65 GW

- 65 GW of the European wind farms will reach the end of their life by 2030
- 250 GW must be installed in Europe by 2030*, a third of this power could come from repowering

Europe is looking for growth drivers, such as offshore wind or repowering: Germany, Spain and UK will be the countries most concerned by this challenge by 2030. **Historical wind farm installation markets are currently the largest markets concerned by repowering, a lever for achieving renewable targets.**



Percentage of installations qualified for repowering by 2030

GW

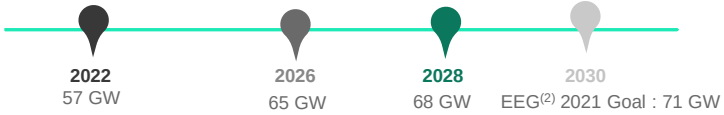
Capacities qualified for repowering

Sources: AIE, TheWindPower , Windeurope, European Commission

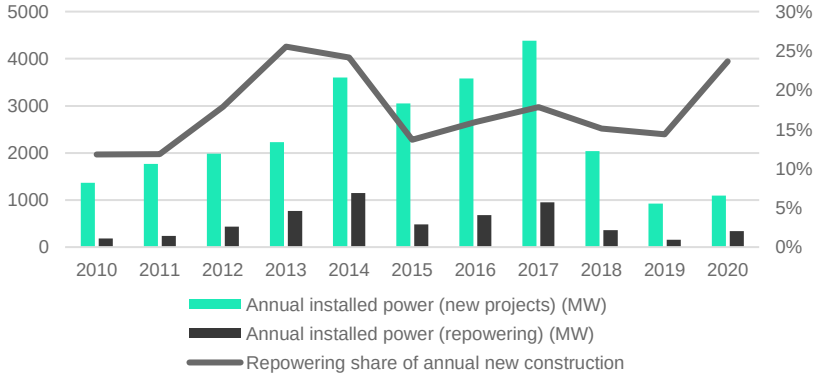
**According to the directive 557 of July 2021 amending the Renewable Energy Directive (REDII) in order to meet the 2050 goals set by the European Green Deal*

Germany targets 71 GW of onshore wind power installed by 2030, Repowering is fully part of its strategy to achieve this goal

Installed onshore wind capacity will need to increase by almost 30% by 2030



Repowering is already an important part of the German wind energy development



Germany is one of the first countries that engaged in repowering and supported repowering legally

Since 2010, repowering projects have been growing steadily, because wind turbines reach the end of their life but also because repowering allows them to keep increasing wind capacity despite the **lack of land for new wind farms**.

In Germany, repowering has the historical background and the legal strength to become a crucial mechanism in the next 10 years

24% the repowering share of new installations in 2020

Repowering is seen as an instrument in the **German policy**. The **Federal Climate Protection Act** (1), passed in June 2021, aims to **make repowering easier**, by facilitating the approval of new windmills in old sites. Repowering opportunities should therefore continue to increase in Germany in the coming years.

Example of repowered farm: "Düngstrup" wind farm (in Wildeshausen) built in 2001, repowered in 2016 (15 years old)

- **Number of old turbines: 8** (10,4 MW)
- **Number of new turbines: 4** (12 MW)
- **Energy production increase : + 15%**

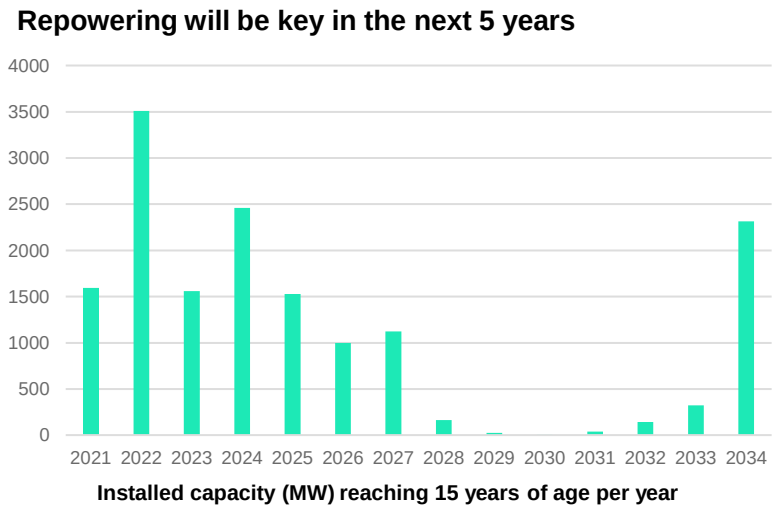
Germany has already integrated **repowering in its wind power development strategy** for the past years and will keep on using it to achieve its ambitious goals for 2030. Furthermore, Germany has passed a **law** that encourages repowering, which shows that repowering should still offer great opportunities in Germany in the coming years.

(1) *Bundesklimaschutzgesetz*
(2) *EEG : the Renewable Energy Act (Erneuerbare-Energien-Gesetz)*

Source: BWE (Bundesverband WindEnergie), Deustche WindGuard (Status des Windenergieausbaus an Land in Deutschland)

Spain has ambitious goals for 2030: to double their wind capacity while repowering the vast majority of their wind farms

Installed wind capacity will need to almost double in 2030 whilst repowering an aging wind power industry



Spain was one of the first countries to invest in wind power: as a result, all wind farms will be repowered before 2030

Spain built 1 GW of wind power every year from 2000 to 2020 (except from 2013 to 2017). The bulk of the total wind power has to be renovated soon: **10 GW must be repowered in 2025, 20 GW in 2030.**
This challenge is added to the MEP's* goals set for 2030: Spain has to build **24 GW of wind power in 10 years**, 2.4 times faster than the current pace.

Repowering is a key lever, especially for one of the oldest countries in terms of wind power installations

The first wind farms had a life cycle of 15 years, they've begun to be repowered or dismantled in 2015.
Most of them were built between 2005 and 2013, therefore there is an important market opportunity for repowering in the coming years

Example of repowered farm: "El Cabrito" wind farm (Cadiz) built in **1995, repowered in 2018** (23 years old)

- **Number of old turbines: 90**
- **Number of new turbines: 13**
- **Power production increase : +16%**

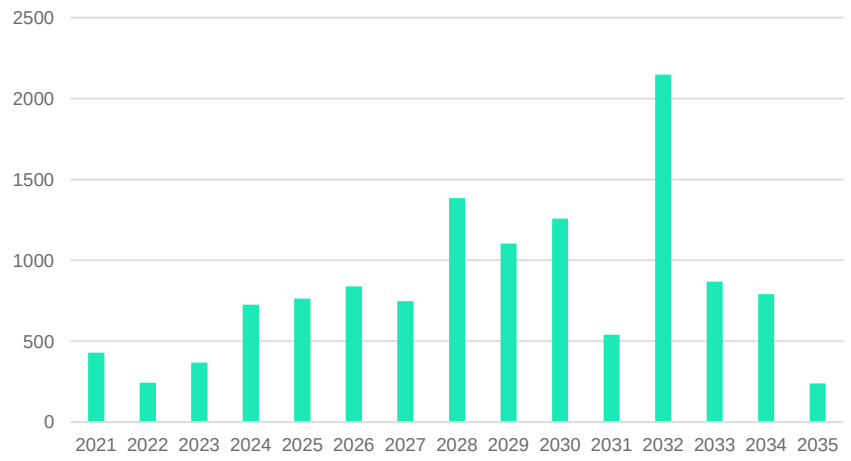
Spain has a **strong well-rooted wind power production**, with an industrial value chain that encompasses every step of a repowering project. The legal framework for Renewable Energies defines repowering and facilitates its process. However, the **average age** of Spanish wind farms is older than other countries. **The challenges for 2030 are double: to duplicate the total installed wind power, and to repower or dismantle 20 GW (75 % of their current wind farms)**

**MEP - Multiannual Energy Plan*

Source: AEE (Asociación Empresarial Eólica), Acciona

The UK has a flourishing wind industry, but the lack of onshore targets for 2030 endangers its development

The repowering of onshore farms could represent a steady income of new capacity



Installed Onshore capacity (MW) reaching 15 years of age per year

The UK has increased its total wind power capacity from 5,4 GW in 2010 to 24 GW in 2019

A similar growth is expected in the next decade: the government has set a goal of 40 GW installed offshore wind capacity by 2030 (from today's 15 GW of offshore power).

The UK has one of the youngest average wind farm park in Europe: the vast majority of the installed power was built after 2006

The UK is not eligible to the goals established by the European Commission for 2030, however the "net-zero 2050" greenhouse gas emissions target must respected. There are not any objectives for the onshore wind industry, therefore its growth in the incoming years could be stagnant. In addition, there are no price support or subsidies since 2015 for new projects, UK operators have preferred to extend the lifespan of existing assets rather than replace with higher capacity turbines.

Example of repowered farm: "XX wind farm (Cadiz) built in **1992, repowered in XX** (XXyears old)

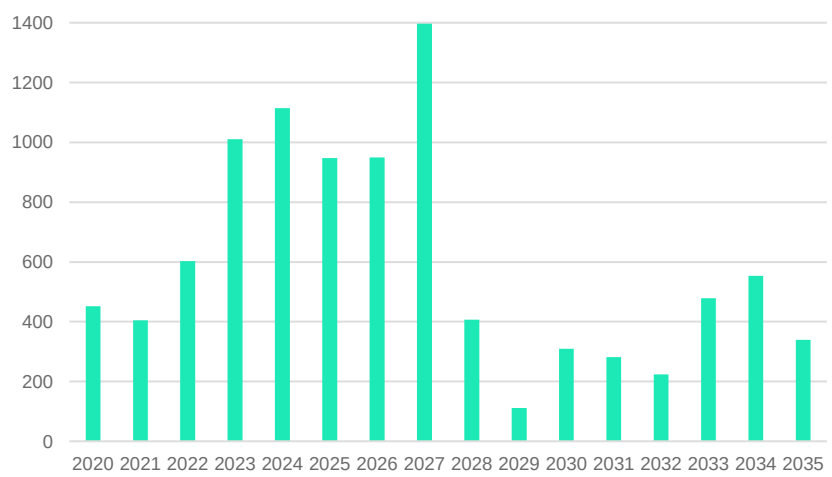
- **Number of old turbines: 103 (31 MW)**
- **Number of new turbines: 103 (102 MW)**
- **Power production increase : +310%**

The UK has a relatively **young wind industry**, with an offshore share that grows every year. The growth of the industry will continue, the goal is to multiply by four the installed capacity of offshore farms by 2030. Although onshore repowering could boost its expansion, the **lack of clear goals and incentives** deters the growth of this sector.

Source: The Ten Point Plan for a Green Industrial Revolution

Italy has ambitious objectives for 2030: they could be enabled by the repowering of its aging winding farms, but it will not be sufficient

Repowering could assure a steady amount of wind capacity in the coming years, much needed to meet the 2030 objectives



Installed capacity (MW) reaching 15 years of age per year

Italy needs to simplify the process of repowering and new farms permits to speed up its development

Italy needs to add at least 7 GW of renewable capacity every year to meet its targets (19 GW of installed wind power and 52 GW of solar power to reach 55% of renewable energy generation) under the Green Deal. Italy's achieved an average of less than 1 GW per year over the past few years with the current permit timetable.

Half of Italy's capacity will reach the end of its operational life by 2030

In its final 2030 NECP, Italy aims to almost double its installed wind power capacity, with a combination of new installations and the repowering of existing wind farms.

25% of the onshore wind farms are older than 15 years in 2021 and could be concerned by repowering, another 25% will be older than 15 in 5 years

Example of repowered farm: "Monreale Partinicowind" farm which will be repowered in 2022

- **Number of old turbines: 19** of 850 kW each
- **Number of new turbines: 10** of 4,2 MW each
- **Power production increase : +260%**

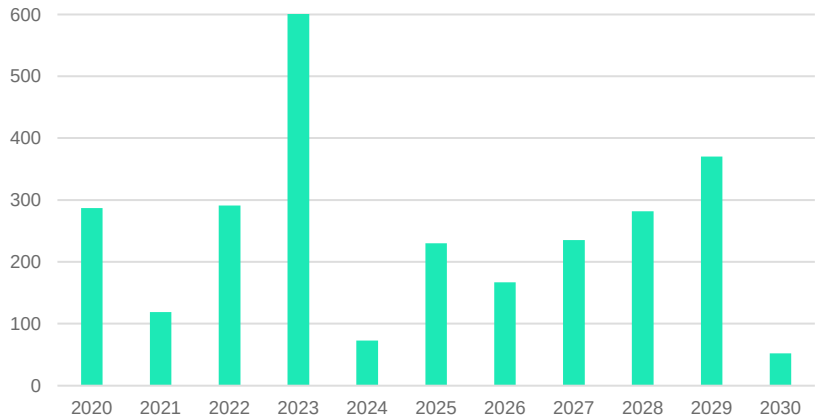
In its current form, the legal framework doesn't allow enough flexibility to repower windfarms. It still contains **restrictions** that prevent the use of the latest available technology, which will make the 2030 objectives unreachable.

Source: WindEurope, Piano Nazionale Integrato per l'Energia e il Clima (Déc 2019)

Denmark wishes to increase wind capacity while diminishing the number of masts on its territory

To keep the installed wind capacity will need to almost while renovating an aging wind power farm

17 years old Average Wind turbine age when decommissioned



Installed capacity (MW) reaching 15 years of age per year

The goal is to reach 55% of renewable energy in the energy mix by 2030 with a focus on offshore wind

The Danish population is strongly against the installation of new projects. Due to its small size, Denmark wishes to focus on the creation of new offshore wind farms and on the reduction of the number of onshore wind turbines from **4300 to 1850**.

Repowering with more powerful wind turbines of similar height

The Danish government wants to push the end-of-life of wind turbines towards renewal with fewer but more powerful turbines, rather than developing the technology towards the extension of their life span

57% of the onshore wind farms are older than 15 years in 2021 and could be concerned by repowering

Example of repowered farm: "Klim Fjordholme" wind farm built in 1996, repowered in 2014 (18 years old)

- **Number of old turbines: 35**
- **Number of new turbines: 22**
- **Power production increase : +220%**

VATTENFALL

Now the biggest onshore wind farm in Denmark

More than half of Denmark electricity production comes from wind power. However, with the growing discontent of the population to install new onshore wind turbines, Denmark intends to halves its number by 2030. The country will keep on investing in offshore projects in the future.

Source: Danish Energy Agency, 2015, Deutsche Windguard

Belgian onshore wind farms growth is stuck, with no possibility of setting an installed capacity goal for the future

Limited repowering potential due to the low number of wind turbines installed in the last 20 years

Installed capacity (MW) reaching 15 years of age per year

A potential based solely on federal wind development plans

The potential of renewable energies in Belgium is low. Federal government is only responsible for setting development targets for offshore windfarms, with a target of 4 GW for 2030. Onshore windfarms fall within the jurisdiction of regional authorities.

Repowering onshore wind farms is not high on the agenda since the Belgian wind industry is fairly young: it only took off in the last decade

Specific legislation dealing with decommissioning does not exist in Belgium and new processes for decommissioning will need to be developed in the upcoming years

9 % of the onshore wind farms are older than 15 years in 2021 and could be concerned by repowering

Example of repowered farm: Sainte-Ode farm

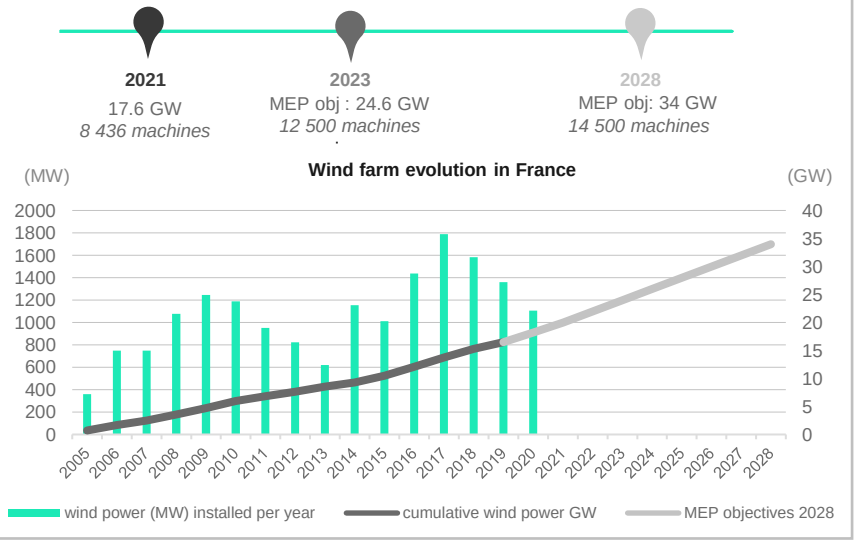
- **Number of old turbines: 6** of 1,25 MW each
- **Number of new turbines: 4** of 3 MW each
- **Power production increase : +250%**

Belgium NECP sets a target for offshore deployment, but for reasons of governmental jurisdiction, the lack of onshore targets and tenders does not encourage the creation of new projects, let alone repowering.

Source: NECP, Elia

Repowering is a key lever to enable France to double its installed wind power capacity in 7 years (objective of the MEP* 2028)

Installed onshore wind generation capacity will need to almost double to meet the ambitious 2028 target



17 GW to be installed by 2028 despite the saturation of the French territory

It is absolutely necessary to **renew existing onshore wind farms**. Repowering projects are still few in France.

Repowering is a key lever to achieve the objectives of the MEP

The life cycle of the first French wind farms, which lasts 15 to 20 years, is coming to an end. The implementation of a mechanism for the repowering of these wind turbines is necessary.

8 GW, ie 47% of the French targets by 2028 could be added to the current capacities.

92 MW	**of installed capacities arrives at the end of their purchase obligation in 2021**
800 to 1200 MW	**per year will arrive in exit of purchase obligation or of remuneration supplement between 2025 and 2035**

The issue of wind turbines replacement is beginning to reach French wind farms for the first time, not that they have reached the limit, but rather because they are at **a stage when major maintenance operations are to be planned** (blades, gearbox). Thus, it is also necessary to anticipate an exit from the purchase obligation or remuneration supplement.

*MEP - Multiannual Energy Plan

Source: ADEME, FEE, Sia Partners calculations

Onshore wind power has reached a significant threshold of installed capacity, concentrated in some regions considered almost saturated

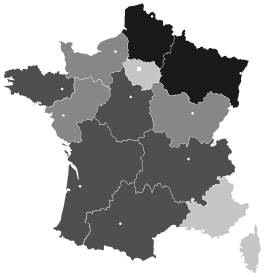
With over 17 GW of installed capacity in France, onshore wind power is starting to run out of steam

	2000-2005	2006-2010	2011-2015	2016-2020
Cumulative installed capacity (MW)	58	873	5979	10363	17000
Cumulative number of wind turbines installed	75	810	3565	5533	8265

Main manufacturers

Vestas, SENVION, SIEMENS Gamesa RENEWABLE ENERGY, ENERCON ENERGIE POUR LE MONDE, NORDEX, acciona Windpower

After a rebound in 2016, the number of wind turbines installed is declining annually by around **20%**, as is the installed capacity, which is falling by around **12% per year**.

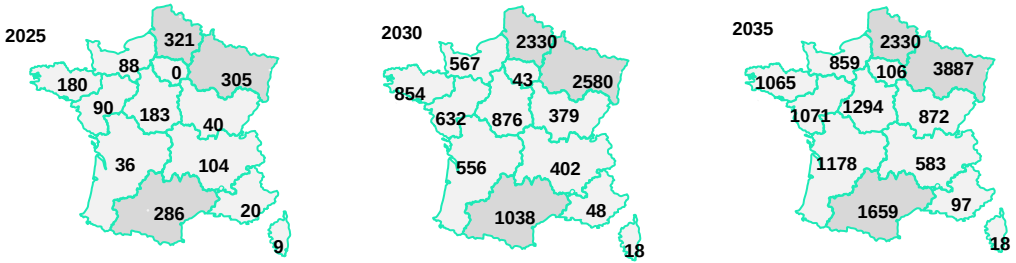


Sources: ADEME

Total capacity of connected wind farms (MW) by region

Wind power capacity is spread over the whole French territory, with almost **1 380 wind farms** comprising **8 260 turbines**. The **two regions** of Hauts de France and Grand Est account for **50% of the connected capacity** in France and are considered almost saturated.

Cumulative installed capacity by region which could be repowered (MW)



Opportunities for repowering in France are mainly located in Hauts de France and Grand Est regions, and in a few years in Occitanie. Historically privileged for their windy locations and the numerous natural and agricultural spaces, these regions benefit besides from a good local acceptability for wind farms projects.

Source: FEE, calculations Sia Partners, assumptions : windfarm lifespan of 15 years & repowering of 1.8M€/MW

MANAGING THE END OF LIFE OF WIND FARMS BASED ON A FRENCH CASE STUDY

3 565 wind farms will reach the end of their life in 2025 in France, for an investment in repowering with capacities x2 of 18 billion euros

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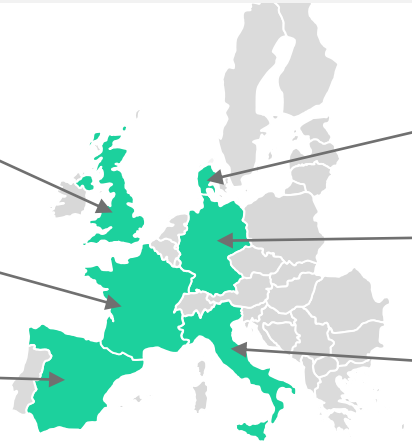
The operator, the legal responsible for the dismantling of its park

Only countries with installed capacities of more than 3 MW and the most developed among them have integrated into their national regulations specific rules governing wind farms end of life, which is explained by the age of the farms to avoid a situation of legal vacuum where farms would not be dismantled.

UK
Sets decommissioning requirements on a case-by-case basis

France
National regulation requires dismantling of wind turbines and excavation of foundations 1 to 3m below ground

Spain
Sets decommissioning requirements on a case-by-case basis



Denmark
Recognizes extension in its regulation, sets decommissioning requirements on a case-by-case basis

Germany
Fee, financial provisions and foundation excavation vary by state

Italy
National regulation requires dismantling of wind turbines and excavation of foundations 1-3m below ground

Source : WindEurope

A process that must be anticipated

Preliminary procedures
Dismantling plan, Site analysis, Residual value calculation

Dismantling
Disconnection, extraction of cables within a radius of 10m, excavation of foundations, waste management, crane contribution

Management of waste
Inventory, service via authorised manager, recycling and recovery of waste

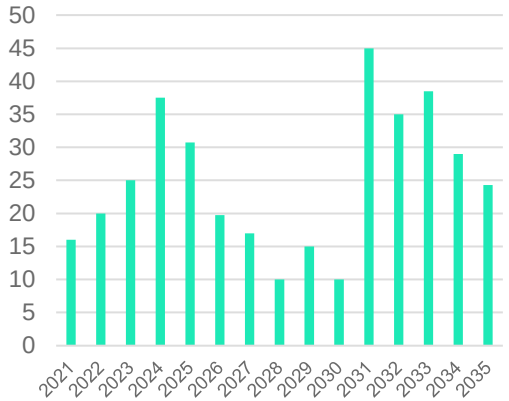
Restauration of the property
Replacement with soil of comparable characteristics, land levelling, soil decontamination

Sources : ADEME, FEE, calculations Sia Partners

Dismantling, a business opportunity for the upcoming years

With 388 MW of wind power decommissioned in 2020, the European market tends to grow. About 9.4 GW could be decommissioned over the next five years in Europe. The market is not very mature in France but with a strong potential: 2 500 wind turbines to be dismantled in the next 5 years and 7 450 wind turbines by 2035.

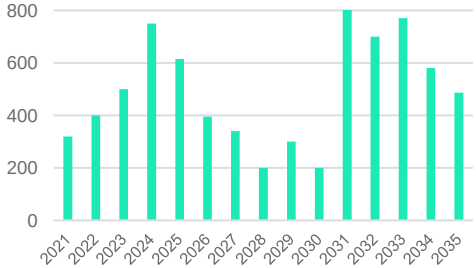
An economic opportunity



Turnover of wind farm dismantling each year (M €) in France

A material recovery market to be developed

The material leaving the park requires specific logistics for components that are difficult to recycle. It is also necessary to ensure the transport, storage and processing of large components in significant quantities



Number of turbines to be dismantled each year in France

Positioning opportunities

- Sia Partners recommends establishing a **national positioning** in order to achieve **economies of scale** and to make an **investment** in a large processing and storage plant **profitable**, for example.
- The company needs to have a **substantial size** to be able to take charge of dismantling, equipment rental and transport expenses.
- Sia Partners recommends signing **partnerships** between several major players in the recycling sector and the operators

More than **50 companies** are active in the European wind farm decommissioning market, the majority of which are Germans. With the growth of the market, **players specializing in the dismantling of wind farms are expected**, as well as centers of expertise among existing players (engineering offices, developers).

Source: ADEME, FEE, Wind Europe, Sia Partners calculations with hypothesis of a 15-year fleet life

The challenge of wind waste to be seized by recycling companies

In France, the Multiannual Energy Program (MEP) includes a clause specifying that the **recycling of the main components of wind turbines** will be **mandatory by 2023**. This law is at the origin of the creation of a French Dismantling-Recycling-Reconditioning-Resale (D3R) sector. Its aims to promote dismantling and recycling techniques within the framework of a circular economy and to demonstrate the **viability of such a sector.** Similarly, in other countries such as Germany or Spain, laws have been passed to greatly facilitate this mechanism, which is seen as crucial for achieving sustainable goals

Price and description of the main materials of a wind turbine in France

Steel 150-250 € / t

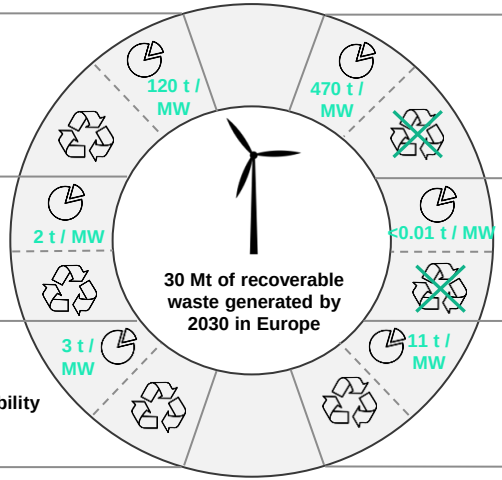
- Its high proportion in the wind turbine and its value make it the **main source of profitability** in dismantling
- The tower can be made of steel or concrete

Aluminum 300-700 € / t

- Light, resistant and essential in the manufacture of a wind turbine
- Raises environmental issues because of its carbon footprint

Copper 2500-4000 € / t

- Mainly used in electrical components and wiring
- Its high cost makes copper the **2th source of profitability** of dismantling



Concrete

- Inert waste easily **reusable**
- **Mandatory partial excavation** of the foundation
- Legislation is being proposed to require full excavation
- Its low value does not allow any benefits to be derived

Rare Earths

- Used in only **6%** of onshore wind turbines in France
- Recycling solutions are being developed and alternative materials are being sought
- Raise ethical and environmental issues

Composite

- **Very large component of the blades**
- **Difficult to recycle:** blades are often buried or used as solid fuel
- Recovery (urban furniture) and development of recycling solutions

Recyclable / recoverable

Selling price after recycling (according to London Metal Exchange)

Average material mass in the composition of the wind turbine (t / MW)

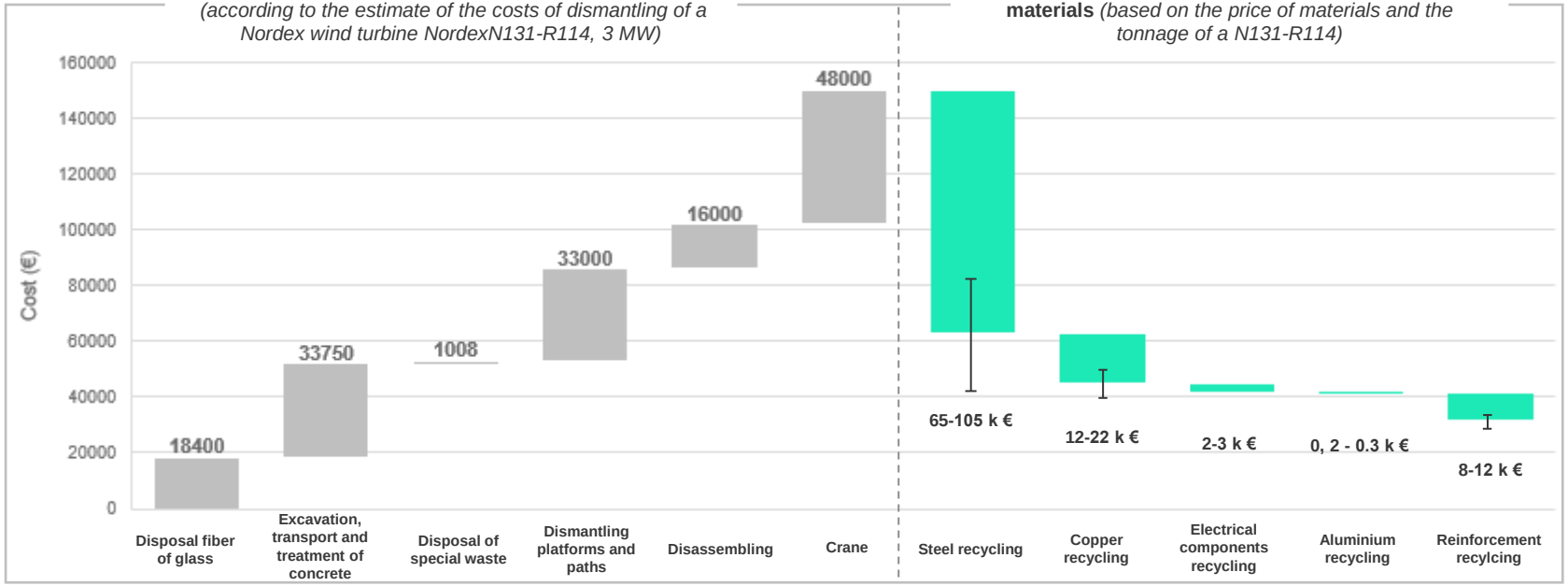
Today about **90% of a wind turbine is recyclable**, and its various components are taken care of by recycling and recovery companies.

Sources: ADEME, London Metal Exchange

A dismantling cost which may seem excessive at first sight, but that should be reconsidered when recycling is involved

Cost of the different dismantling operations
(according to the estimate of the costs of dismantling of a Nordex wind turbine NordexN131-R114, 3 MW)

Estimated profits from the resale of dismantling materials *(based on the price of materials and the tonnage of a N131-R114)*



Dismantling a wind turbine is **expensive**, but **recycling materials and components** can **greatly reduce these costs**. For a Nordex 3MW wind turbine, the cost of dismantling is €150,000, and about €50,000 after recycling, which is equivalent to the financial guarantees imposed in France by the State(1). However, the benefits of recycling depend on the price of the materials and are therefore **volatile.**

(1) Reminder: the financial guarantees prior to the commissioning of an installation are set at € 50 000 for a 2MW wind turbine and € 10 000 per additional MW

Source: ADEME, Nordex estimation

Recycling players are positioned around dismantling

Already positioned in France…

Major recycling, recovery and waste management companies such as Suez and Veolia are already invested in **wind turbine recycling projects in France**

…major recycling players form partnerships…

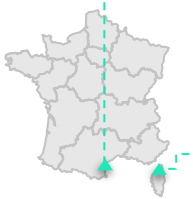
International partnerships have been formed, such as Veolia's collaboration with General Electric **in the United States and Germany for the recycling of wind turbine blades**

…and invest in research

Major players are investing in research, such as the Zebra (Zero wastE Blade ReseArch) project, which aims to develop and design **the first 100% recyclable wind turbine blade**

Focus on various projects

Wind farm of Port-la-Nouvelle



- Dismantling in 2019 of the **first wind turbine commissioned** in France in 1991
- Completion of the **dismantling of the 15 wind turbines** on the site in 2020
- **2 of the 5** companies mobilized for the dismantling are local

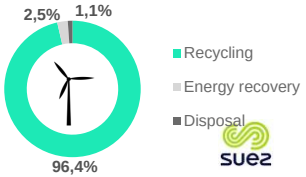
Number of wind turbines before dismantling
15

Number of wind turbines (planned) after dismantling
10

Installed power before dismantling
8.8 MW

Installed capacity (planned) after dismantling
30 MW

Material balance of the dismantling of the first 3 wind turbines of the site



Wind farm of Cap Corse

- Dismantling in 2020 of the Tenesa wind farm commissioned (20 years old)
- **Reduction in the number of wind turbines installed** and noise pollution for the **same power**
- **+ 15% increase in energy production**

Number of wind turbines before dismantling
20

Number of wind turbines (planned) after dismantling
13

Installed power before dismantling
12 MW

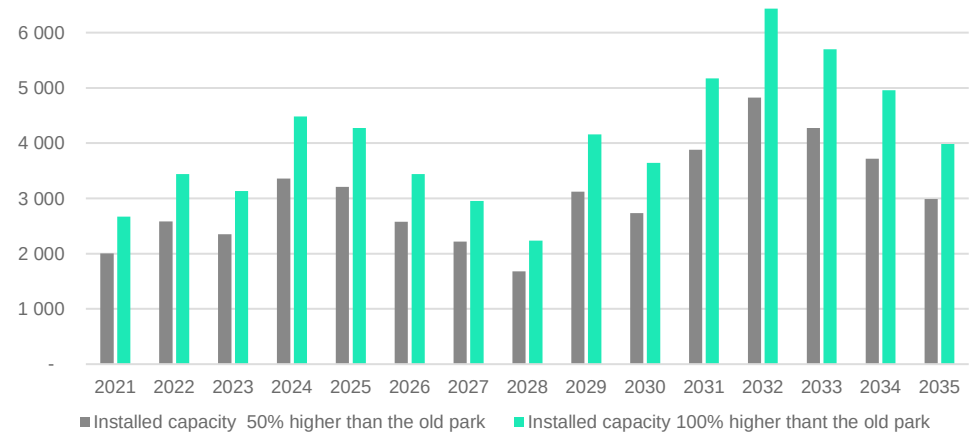
Power installed (planned) after dismantling
11.7 MW

Innovation and research for the recycling of wind turbines are developed through **partnerships between major international players** who are often already invested in this market. Dismantling sites also benefit **local players** who are mainly involved in dismantling, cutting or transport operations.

Business opportunities around repowering

Four financial benefits are at the heart of repowering projects. Firstly, for the operators of the old park, there is **no need to make an acquisition, as it is a reinvestment in a new asset for the owner operators.** On the other hand**, the value of the assets increases,** due to the significant increase in production through the installation of larger turbines with a greater efficiency. Lastly, **operating times** of new turbines is longer (less faults) and **headcount** is smaller (due to better turbines and greater automation/SCADA systems nowadays)

An economic opportunity



Investment in repowering each year (M €) according to the installed capacity in France

By 2035, the turnover of wind farms repowering in France will amount to more than € 60 billion for installed capacities 2x higher than the old park

Positioning opportunities

In France, repowering projects have been launched recently. Initially operated by large energy companies, these projects are also of interest to wind developers, who are also positioning themselves on the repowering of the **farms they have built and operated**. Repowering allows them to capitalize on the windy location of the old farm and increase the energy production performance, generally from 30% to 100%.

TOTAL Quadran · EDF renouvelables · RES · Kallista energy · BORALEX · ENGIE Green · valeco

A new market is opening up, with some companies positioning themselves to **acquire small wind farms at the end of their lives**, with the aim of renewing them.

RES

Wind farm of Lascombes (Aveyron, Fr), purchased in March 2021

NUMBER OF WIND TURBINES
2 -> 2

PLANNED POWER
+ 400%

Source: ADEME, FEE, calculations Sia Partners with life expectancy assumptions of 15 year & repowering of 1.8M € / MW

Repowering mobilizes the traditional professions of wind power, but also jobs in the materials recovery sector

The dismantling of existing wind turbines, their recovery and the installation of new wind turbines generate jobs in the traditional wind farm development and waste management professions. Repowering also allows local jobs to be sustained (maintenance in particular) by prolonging the activity of the farm.

Dismantling

Dismantling activities are usually carried out by the **same type of service providers as those involved during installation** (lifting, crane and transport companies, civil engineering, electrical engineering, etc.)

A **total excavation of the foundations** (concrete blocks) is generally necessary in case of relocation of a new wind turbines on the same site: a higher wind turbine of a different model systematically requires a **new foundation** (foundation certification issue)

5 working days per machine(4) excluding excavation (~ 10 days, or 4 days with blowing up)

Management of waste and industrial products

New **companies** will be mobilized, particularly **service providers** specialized in **recovery and reuse of industrial products** (towers, blades, turbines…) and **waste** (construction and industrial waste), which intervene according to the type of material to be recovered (concrete, scrap metal, composite materials, obsolete cable networks, etc). Most materials(1) enter **structured and identified collection, sorting, reuse** or even **recycling** channels.

Examples of players likely to position themselves in this market:

- **Recycling Industrials** : Suez and Veolia (already positioned), Derichebourg environnement...
- Service providers specializing in **dismantling of boats or aircraft** (due to the equipments they have and their knowledge of the materials to be recovered)
- Projects for **the creation of companies and / or specific platforms**: for example, the association AD3R(2) in France

The market of the wind turbines recycling could represent a cumulative amount varying according to estimates between **210 and 440 M €** by **2030** and could **create around 100 to 220 jobs in France** by **2030**, particularly in the **Hauts-de-France, Grand Est and Occitanie regions**(3).

Installation of new wind turbines

Repowering generally involves **substantial modifications** on the site. The **redesign of the wind farm** therefore mobilizes **all the traditional professions involved in developing a wind farm** on a greenfield site:

- **Studies and development**: the data acquired during the operation of the previous wind farm may enable the engineering offices to shorten the technical appraisal phase, but in general, impact studies as detailed as those for the creation of the wind farm are required.
- **Manufacture of components:** second-hand parts are forbidden on a repowered French wind farm, manufacturers will respond to a tender like in the case of a new wind farm
- **Engineering and construction:** civil engineering, electrical engineering and network connection (for example, companies specialized in cabling involved in the creation of a wind farm are called upon to modify or reinforce the existing networks)

Need for experienced technicians when turnover is already high (15% per year) (5)

(1) concrete, ferrous and non-ferrous metals, electrical and electronic materials (2) Association for Dismantling, Recycling, Reconditioning and Resale
(3) Source: Economy circular in the onshore wind sector in France - Report to the Minister of Ecological Transition and Solidarity, 2019 (fr)
(4) Source: *Dismantling and recycling of wind turbines*, Wörmann Team, GmbH & Co. KG (5) Source : *Towards a prospective vision of the challenges of onshore wind energy*, CGDD_MTES, 2017 (fr)

THE 3 MAJOR CHALLENGES SURROUNDING A REPOWERING PROJECT

Regulatory, legal and technological challenges must be taken into account when considering a repowering project

3 major challenges surrounding a repowering project

The success of a repowering project depends on the operator's ability to take into account the various challenges surrounding repowering at an early stage.

Challenge 1
Regulatory

Depending on the modifications selected for the renewal of the park, the time spent on the new project to **obtain the necessary regulatory authorizations** can vary from **a year to 7 years** and influence the energy production capacities

Challenge 2
Technological offer

The evolution of the technological offer between the year of construction of the wind farm and its dismantling will increase the production capacity. The number of turbines to be renewed to maintain the same level of production may therefore be lower than the initial number of turbines, but regulatory requirements must be taken into account when choosing the size and power of the turbines.

Challenge 3
Legal

Depending on the modifications selected for the renewal of the park, the renewal can be considered as a new project. In this case, a project definition, which is as demanding as for a new project, is required, as well as an application for an **environmental impact assessment permit and sometimes associated to a public enquiry process**.

These challenges will influence the type of repowering according to various criteria that can be aggregated

- **Wind turbine size**
- **Addition of new towers**
- **Blade size**
- **The power of the rotor**
- **Tower location**

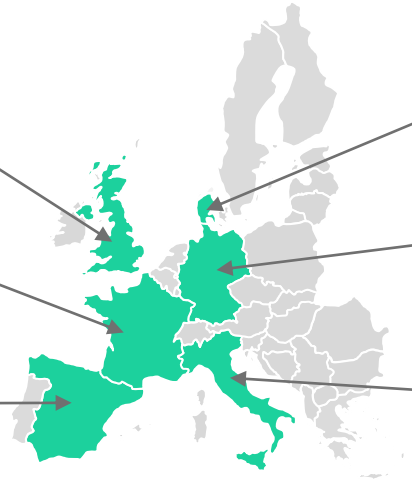
Repowering regulations around Europe

In most legislations, repowering is not necessarily simplified from a regulatory point of view compared to a new park, it must be subject to the same studies

UK
New permit required regardless of repowering type

France
Does not recognize extension but recognizes repowering, eligible for a purchase contract (remuneration complement), generally associated with a new permit

Spain
No specific legislation regarding expansion or repowering



Denmark
New permit required and same constraints as a new windfarm regardless of the kind of repowering

Germany
Repowering considered as a new project with permit required and benefits from the financial support applicable to wind energy

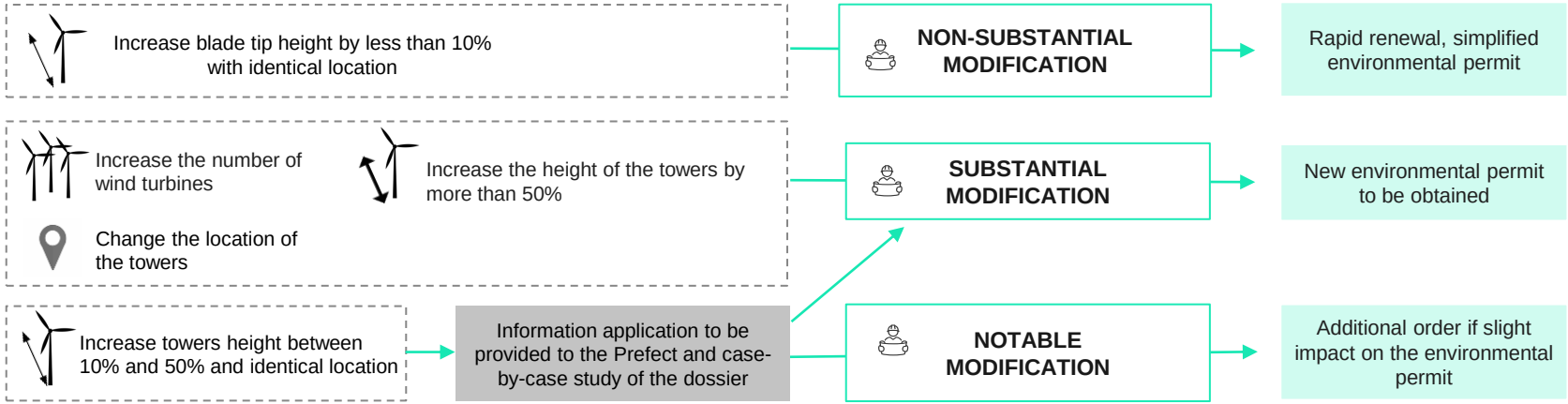
Italy
Incentives for expansion, new permit required for any repowering and support system for renewal via feed-in tariff obtained by participating in RFPs

Source : WindEurope

The levers for triggering a renewal are very diverse at the European level because they are at the intersection of three areas: Regulatory, Project economics and the Engineering Capabilities

The French exceptions for repowering: the specificities of wind farms modifications

The 11th of July 2018 circular introduces a **definition** for wind farm renewal as well as a **distinction** in the type of renewal, setting out the rules for assessing wind farm modification projects for government agencies (administrations and prefectures). The operator must carefully consider its modification choice, in view of the resulting regulatory obligations.



For wind turbine developers, it is therefore better to promote projects benefiting from a simplified procedure if they want to carry them out within a reasonable timeframe. Especially since in this case, they also benefit from the acquired rights of the old regulations, which have often become stricter over the years.

The evolution of the technological offer available to developers

The wind energy sector has made a **technological leap** in the recent years. Current technologies allow the operation of new wind farms that are **twice as efficient** as the older ones. **Recent models are achieving unprecedented performances, which are based on an increase in the size of the wind turbines**. However, this can complicate the acceptability of projects. The **availability of technologies** will also influence the choice of renewal.

An opportunity in terms of energy production for energy operators

A quickly evolving technology

In almost 20 years, wind turbines have increased their capacities significantly

- **+350%** of installed capacity, 2.8 MW in 2021
- **+90%** in size, reaching up to 190m
- **+ 100%** increase in blade length (80m)

Repowering is an opportunity for operators to enhance the potential of their older wind farms with new market technologies. Repowering allows, by using new technologies, to increase the yield of existing farms

A technological offer limited to large and powerful models, which can create additional constraints

The growth in the size of wind turbines leads to an increase in impacts

- on landscapes
- on aerial activities
- on the environment and biodiversity

+

An increased need for connection

Significant additional connection requirements could be necessary. The capacity increase potential related to renewal must be anticipated to evaluate the interconnection needs and not to limit the power that could be injected into the grid.

Older models out of the market and new sizes that do not fit certain repowering constraints

Repowering projects are constrained by regulations, and new models of wind turbines are not suitable for any repowering project: the operator cannot choose the new models if he wants a near-identical renewal, as the dimensions have grown too much compared to the initial turbines.
Furthermore, smaller and less powerful wind turbines are no longer available on the market. In France, the installation of old models bought on specialized second-hand websites, such as Wind-turbine.com or sparesinmotion.com, is forbidden. Thus near-identical renewal is not always possible.

Repowering projects are not guaranteed in advance and can face different risks

Due to regulatory changes, a significant proportion of the wind farms installed in the 2000s are now subject to new space and height **constraints**. Due to the omnipresent obstacles, the delays in the instruction and appeal process, and the uncertainty of the calls for tender, producers do not always have the possibility to quickly renew their wind farms after the end of the remuneration supplement. The possibilities of repowering, especially with larger and more powerful wind turbines, will not always be successful and they face two major legal risks:

The request for a new environmental impact assessment

The project can be considered as a **new project**. Even if the preliminary studies surrounding the choice of the site do not arise, **expert assessments** lasting one year will have to be carried out: these will primarily be **updates or assessments** (noise, naturalistic, road, landscape, wind measurements, hydrogeological, consultation, etc.).
The **definition of the project** is just as demanding as for a new project, and an application for **environmental authorization** must be submitted

The environmental impact assessment request file

The project will require an **impact assessment** which is a proportionate analysis of the following issues:

- visual and sound nuisances
- disturbances on radars and air navigation (civil and military)
- Landscape, heritage and biodiversity

The investigation for the environmental authorization lasts few months, sometimes followed by a public enquiry in some countries, in order to decide whether or not the authorization should be granted by the region

The risks of administrative appeals

After the environmental authorization has been issued, even if the regional authorities approves the project, the project may be subject to **appeals which de facto suspend the project and the work in progress**. These appeals can **last up to 4 years**, especially if the Council of State (Conseil d'état) is seized.

Source: ADEME

Europe needs to install 250 GW of wind power by 2030 to meet its targets, of which 65 GW can be installed through repowering up to 2030

If every expiring wind farm was repowered with new turbines just twice as efficient

65 GW, ie more than the quarter of the European target by 2030

8 GW, ie 47% of the French targets by 2028

22 GW, ie 150% of the German targets by 2030

increase of capacities can be reached through repowering without having to look for new sites.

Wind power installation targets

250 GW of wind power by 2030 (1)

17 GW by 2028 (2)

16 GW by 2030 (3)

The dismantling of existing wind turbines, the refurbishing and the installation of new wind turbines **generate jobs** in :

- traditional wind farm development
- waste management professions.

Repowering also allows local jobs to be sustained (maintenance in particular) by prolonging the activity of the farm.

All of the jobs created are not relocatable elsewhere.

(1) Objective written in the Renewable Energy Directive (REDII)
(2) Objective written in the MEP (Multiannual Energy Plan) objective
(3) Objective written in the Renewable Energy Act (EEG Erneuerbare-Energien-Gesetz)

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